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## **The influence of bilingualism on speech production: A systematic review**

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**Running head:** Systematic review of bilingual speech production

**Key words:** *bilingual, multilingual, speech production, speech sound disorder*

**Declaration of Interest**

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

## **Abstract**

**Background:** Children who are bilingual and have speech sound disorder are likely to be under-referred, possibly due to confusion about typical speech acquisition in bilingual children.

**Aims:** The aim of this review was to investigate what is known about the impact of bilingualism on children's acquisition of speech in English to facilitate identification and treatment of bilingual children with speech sound disorder.

**Methods:** A systematic review of studies from the last 50 years was conducted. Studies investigating speech acquisition in bilingual infants and children (where one language was English) were identified through searching 7 electronic databases, bibliographies of relevant articles and emailing authors. Sixty six studies investigating bilingual speech production met inclusion criteria, with 53 describing typically developing children and 13 describing children with speech sound disorder. The 66 studies were analysed thematically and summarised in terms of methods, key findings and underlying theories.

### **Main Contribution:**

There was limited evidence to suggest that bilingual children develop speech at a slower rate than their monolingual peers; however, there was evidence for qualitative differences and increased variation in speech production. Nearly all studies provide evidence for transfer between the two phonological and language structures, although the amount of transfer varied between studies. There was evidence of positive and negative transfer of features from the dominant language (L1) to the second language (L2) as well as from L2 to L1. Positive transfer became more evident with increased age and length of exposure to a second language. More recently researchers have moved away from investigating whether there are one or two phonological systems and accept that there are two systems that interact. Interest has shifted to

examining how phonological systems interact and to identifying factors that influence interactions. The review revealed a number of inconsistencies in the findings of studies due to differences in methodology, languages investigated, and degree of language exposure. Overall, measurement issues were addressed well but most studies provided limited sample information about language experience, schooling and socio-economic status.

**Conclusions:** There are differences in speech sound acquisition between monolingual and bilingual children in terms of rate and patterns of error, with both positive and negative transfer occurring in bilingual children.

## **Introduction**

In recent years, there has been a rise in the number of school children who speak languages other than English in English speaking countries. In England alone the 2010 schools census showed that 16.0% of pupils in primary schools (age 4-11) and 11.6% of children in secondary schools (age 11-16) were known or believed to speak English as an additional language (Department for Education 2010), an increase from 14.3% and 10.6% respectively in 2008 (Department of Children, Schools and Families 2008). Figures in some other English speaking countries are higher, with 21% of children of school age in the US speaking a language other than English at home (Federal Interagency Forum on Child and Family Statistics 2010) and 22% of children in the state of Victoria in Australia (State Government Victoria 2009). Moreover the range of languages spoken is extensive with 240 different languages reported for those children whose first language is other than English in the 2008 England schools census alone (Department of Children, Schools and Families 2008).

The majority of SLTs who work with children in predominantly English-speaking countries have at least one bilingual child on their caseload (Skakan, Watson and Lof 2007; Williams and McLeod, 2012; Winter 1999). It would be reasonable to expect that the figures for numbers of children referred to speech and language therapy would reflect these percentages of children whose first language is not English. However, the evidence to date suggests that this is not the case. Winter (1999, 2001) found that bilingual children in the UK were both under- and over-represented in speech and language therapy caseloads. Where referrals for children with speech sound disorder alone are considered, referrals for bilingual children have been shown to be almost half that compared to children who are monolingual (Stow and Dodd 2005).

If a child is referred, clinicians may be struggling to follow recommended practices regarding assessment for bilingual children, such as those provided by the Royal College of Speech and Language Therapists (RCSLT) (2007). Caesar and Kohler (2007) surveyed speech and language therapists (SLTs) in the US regarding their assessment of bilingual children on their caseload. They found that there was a heavy reliance on the use of formal standardized measures even though the evidence reports that these are inadequate due to under representation of bilingual children in normative samples and linguistic and content bias (De Lamo White and Jin 2011). Moreover, only 70% of respondents indicated that they used interpreters to assist them with assessment and only 53% consistently assessed children in their native language. Williams and McLeod (2012) surveyed 128 Australian SLTs regarding their work with multilingual children and similarly found that English was the primary language used during assessment, informal rather than standardized measures were preferred, and 50.5% assessed multilingual children's speech without assistance from others (including interpreters).

Opinions about why referral processes and assessment procedures are less than optimum vary. Kritikos (2003) reported that clinicians' own language skills are relevant in a survey of SLTs in the US. Those SLTs who were proficient in more than one language regarded themselves as more competent in the assessment of bilingual children compared to monolingual SLTs. In addition, Stow and Dodd (2003), in their review of the literature relating to provision of speech and language therapy for children who are bilingual, argue that there is a need for more assessment tools, training and research in order to improve current referral and assessment practices for this client group.

Winter (1999) considers that lack of knowledge about bilingual children and their needs is largely responsible for current referral and assessment practices as it is and highlights the need

for more information for speech and language therapists regarding typical and atypical development in children learning two or more languages. Similarly, Kohnert (2010) comments that an understanding of typical development in dual language learners is vital for a reliable assessment of a child's speech and language development and subsequent management. There is a need therefore to review and summarise evidence regarding typical as well as atypical development of children's speech within a bilingual environment.

The current review was limited to studies of speech rather than speech and language in order to narrow the search and restrict the likely range and precision of emergent themes. Speech development was selected over language as children whose speech was a cause for concern were identified by Stow and Dodd (2005) as having lower referral rates compared with monolinguals in their investigation of referral procedures. Both speech perception and speech production skills are acknowledged as important in acquiring adult like competence in the production of one's language(s). Indeed the Stackhouse and Wells (1997) model of speech processing provides a useful hierarchy of the range of skills necessary for a child to acquire speech with a clear delineation of input (speech perception) and output (speech production) processes. Therefore, studies addressing speech perception, speech production and speech processing skills were included in the review; however, the focus of this paper is on studies addressing speech production in bilingual environments. Further papers are planned to report on studies relating to speech perception and speech processing skills.

#### *Definitions of bilingualism*

This review has focused specifically on the development of speech in children who are exposed to bilingual or multilingual environments. However, definitions of bilingual and multilingualism vary in the literature and children described as bilingual are a more heterogeneous group than



those described as monolingual. Variation in the number of languages that they are exposed to, the age and timing of that exposure and the degree of proficiency in each language will all impact on the child's progress in their speech development across each of the languages they speak.

Grech and McLeod (2012) have summarised the breadth of definitions of bilingualism within the language acquisition literature into three categories: i) bilingual exposure from birth ii) using more than one language in day to day functioning and iii) a continuum of use and proficiency of more than one language. These distinctions have important implications for sampling and subsequent interpretation of findings from studies. The intention of this review is to explore the breadth of studies that have examined bilingual or multilingual speech sound acquisition, therefore any study whose intention is to investigate infants or children whom the study authors' consider bilingual or multilingual is considered of interest and definitions of bilingualism are explored as part of the investigation.

#### *Children's speech acquisition*

The acquisition of speech, whether by monolingual or bilingual speakers, can be simplified into three phases: input → storage → output and the psycholinguistic model by Stackhouse and Wells (1997) provides a useful framework of skills necessary for each phase. Speech perception (input) requires the ability to hear a sound and recognize that it is a speech sound within the ambient language. Speech processing (storage) requires the ability to process words phonologically and semantically. Speech production (output) requires motor planning and execution via nerve pathways and oromusculature. Each of these skills is important for acquiring a competent speech sound system. When children acquire one language, identification and production of phonemes and words within the ambient language can take a number of years to

master. When children are exposed to and acquire more than one language, additional storage and pathways are necessary. Debate in the literature regarding the dual-systems model (Paradis 2001) and the presence or absence of separate phonological systems for each language is fuelled by the multiplicity of findings across different language groups and populations. Historically, bilingual children were seen as being at a disadvantage for English speech and language proficiency. However, more recently, when all languages spoken by children are considered, bilingualism has been found to be both an advantage and a disadvantage to their overall speech and language proficiency. Goldstein and McLeod (2012) refer to this respectively as positive transfer – where bilingual children are advanced in their development compared to their monolingual peers, and negative transfer – where the reverse occurs. Given the heterogeneity within the population of bilingual children, it is likely that there will be variation in the degree to which bilingualism provides positive and negative transfer. Moreover, variations within languages in terms of phonetic complexity, functional load and phonetic frequency (Ingram 2012) may further confound findings as comparisons of some language pairs may yield different results to others.

#### *A systematic review*

Given the apparent diversity of the literature, it was decided that a systematic review was needed to understand the influence of bilingualism on speech acquisition, since the systematic review is less prone to bias in the selection and interpretation of studies. The review therefore provides an explicit description of the terms used to search for studies and of the criteria used to include and appraise studies. We have not limited the design of included studies, but have included a review of the design types in the quality appraisal process. A meta-analysis of effect

sizes was not possible because of the variety of designs used but also because the variety of measures used in the analysis of the components investigated. The synthesis can therefore be viewed as a narrative synthesis.

The aim of this investigation was to systematically review empirical studies of speech acquisition in children who are exposed to English plus at least one other language that have been published in the last 50 years. The objective was to investigate how speech sound acquisition is affected when children who are typically developing or disordered in their development are learning English in the context of exposure to other languages. The review was limited to studies of bilingual children exposed to English in order to restrict the diversity of language contexts to more easily allow comparisons across studies.

## **Method**

### *Inclusion and exclusion criteria*

Studies were included if they were peer reviewed articles and book chapters published between 1960 and September 2010; they addressed any aspect of speech acquisition, including speech production, speech perception, and speech processing skills; they involved individuals under 18 years reported to be *bilingual* or *multilingual* by the study authors, with one language including English; and the abstract was available in English. Studies were excluded if their focus was on other aspects of language acquisition such as grammar, vocabulary or literacy. All included studies were assigned to one of the three categories of speech production, speech perception, and speech processing, dependent on the purpose and design as described in the publication. Only studies that fell within the speech production category are included in this report.

### *Search methods*

The search words in Table 1 were entered into 7 electronic databases (PsychINFO, Medline, CINAHL, Embase, British Nursing Index, AMED and CSA) in April 2009 and again in September 2010. All abstracts were screened by the first author and relevant articles were retrieved. Bibliographies of review and study articles were also searched and authors known to the reviewers in the field were contacted to see if they had conducted studies that were in press. Book chapters were only included if they described studies that had not been published elsewhere.

[Insert table 1 here]

### *Terminology*

The search was inclusive of studies involving children speaking more than two languages; however, all studies investigated bilingual infants or children except for one case study of a trilingual child with speech sound disorder (Ray 2002). Therefore, the term *bilingual* is used instead of *multilingual*. For this review, the terms *papers* and *studies* are used purposefully, and refer to different phenomena. The number of *papers* describes the number of journal articles plus the number of book chapters. The number of *studies* relates to the number of research investigations (since some papers included more than one study, and some studies were described in more than one paper). Studies involving the same sample of children are marked with an asterisk in the appendices' summary table. Throughout this article the term *speech sound disorders* is used to refer to all children who have, or are suspecting of having, speech sound disorders with or without concomitant language disorder(s). The term is used inclusively to encompass both articulation and phonologically-based problems. The terms that study authors

have used can be found in the summary table in the Appendices and are also used in the text where individual studies are described in detail.

### *Narrative synthesis*

The following information from each article was also recorded into a spreadsheet by the first author: sample information (including number of participants, age at assessment, age at follow up, languages spoken, bilingual status, presence or absence of speech sound disorder); study design; underlying theories; assessment methods; summary of findings; and study limitations. Summaries of findings, study limitations, assessment methods and underlying theories were analysed thematically and frequencies of languages spoken, bilingual status and study designs were calculated. Studies of children who were typically developing were considered separately from those which included samples of children with speech sound disorders. Findings for these two groups are reported separately in the results below.

### *Study design and quality appraisal*

The range of study designs was summarized for all 66 studies and issues relating to quality appraisal were identified. It was initially envisaged that the quality of each study would be assessed using a numerical score; however, given the range of study designs included, a description of limitations of each study was more appropriate. This is consistent with the guidance from Marshall *et al.* (2011) regarding the over reliance on simple checklists in their report on the application of systematic reviews in speech and language therapy. In addition, the following questions relating to quality were asked of each study. What design was used? Were the aims clearly stated? Was potential sample bias assessed? Were participation rates described?

Were participants randomly selected? Were valid data collection tools used? Were analysts blind to participants? Was the reliability of coding/analyses checked?

#### *Inter-rater reliability*

A sample of the studies retrieved was reviewed by the second author for inclusion in the review, quality appraisal and categorization to speech perception, speech production and speech processing skills. A total of 14 studies were subject to this reliability check and the authors agreed on all but two of them (86% reliability). Where there was disparity, the reviewers discussed findings and reached consensus regarding both the inclusion and categorization status of each.

### **Results**

A total of 1,407 abstracts were located during the database searches and a further 6 through contact with authors. Of these, 114 were identified as potentially relevant. A further 92 were identified through bibliography searches of these articles, resulting in a total of 206 papers. On inspection, 93 papers were identified as meeting the inclusion criteria and were categorized as follows: 63 addressed speech production, 24 speech processing skills and 6 speech perception. Within these 63 papers addressing speech production, 66 studies were reported and are described within this paper. The majority (53) of studies involved typically developing participants while 13 involved children with speech sound disorder. Figure 1 summarises the identification process.

[Insert Figure 1 here]

Studies investigated speech sound acquisition in 23 different known bilingual language populations (see Table 2). The most commonly studied was Spanish-English, followed by Cantonese-English, Pakistani heritage languages-English, Welsh-English, Arabic-English, French-English, Italian-English, Korean-English, and Dutch-English.

[Insert Table 2 here]

### *Speech production in typically developing bilingual children*

#### *Appraisal of study designs*

Fifty three studies investigated speech production in typically developing bilingual children (see Appendix A). Eighteen studies were exploratory case studies (14 single case studies and 4 multiple case studies), 15 used a case control design to investigate differences in speech production between bilingual children and typically developing monolingual children and 20 cohort observation studies investigated speech production in bilingual populations and made comparisons to acquisition norms. A summary of the study designs is shown in table 3.

[Insert Table 3 here]

The eighteen case studies investigated interactions between a child's two developing phonologies. The studies were typically longitudinal and involved bilingual children under the age of 4 years, although several involved children up to 12 years of age. Only one early case study relied solely on diary entries (Celce Murcia 1978), all other studies tended to use a combination of observation approaches: audio or video recording of spontaneous and prompted speech and used a diary to record observations at regular intervals.

The fifteen case control studies and cohort observation studies commonly investigated phoneme repertoires, phonological error patterns and articulation errors of children between the ages of 2 and 6 years. Only a handful of studies reported speech sound acquisition patterns with large samples of bilingual children: 286 Pakistani children living in the UK (Stow and Pert 2006), 83 children growing up in Wales (Ball *et al.* 2001a, 2001b, 2006, Munro *et al.* 2005) and 93 bilingual children in Malta (Grech and Dodd 2008). Other characteristics of speech production that have been investigated are Voice Onset Time (VOT), voice pitch, rhythm, prosody and fluency (Deutchar and Clark 1996, Fokes *et al.* 1985, Ng *et al.* 2010, Simon 2009, Yavaş 2002).

Frequently used measurement tools include picture naming to elicit target words, such as the *Goldman-Fristoe Test of Articulation* (Goldman 2000), the *South Tyneside Assessment of Phonology* (STAP) (Armstrong and Ainley 1988), the *Cantonese Segmental Phonology Test* (So 1993) and the *Bilingual English Spanish Assessment* (BESA) (Peña *et al.* 2007). Other methods of elicitation of speech included sentence repetition and speech samples collected through free play. The majority of studies assessed accuracy by measuring the percentage of consonants correct (PCC) or the percentage of vowels correct (PVC). More recent studies explored other ways to measure speech accuracy by assessing different speech units, such as the phonological mean length of utterance (pMLU) (Bunta *et al.* 2009, Burrows and Goldstein 2010), proportion of whole word proximity (PWP) (Bunta *et al.* 2009) and early, middle and late developing sounds (EML) (Fabiano-Smith and Goldstein 2010a).

*Summary of findings regarding typical bilingual speech sound acquisition*



A number of theoretical and applied questions have been addressed relating to typical bilingual speech sound acquisition. One frequent aim has been to identify patterns of speech acquisition for typically developing bilingual populations and to examine whether patterns of acquisition differ to monolingual acquisition in one or both of the languages in terms of the rate and order of acquisition of phonemes and the presence of developmental error patterns. Bilingual language populations where phoneme repertoires and developmental error patterns have been explored include Spanish-English (Brice *et al.* 2009, Fabiano-Smith and Barlow 2010, Gildersleeve-Neumann *et al.* 2008, Goldstein and Bunta 2010, Goldstein and Washington 2001, Goldstein *et al.* 2005, Yavaş and Goldstein 2006), Maltese-English (Grech and Dodd 2008), Pakistani heritage languages-English (Holm *et al.* 1999, Stow and Pert 2006), Welsh-English (Ball *et al.* 2001a, Ball *et al.* 2001b, Ball *et al.* 2006, Munro *et al.* 2005), Cantonese-English (Holm and Dodd 2006), Mandarin-English (Lin and Johnson 2010), Russian-English (Gildersleeve-Neumann and Wright 2010) and Samoan-English (Ballard and Farao 2008). Studies provide a mixed, complex picture in terms of rate of acquisition of phoneme repertoires with some studies showing evidence of delayed acquisition of sounds in English (Bunta *et al.* 2009, Dodd *et al.* 1996, Fabiano-Smith and Goldstein 2010a, Gildersleeve-Neumann and Wright 2010, Gildersleeve-Neumann *et al.* 2008, Holm and Dodd 2006, Stow and Pert 2006), others finding no difference in rate of acquisition (Burrows and Goldstein 2010, Fabiano-Smith and Barlow 2010, Gildersleeve-Neumann and Wright 2010, Goldstein *et al.* 2005, Lin and Johnson 2010) and two studies observing accelerated acquisition compared to monolingual peers in English (Goldstein and Bunta 2010) and in Maltese (Grech and Dodd 2008). Evidence from these studies in terms of the rate of bilingual acquisition compared to monolingual acquisition is complicated by factors such as language dominance and is explored in more depth in the discussion.

Typically developing bilingual children tend to show a different pattern of development to their monolingual peers. Children who speak Pakistani heritage languages and English (Holm *et al.* 1999), Cantonese-English (Dodd *et al.* 1996, 1997, Holm and Dodd 2006), Russian-English (Gildersleeve-Neumann and Wright 2010), Spanish-English (Goldstein and Washington 2001) and Samoan-English (Ballard and Farao 2008) produced atypical developmental errors in one or both languages as well as delayed and more frequent use of some typical developmental errors. Authors often discussed these errors as evidence of interactions between the lexical structures and phonological characteristics of specific language pairs. There was not only evidence for transfer from the dominant language (L1) to the language acquired later (L2) (Anderson 2004, Ball *et al.* 2001a, Ball *et al.* 2001b, Brice *et al.* 2009, Sato 1984) but there was also evidence of transfer from L2 to L1 in terms of voice onset time (VOT) (Simon 2010, Yavaş 2002).

A theoretical question frequently addressed in early case studies, but also using other study designs is whether there was evidence for separate phonological systems or a unitary system. Only two studies (Schnitzer and Krasinski 1994, Vogel 1975) argued for a unitary phonological system which develops into two systems around age 2 years. The majority of subsequent studies have argued for separate phonological systems based on one or more observations that phonemes shared in both languages are often acquired in one language before another and different phonological errors are observed in each language. More recently researchers have moved away from questioning whether there are one or two phonological systems and accept that there are two systems that interact. Investigations are more focused on finding evidence of positive and negative transfer and cross linguistic effects.

## *Speech production in bilingual children with speech sound disorder*

### *Appraisal of study designs*

Thirteen studies involved participants with suspected or formally diagnosed speech sound disorder. Most frequent language populations studied were Spanish-English (3) and Pakistani heritage languages-English (3). These studies are listed in the Appendix B and designs are summarised in Table 3. A range of approaches were used to identify children as having speech sound disorder. In some cases, terms such as phonological or articulation delay or disorder were used. In other studies, less specific terms such as “late talker”, “attending language unit” or “receiving speech and language therapy” were used. Some studies described the language status of the child rather than speech specifically and children were described as having specific language impairment or having speech and language delay. Some studies also included children with more general learning difficulties.

Nine case studies (three single case studies and six multiple case studies) investigated a total of 18 bilingual children with speech sound disorder. Four of the case study reports explored whether error types shown in the child’s speech fell into one of Dodd’s four classification of disorder categories of articulation, delayed phonology, disordered phonology with consistent errors and disordered phonology with inconsistent errors, and/or the extent to which there was evidence for one unitary or two separate phonological systems (Dodd *et al.* 1997, Holm *et al.* 1997, Holm and Dodd 1999b, Ray 2002). Three case studies explored different therapeutic approaches taken with children with speech sound disorder (Holm, Dodd and Ozanne 1997, Holm and Dodd 1999c, Ray 2002). The remaining case studies considered phoneme inventories and contrastive variants in Welsh-English children (Ball *et al.* 2006), phoneme error patterns in

children from Pakistani heritage families (Holm *et al.* 1999) and differences in VOT (Konefal and Fokes, 1981).

Two studies used cohort observation methods to explore speech sound acquisition in bilingual children with and without speech sound disorders (Yavaş 2010) and to investigate differences between bilingual and monolingual children attending language units (Crutchley *et al.* 1997). The remaining two studies used case control designs (one prospectively and one retrospectively) to compare typically developing bilingual children with monolingual children with speech sound disorders (Cataño *et al.* 2009, MacLeod and McCauley 2003).

*Summary of findings regarding bilingual speech sound acquisition in children with disorder*

Given the lack of knowledge about typical speech acquisition in bilingual children and consequently a lack of knowledge about delayed and/or disordered speech sound acquisition in this population, the majority of studies focused on issues relating to identification of disorders. Within the four case studies which investigated Dodd's classification of speech sound disorder (Holm and Dodd 1999b, Holm and Dodd 1999c, Holm *et al.* 1997, Holm *et al.* 1999), two children made inconsistent errors in both languages, supporting the classification of inconsistent speech disorder. One of the other children produced delayed, typical developmental errors but very few atypical errors. This case was interpreted as evidence for disorder within the 'delayed phonological skills' category, however, given that there had been no prior concern with this child in regard to their speech development, it is possible that the delayed phonological skills were a manifestation of typical cross-linguistic transfer rather than disorder. The case studies provide tentative support for Dodd's classification categories, however as there was little information

provided about case selection, and potential confusion between manifestations of cross-linguistic transfer and disorder, it is difficult to draw firm conclusions.

Some of the studies which considered children with speech sound disorder explored the challenges of distinguishing between disorder and cross-linguistic transfer. Yavaş found very little difference between the Spanish-English children with phonological disorder and their typically developing bilingual peers, in the productions of /s/ clusters (Yavaş 2010, Yavaş and Barlow 2006). Similarly, a Cantonese-English child's production of atypical articulation and phonological errors were considered evidence for disorder when compared to monolingual developmental error patterns; however, comparison with a small sample of typically developing Cantonese-English children revealed that these errors were typical for Cantonese-English bilinguals and should not necessarily raise concern. In addition, a case of a 3-year-old with a history of delayed speech acquisition (Dodd *et al.* 1997) produced atypical error patterns in English that were evident in a typically developing bilingual sample; however, atypical error patterns were observed in Cantonese that were not evident in typically developing bilingual's Cantonese. Examples such as this support the argument for assessment in both languages and suggest taking a careful history of acquisition in both languages to inform referral decisions.

Studies comparing speech acquisition in bilingual children with speech sound disorder with monolingual children with speech sound disorder and/or typically developing bilingual children report mixed results. MacLeod and McCauley (2003) found that French-English 7-8 year olds with SLI were attempting more complex words than monolingual children with SLI, but were also significantly less accurate compared to monolingual children with SLI when assessed on the percentage of consonants correct (PCC). Ball *et al.* (2006) observed restricted phonetic inventories in a child with speech and language delay and a child with learning

difficulties, whereas MacLeod and McCauley observed similar phonetic inventories across bilingual and monolingual children with SLI and typically developing monolingual children. In addition, age did not predict the level of complexity of phonological inventories in monolingual children with SLI and typically developing bilingual and monolingual children (Cataño *et al.* 2009). Cataño noted that individual variation in complexity of phonological acquisition was not confined to children with speech sound disorder, but was also observed in typically developing bilingual and monolingual children. Crutchley *et al.* 1997 assessed children attending language units on an articulation task and did not find any differences between bilingual and monolingual children; Konefal and Fokes (1981) observed a different pattern of voice onset time (VOT) for a language delayed Spanish-English 10 year old compared to their typically developing younger siblings. The array of findings from the small number of studies that have compared speech sound acquisition in bilingual children with speech sound disorders with monolingual children with disorders and/or typically developing bilingual children highlight some of the challenges faced by speech and language therapists and teachers to identify speech sound disorders in bilingual children and the need for further research to improve identification.

Only three studies investigated intervention approaches. One case study explored two different therapeutic approaches, one articulation and the other phonological (Holm and Dodd 1997). Both therapeutic approaches were successful; however, articulation therapy was found to transfer from one language to the other, whereas the phonological therapy was only successful in the target language. A second case study investigated a core vocabulary therapeutic approach that was aimed to enhance underlying phonological planning of a Punjabi-English 5-year-old (Holm and Dodd 1999c). A treatment effect was seen in both languages even though intervention targeted English only, suggesting that it was successful in improving phonological

planning skills underlying both languages. The third case study described intervention in English using a cognitive linguistic approach for a trilingual 5-year-old who made inconsistent productions of speech sounds across all languages (Ray 2002). After 14 sessions of intervention, consonant accuracy improved and error patterns were reduced. However, it was not clear whether transfer to the other languages occurred because the child was not assessed in Hindi or Gujarati post-intervention. Further studies are needed to examine the efficacy of different therapeutic approaches in one or both languages.

#### *Differences in defining bilingualism impacts interpretation of results*

For all studies that were testing a bilingual population using a cohort or case-control methodology (n=39) (i.e. not case studies), the definition and method of assessment of *bilingualism* was investigated. It was found to vary considerably from study to study. Eleven studies defined bilingual children as those who have two non-English speaking parents who live in an English-speaking country and who predominantly speak one non-English language in the home. The children were often first introduced to English formally at school. Typically, these studies involved Hispanic populations living in the US (Yavaş 2002) and Pakistani and Cantonese populations living in the UK and Australia (Dodd *et al.* 1996, Holm *et al.* 1999). This approach did not take into account exposure to English via siblings and other caregivers and through surrounding cultural mediums such as television and radio.

Sixteen studies used language background questionnaires to elicit more detailed information about individuals' exposure to and proficiency in different languages (e.g. Restrepo 1998). Some of these studies were conducted in locations where bilingualism is prevalent, such as Wales and Malta (Ball *et al.* 2001, Grech and Dodd 2008, Munro *et al.* 2005) and other more

recent studies were conducted with Hispanic populations in the US (Bunta *et al.* 2009, Burrows and Goldstein 2010; Fabiano-Smith and Barlow 2010, Fabiano-Smith and Goldstein 2010a,b). Individuals were often classified as either *dominant* in one of their languages or *bilingual* (simultaneous bilingual children) based on estimations of exposure and language use.

There was variation across studies as to how ratings were used for classification. For example in one study individuals were placed in the *dominant* category if their language use in one language was more than 80% of the time and were classified as *bilingual* if between 21 – 79% of the time (Goldstein *et al.* 2005). Another study considered individuals to be *bilingual* if language use in both languages was between 35% – 65% and *monolingual* if speaking a language more than 80% of the time (Bunta and Ingram 2007). Other methods were also used to classify individuals as bilingual. These included loose definitions such as “knowledge present in more than one language” (Goldstein and Washington 2001, pg 155) and more specific definitions, such as “substantial exposure to both languages due to there being one or more consistently present caretaker being a native speaker” (Oller *et al.* 1997, pg 410). Five studies did not describe how the bilingual population had been identified.

Categorisation of bilingualism partly depends on the goal of a study and the bilingual population under investigation as there are many different linguistic contexts in which the study of bilingual speech sound acquisition is undertaken. For example, investigators carrying out an experimental study in a country where two languages are dominant may be more concerned about the relative exposure and use of each language compared to investigators who are concerned with identifying speech sound disorders in a more linguistically diverse bilingual population living in a predominantly English-speaking country. However, in order to compare findings across studies and languages there needs to be greater consensus regarding classification



of bilingual status. Categorisation may be facilitated by the use of a detailed description of language background using a questionnaire or interview (Paradis, Emmerzael and Duncan 2010). Any description will need to take account of cultural language use patterns; however, individual variability in language use is a challenge to any population research.

### *Differences in quality of studies impacts interpretation of results*

#### *Sample bias*

Table 4 summarizes the quality appraisal for all studies. Risk of sample bias confounding the findings was a problem within the majority of studies. Only two studies (Crutchley *et al.* 1997, Grech and Dodd 2008) provided information about how participants were recruited and the proportion of participants who agreed to take part. Therefore, it was difficult to assess the risk of bias in many studies due to the lack of information. In addition, only three studies (Goldstein and Bunta 2010, Goldstein *et al.* 2010, Goldstein and Washington 2001) reported randomly selecting participants. This low figure is not necessarily surprising given that bilingual children were often a minority population and may have been hard to locate and recruit in large numbers. However, it was unclear as to whether some studies considered potential confounding factors, such as education experience, language experience and variations in dialect. Sample bias was considered in 48.7% of studies in terms of assessing one or more of SES, education, and language exposure. Goldstein *et al.* (2010) found that parental language input and language proficiency were significant predictors of speech sound accuracy in Spanish-English bilingual children, whereas frequency of language output was not. Therefore, it is important to understand the language input of participants to assist interpretation of findings.

[Insert Table 4 about here]

In case studies, selection of cases was also rarely described. Participants of 6 of 27 case studies were close relatives of the author, often the author's own son or daughter. As a parent, the researcher is in a privileged and unique position to be able to observe acquisition over a long period of time and record observations at regular intervals. However, alongside this advantage is the opportunity for bias for several reasons. Firstly, the researcher may selectively attend to language output that fits with their theories of speech acquisition, particularly if diary observations are analysed at the time of data entry, rather than being audio-recorded speech samples. Also, language is an interactive process. It does not develop in isolation and the researcher may subconsciously or consciously influence the child's speech output. Speech acquisition may also be accelerated in such an environment as it is a key interest of at least one of the parents and there is a potential bias for over observation in the language of the researcher and under observation of the child's other language use.

#### *Measurement quality*

Measurement issues were often addressed well in studies. The majority of studies (62.1%) used validated data collection tools or carefully developed the tools for use in an additional language. However, cultural and language differences in task performance had the potential to impact on measurement and were rarely considered. For example, Stow and Pert (2003, 2005) noted in their work with Pakistani heritage families that children are expected to show respect for adults by keeping silent in their presence. Therefore, the experience of assessment for Pakistani children was unusual for the children and the younger participants were sometimes reluctant to name simple objects. Many studies did not explicitly reflect on cultural and language influences on measurement.

#### *Reliability*

Over half of studies (56.1%) assessed the reliability of their analyses, but only 4.5% of studies reported the analysts were blind to participants. This low number may reflect reporting norms in linguistic, psychological and speech and language therapy research as it is possible that analyses were performed blind to participant identities and group allocation, even though this was not reported in publications. Also blinding may not have been possible for some studies, such as case studies, and may be difficult in practice because of the presence of accents. Many studies reported increased variation in bilingual speech sound production and acquisition compared with monolingual children, both within and between individuals, providing a further challenge to discrimination between populations, identification of speech sound disorder and determination of intervention targets.

## **Discussion**

### *Are bilingual children advantaged or disadvantaged for speech sound acquisition?*

Within the general monolingual population is an assumption that acquiring two languages simultaneously may delay speech sound acquisition in children due to increased demands on language learning capacities. Genesee et al. (2004) describe this as the limited capacity hypothesis. A contrasting view highlights the astonishing capacity of young children for multiple language learning at an early age and the lack of evidence for delayed acquisition. Clarification of whether exposure to, and use of, more than one language in childhood is an advantage or disadvantage for speech acquisition has important implications for parenting, formal and informal education, and speech and language therapy in bilingual contexts.

Ten studies in the review compared phoneme repertoires and phonological error patterns in monolingual and bilingual populations. Eight of these have investigated Spanish-English

populations, enabling comparisons across studies more easily. Three studies provide evidence for negative transfer in speech production skills in Spanish-English bilingual children compared to their English-speaking, monolingual peers. Specifically performance was worse in the production of consonant clusters in English (Gildersleeve-Neumann *et al.* 2008); and in the accuracy of consonant production (PCC), phonological Mean Length of Utterance (pMLU) and proportion of whole word proximity (PWP) in English more than Spanish (Bunta *et al.* 2009). A third study compared bilingual children with their Spanish and English monolingual peers and found that bilingual children were less accurate at Spanish consonant production (PCC) and English early developing sounds (Fabiano-Smith and Goldstein 2010b). In contrast, three other studies found no difference between bilingual children and monolingual children: in the complexity of their phonetic inventories in both languages (Fabiano-Smith and Barlow 2008); PCC for English (Fabiano-Smith and Goldstein 2010a); and in pMLU or PWP in both languages (Burrows and Goldstein 2010).

Taken together, the findings of these studies (with the exception of the Fabiano-Smith and Goldstein, 2010b) suggest that bilingual children's production in English may be more negatively affected than their Spanish. This disadvantage for English over Spanish may reflect the quantity and quality of English language exposure and teaching and the dominance of Spanish, rather than the impact of bilingualism per se (Goldstein *et al.* 2010). Indeed, a recent study controlled for language use and proficiency and consequently observed a bilingual advantage with higher scores for proximity, the percentage of vowels correct (PVC) and PCC for nasals in English by 5- to 6-year-olds compared to their monolingual peers (Goldstein and Bunta 2010). Interestingly, in this study there were no differences in accuracy or complexity between bilingual children and monolingual children for Spanish productions. One other study has found

similar evidence for positive transfer. Maltese-English 5- to 6-year-old children made fewer articulation and phonological errors compared to their monolingual Maltese peers, but there was no bilingual advantage for younger children (Grech and Dodd 2008). Malta also provides a different bilingual-English context compared with immigrant bilingual populations in the US, UK and Australia that are more commonly studied. Maltese is spoken widely as a native language but English is seen as a prestigious language, used increasingly in education and literacy (Grech 2006). It is unclear whether cultural and socio-economic status (SES) factors may have confounded findings.

Both studies that found positive transfer involved older children and it is plausible that positive transfer becomes more evident with age and length of exposure to a second language. Indeed, positive transfer has also been observed in 5 to 6 year old bilingual children for speech processing skills, such as sublexical and syllable deletion (Campbell and Sais 1995), rime awareness (Bruck and Genesee, 1995) and phoneme segmentation (Bialystok et al., 2003) and elision and blending (Marinova Todd et al., 2010). In addition, enhanced working memory and executive control have also been observed in bilingual children (Bialystok 2011). Further research is required to understand the impact of language exposure, proficiency, age and cognitive development on positive and negative transfer. If positive transfer is in part a function of age and development, it would suggest that for bilingual children the critical time for development of bilingual speech acquisition may be longer than that for monolinguals in that developmental changes are ongoing at least up until 5 or 6 years and possibly beyond.

Authors of case studies and surveys of speech sound acquisition in bilingual children have interpreted observations in relation to recognised developmental acquisition norms. One large study (Stow and Pert 2006) provided some evidence that acquisition of consonants in

bilingual Pakistani heritage children was later than for monolingual, English-speaking children, although this may be in part due to cultural differences in the picture naming task, differences in English proficiency and SES. Holm and Dodd (2006) found Cantonese-English bilingual children in Australia were also less accurate when compared with English, monolingual norms; however, there was no difference between bilingual phoneme repertoires and Cantonese norms. Without careful, case control studies it is difficult to know whether later acquisition compared to monolingual norms is indicative of a bilingual population who has less exposure to and proficiency in English or whether they provide further evidence for negative transfer.

There is therefore a lack of strong evidence to suggest that bilingual children develop speech at a slower rate than their peers; however, there is evidence of qualitative differences and increased variation in speech production (Dodd *et al.* 1996, Holm *et al.* 1999, Yavaş and Goldstein 2006). These differences have been interpreted as evidence for transfer between phonological systems and are supported by the findings of case studies and surveys which show early acquisition of specific sounds that are found in both languages and delayed acquisition of other sounds. For example, a Romanian-English child's early production of /s/ and /t/ in English compared to monolingual children was interpreted as evidence of interaction of the two languages within a unitary phonological system due to the frequent occurrence of /s/ and /t/ in Romanian (Vogel 1975).

*What factors affect cross-linguistic transfer?*

Nearly all studies provide evidence for transfer between the two phonological and language structures, although the amount of transfer has been found to vary between studies (e.g. Keshavaz 2002 and Schnitzer and Krasinski 1994, 1996), between individuals (Cataño *et al.* 2009, Fabiano-Smith and Goldstein 2010b, Yavaş and Goldstein 2006) and within individuals (Frant Hecht 1982). Interpreting findings is complicated by variation within and between

individuals' speech productions. An illustrative example of individual variation and its impact on interpretation comes from two studies by Schnitzer and Krasinski (1994, 1996). They observed two of their children and interpreted speech acquisition in the younger one as support for a unitary consonant system between the ages of 1;11 years and then two systems from the age of 2;7 years (Schnitzer and Krasinski 1994). Their second child developed his language in a different, more cautious but accurate manner and could be interpreted as evidence for two separate phonological systems from an early age (Schnitzer and Krasinski 1996). Variation in cross-linguistic transfer is not only dependent on the characteristics of the language pair under investigation, such as the functional load of specific sounds in each language (Cataño *et al.* 2009), but also on individual factors including language dominance (Anderson, 2004, Ball *et al.* 2001a, Ball *et al.* 2001b, Brice *et al.* 2009, Sato 1984, Simon 2010, Yavas 2002), age of L2 acquisition and language ability (Ha *et al.* 2009), and personal interaction strategies (Schnitzer and Krasinski 1994, 1996).

The direction of cross-linguistic transfer has been investigated through several longitudinal case and cohort observation studies with some surprising findings. Anderson (2004) followed five bilingual children: three Korean-English bilingual children, a Russian-English and a French-English child over time as they acquired their second language, English. Cross-linguistic transfer was observed in all children in the direction of L1 to L2; however, over time the relative influence of L1 on L2 diminished as the children acquired L2. Two studies have examined VOT in relation to language dominance. Yavaş (2002) investigated VOT for Spanish-English 7- and 8-year-olds and was expecting to observe cross-linguistic transfer in the direction of L1 to L2 but was surprised to observe a mutual influence of each language on each other. Similarly, Simon (2010) investigated VOT of a Dutch 3-year-old as they acquired English and

found the production of Dutch prevoicing decreased over a 7 month period. These studies suggest that cross-linguistic transfer, and VOT in particular, is two way, not just in the direction of L1 to L2.

Interactional based models of speech acquisition, such as an *Interdependence model* (Paradis and Genesee 1996) where transfer, deceleration and acceleration takes place in the simultaneous acquisition of two language systems provide a platform by which to further investigate positive and negative transfer and cross-linguistic interactions between specific language pairs (Genesee, Paradis and Crago 2004; McLeod and Goldstein 2012). Fabiano-Smith and Goldstein (2010b) have explored acquisition trends of shared and unshared sounds in Spanish-English bilinguals. They found some evidence of accelerated acquisition of sounds that are shared across Spanish and English in bilingual children. As anticipated, this result was not observed in English monolinguals; however, it was unexpectedly found to some extent in Spanish monolinguals. Their study provides some support for the *Interdependence model*, but further investigation is needed to ascertain why accelerated acquisition of sounds shared between English and Spanish was also found in Spanish monolinguals.

The authors also suggest that the advantageous impact of bilingualism may be countering deceleration, thus explaining why bilingual children fall in the normal range within some studies. They propose that where bilingual children show a similar rate of speech acquisition to their monolingual peers yet show some qualitative differences in speech acquisition, this can be interpreted as positive transfer given the additional load that is placed on children acquiring two languages (Fabiano-Smith and Goldstein 2010, Goldstein and McLeod 2011). This would suggest potential further evidence for positive transfer in Spanish-English (Burrows and Goldstein 2010, Fabiano-Smith and Barlow 2008; Fabiano-Smith and Goldstein 2010a,



Goldstein *et al.* 2005), Russian-English (Gildersleeve-Neumann and Wright 2010) and Mandarin-English (Lin and Johnson 2010) bilingual children.

### *Summary*

Establishing whether exposure to two languages in childhood results in advantages or disadvantages in speech sound acquisition is not straight forward. In general, there is no substantial evidence for bilingual children acquiring speech sounds at a slower or faster rate than their monolingual peers when assessed with global acquisition scores. More detailed, in depth studies suggest that acquisition of some sounds may be accelerated and others decelerated depending on interactions between specific language structures. Spanish-English bilingual speech sound acquisition has been by far the most researched bilingual language population. Researchers are in a better position to test theories of language specific interactions and their impact on bilingual speech sound acquisition using *a priori* hypothesis testing within tightly designed studies and recent focus has turned to examining some of these language specific issues, particularly within Spanish-English populations (Fabiano-Smith and Barlow 2010, Fabiano-Smith and Goldstein 2010a, 2010b). Obtaining strong statistical evidence for positive and negative transfer and interactions between languages remains a challenge due to increased variation in speech sound production that is apparent within and between individuals acquiring more than one language.

A range of methodological designs can play a role in increasing our understanding of bilingual children's speech sound acquisition. Exploratory case and cohort studies may be particularly useful for building knowledge on typical bilingual children's speech sound acquisition in less researched bilingual populations while longitudinal studies can be useful for

examining factors involved in cross-linguistic transfer in simultaneous and sequential bilingual acquisition. Developing models of cross-linguistic bilingual speech acquisition that take into account age of acquisition, length and type of L2 exposure, language proficiency, the development and capacity of perceptual and cognitive systems, individual variation alongside other phonological areas, such as rhythm and intonation is an enormous challenge but will assist practitioners as they assess the speech of bilingual children and attempt to understand the relative impact of the L2 on the stage of development.

### *Clinical implications*

The issue of whether bilingual children have two distinct phonological systems and the extent of interaction between these systems has implications for the identification of and intervention for speech sound disorders in bilingual children. Specifically will treating a disorder in one language transfer to the other language or are separate interventions required for each language? There is some evidence to suggest that this might be determined by the nature of the child's speech deficit and the type of intervention provided. Holm *et al.* (1997) used a case study design to explore these questions by testing two different therapeutic approaches. A 5-year-old boy with articulation and phonological errors was given articulation therapy first in both languages followed by phonological therapy in English. Articulation improvements were seen in both languages. For the phonological therapy, cluster reduction was targeted as this was seen in both languages; however, there was no transfer to Cantonese. The authors suggest that the case provides evidence for the distinction between articulation and phonology and also for two separate phonological systems. However, scholars of Cantonese do not agree about the presence of consonant clusters in Cantonese (e.g., Zee 1999), so additional examples are needed with

other phonological processes and with other languages to support the claim that phonological therapy is not transferred between languages.

Whilst findings from this review are unable to provide categorical answers to the extent to which phonological systems interact, some key messages for clinical practice can be taken. Heterogeneity is a feature of all speech sound disorders but it is clear from the review that there is greater variability in the development, and by implication disorder, of speech sounds in children who are being brought up in bilingual environments. Of prime importance therefore is the need to take a careful case history which details the child's language environment in terms of the languages he or she is exposed to and the proportion of time he is exposed to each. For example, children who rarely hear English other than when they attend pre-school should be expected to have less proficiency in this language than that of his home. In addition, the age at which they are exposed to each language is important in determining the expected proficiency. Variation in performance will also relate to the properties of the specific languages spoken in terms of phonetic complexity, functional load and phonetic frequency (Ingram 2012).

The presence of atypical developmental errors does not necessarily indicate disorder as many typically developing bilingual populations produce atypical developmental errors. However, atypical developmental errors are rare in some populations such as Russian-English children and so may be an indicator of disorder for this population (Gildersleeve-Neumann and Wright 2008). Access to information on patterns of typically developing bilingual children's speech sound acquisition for specific language pairs is essential to assist identification of disorders.

To summarise, clinical assessment of the speech of bilingual children must take account of the types of languages spoken, the length and frequency of exposure to both languages and the

child's age and broader speech processing and memory skills. Whilst it is impossible to present an overview of all the possible combinations of languages children might speak and the typical error patterns which might be observed, the evidence does suggest that bilingual children might be more likely to use atypical speech substitutions and omissions. Such errors need not necessarily constitute the red flag response which might typically occur for monolingual children. In addition, it is reasonable to allow a greater range of normal variation in the bilingual children and allow more time for speech milestones to be reached. Whilst all these factors suggest leniency in the assessment of a bilingual child, it should not be forgotten that some of these children will have speech sound disorder and it is important that they are identified as early as possible in order to allow for intervention to commence. There is a greater need in this population for a detailed language history and speech sound analysis in all languages spoken in order to maximize the identification of children with real difficulties.

#### *Limitations of this review*

The study was ambitious in its aim to review a large number of studies with a range of different designs, focusing on various aspects of speech sound acquisition across numerous English bilingual populations. Whilst the search terms aimed to identify all studies that had been published in this area, it is possible that some studies have not been identified. A large number of studies were identified through searching bibliographies, suggesting that the database search net may not have been cast wide enough. However, the bibliography search soon became exhaustive and study records were also cross checked with the third author's records so there is confidence that most studies have been identified. The review has not included informal research, such as that presented at conferences or published in magazines and it has not searched for studies published in other languages. The first author was responsible for initially screening abstracts.

The second author screened all included studies, but did not verify the initial screening of abstracts. Therefore, it is possible that there may not have been agreement on the exclusion of some studies at the initial stage. However, there was good agreement between authors for studies that were included and strong inter-rater reliability for the quality appraisal.

## **Conclusions**

There are many discrepancies in the findings of the review owing to differences in methodology and the languages observed as well as the degree of language exposure a child has. Nevertheless there are two key messages to take from these findings which are relevant for both researchers and clinicians. Firstly, it is clear from this review that speech acquisition is qualitatively different in monolingual children compared with bilingual children. Specifically, children developing speech sounds in a bilingual environment present with different phonological error patterns and acquire sounds at different rates in comparison to their monolingual peers. The evidence is inconclusive with regard to whether being bilingual results in acceleration or deceleration of acquisition of speech sounds. Rather it may be that there is variation across sounds with positive and negative transfer occurring simultaneously. There are some tentative indications that older bilingual children, aged 5 to 6 years, are more accurate in their production of vowels and consonants compared to monolingual children (Grech and Dodd 2008, Goldstein and Bunta 2010), but this needs to be tested further. Secondly there are clear differences between languages in terms of influence on speech sound development and impairment. Moreover there is evidence for language interference on speech sound development with one language affecting the progress and development in the other. How this influence takes place appears to vary from one person to another and is in part determined by the type and length

of language exposure that an individual child experiences. As with development of the speech sound system in monolingual children, there is large individual variation in acquisition of sounds and error patterns. However, there is evidence to suggest that there is more variation in bilingual children than in monolingual children.

This review has highlighted specific areas which warrant further investigation. Specifically, there is a need to continue to develop bilingual norms for different language populations. Further research is also needed to understand how the phonologies of specific languages interact with one another while the relative influence of different levels of language exposure needs to be better understood and accounted for. With regard to children with speech sound disorder, there is a need to investigate ways to improve feasibility of assessing and treating in both languages.

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**What is already known on this subject:** Children who speak more than one language are increasingly entering the school systems in English-speaking countries. Children who have speech sound disorder and are bilingual are less likely to be referred to speech and language therapy than their monolingual peers. Explanations for this vary but there is some concern that professionals do not have sufficient knowledge about typical and atypical bilingual speech sound acquisition.

**What this study adds:** Findings are inconsistent but in general, there is no substantial evidence for typically developing bilingual children acquiring speech sounds at a slower or faster rate than their monolingual peers. However, it is clear that speech acquisition in bilingual children is qualitatively different from that of monolingual children with different error patterns and rates of progress observed. Patterns of speech acquisition vary in children who are bilingual and there are clear differences between languages with regard to their influence on speech sound development and impairment.

## References

References marked with ‘\*’ are papers or book chapters included in the review.

- \*ANDERSON, R. T., 2004, Phonological acquisition in preschoolers learning a second language via immersion: A longitudinal study. *Clinical Linguistics and Phonetics*, 18, 183-210.
- ARMSTRONG, S. and AINLEY, M., 1988, *The South Tyneside Assessment of Phonology* (Northumberland: Stass).
- \*BALL, M. J., MÜLLER, N. and MUNRO, S., 2006, Phonological development and disorder of bilingual children acquiring Welsh and English. In Z. Hua and B. Dodd (Eds.), *Phonological development and disorders in children: A multilingual perspective* (Clevedon, UK: Multilingual Matters), pp. 346-382.
- \*BALL, M. J., MÜLLER, N., and MUNRO, S., 2001a, The acquisition of the lateral fricative in Welsh-English bilinguals. *Multilingual*, 20(3), 269-284.
- \*BALL, M. J., MÜLLER, N., and MUNRO, S., 2001b, The acquisition of the rhotic consonants by Welsh-English bilingual children. *The International Journal of Bilingualism*, 5(1), 71-86.
- \*BALLARD, E., and FARAO, S., 2008, The phonological skills of Samoan speaking 4-year-olds. *International Journal of Speech-Language Pathology*, 10(6), 379-391.
- \*BERMAN, R. A., 1977, Natural phonological processes at the one-word stage. *Lingua*, 43, 1-21.
- BIALYSTOK, E., 2011, Coordination of executive functions in monolingual and bilingual children. *Experimental Child Psychology*, 110(3), 461-468.
- BIALYSTOK, E., MAJUMDER, S., and MARTIN, M. M., 2003, Developing phonological awareness: Is there a bilingual advantage? *Applied Psycholinguistics*, 24, 27-44.



- \*BRICE, A.E., CARSON, C.K. and O'BRIEN, J., 2009, Spanish-English articulation and phonology of 4- and 5-year-old preschool children: an initial investigation. *Communication Disorders Quarterly*, 31(1), 3-14.
- BRUCK, M., and GENESEE, F., 1995, Phonological awareness in young second language learners. *Journal of Child Language*, 22, 307-324.
- \*BUNTA F., and INGRAM, D., 2007, The acquisition of speech rhythm by bilingual Spanish- and English-speaking 4- and 5-year-old children. *Journal of Speech, Language, and Hearing Research*, 50(4), 999-1014.
- \*BUNTA, F., DAVIDOVICH, I., and INGRAM, D., 2006, The relationship between the phonological complexity of a bilingual child's words and those of the target languages. *International Journal of Bilingualism*, 10, 71-86.
- \*BUNTA, F., FABIANO-SMITH, L., GOLDSTEIN, B. and INGRAM, D., 2009, Phonological whole-word measure 3-year-old bilingual children and their age-matched monolingual peers. *Clinical Linguistics and Phonetics*, 23(2), 156-175.
- \*BURROWS, L. and GOLDSTEIN, B.A., 2010, Whole word measures in bilingual children with speech sound disorders. *Clinical Linguistics and Phonetics*, 24(4-5), 357-368.
- CAESAR, L. G., and KOHLER, P. D., 2007, The state of school-based bilingual assessment: Actual practice versus recommended guidelines. *Language, Speech, and Hearing Services in Schools*, 38, 190-200.
- CAMPBELL, R., and SAIS, E., 1995, Accelerated metalinguistic (phonological) awareness in bilingual children. *British Journal of Developmental Psychology*, 13, 61-68.
- \*CATAÑO, L., BARLOW, J. A., and MOYNA, M. I., 2009, A retrospective study of phonetic inventory complexity in acquisition of Spanish: Implications for phonological universals.

- Clinical Linguistics and Phonetics, 23(6), 446-472.
- \*CELCE-MURCIA, M., 1978, The simultaneous acquisition of English and French in a two-year-old child. In E. Hatch (Ed.), *Second language acquisition: A book of readings* (Rowley, MA: Newbury House), pp.38-53.
- \*CRUTCHLEY, A., CONTI-RAMSDEN, G., and BOTTING, N., 1997, Bilingualism and specific impairment in children attending language units. *European Journal of Disorders of Communication*, 32, 267-276.
- DE LAMO WHITE, C., and JIN, L., 2011, Evaluation of speech and language assessment approaches with bilingual children. *International Journal of Language and Communication Disorders*, 46, 613-627.
- DEPARTMENT FOR CHILDREN SCHOOLS AND FAMILIES, 2008, *Pupil characteristics and class sizes in maintained schools in England*. SFR 09/2008. (London, UK: Department for Children, Schools and Families).  
<http://www.education.gov.uk/rsgateway/DB/SFR/s000786/sfr09-2008.pdf> (accessed 7 February 2011).
- DEPARTMENT FOR EDUCATION, 2010, *School, pupils and their characteristics*, January 2010. SFR 09/2010. (London, UK: Department for Education).  
<http://www.education.gov.uk/rsgateway/DB/SFR/s000925/sfr09-2010.pdf> (accessed 7 February 2011).
- \*DEUCTHAR, M., and CLARK, A., 1996, Early bilingual acquisition of the voicing contrast in English and Spanish. *Journal of Phonetics*, 24, 351-365.
- DODD, B., 2005, *Differential diagnosis and treatment of children with speech disorder* (Chichester: Whurr).

- \*DODD, B., HOLM, A., and WEI, L., 1997, Speech disorder in preschool children exposed to Cantonese and English. *Clinical Linguistics and Phonetics*, 11, 229-243.
- \*DODD, B., SO, L. K. H., and WEI, L., 1996, Symptoms of disorder without impairment. In B. Dodd, R. Campbell and L. Worrall (Eds.), *Evaluating theories of language: Evidence from disorder* (London: Whurr), pp.119-136.
- \*FABIANO-SMITH, L. and BARLOW, J.A., 2010, Interaction in bilingual phonological acquisition: Evidence from phonetic inventories. *International Journal of Bilingual Education and Bilingualism*, 13(1), 81-97.
- \*FABIANO-SMITH, L. and GOLDSTEIN, B.A., 2010a, Early-, middle-, and late-developing sounds in monolingual and bilingual children: an exploratory investigation. *American Journal of Speech-Language Pathology*, 19(1), 66-77.
- \*FABIANO-SMITH, L. and GOLDSTEIN, B.A., 2010b, Phonological acquisition in bilingual Spanish-English speaking children. *Journal of Speech, Language and Hearing Research*, 53(1), 160-178.
- FEDERAL INTERAGENCY FORUM ON CHILD AND FAMILY STATISTICS, 2010, *America's children in brief: Key national indicators of well-being, 2010*. (Washington, DC: US Government Printing Office).
- \*FOKES, J., BOND, Z. S., and STEINBURG, M., 1985, Acquisition of the English voicing contrast by Arab children. *Language and Speech*, 28(1), 81-91.
- \*FRANT HECHT, B., and MULFORD, R., 1982, The acquisition of a second language phonology: Interaction of transfer and developmental factors. *Applied Psycholinguistics*, 3, 313-328.
- GENESE, F., PARADIS, J., and CRAGO, M.B., 2004, *Dual language development and disorders: A handbook on bilingualism and second language learning* (Baltimore: Brookes).

- \*GILDERSLEEVE-NEUMANN, C. E., KESTER, E. S., DAVIS, B. L., and PEÑA, E. D., 2008, English sound development in preschool-aged children from bilingual English-Spanish environments. *Language, Speech, and Hearing Services in Schools*, 39, 314-328.
- \*GILDERSLEEVE-NEUMANN, C., and WRIGHT, K., 2010, English speech acquisition in 3- to 5-year-old children learning Russian and English. *Language, Speech, and Hearing Services in Schools*, 41, 429-444.
- GOLDMAN, R., and FRISTOE, M., 2000, Goldman-Fristoe Test of Articulation–Second Edition. (Circles Pines, MN: American Guidance Service).
- GOLDSTEIN, B. A. and McLEOD, S., 2012, Typical and atypical multilingual speech acquisition. In S. McLeod and B. A. Goldstein (Eds.) *Multilingual aspects of speech sound disorders in children*. (Bristol, UK: Multilingual Matters), pp. 84-100.
- \*GOLDSTEIN, B. and BUNTA, F., in press, Positive and negative transfer in the phonological systems of bilingual speakers. *International Journal of Bilingualism*.
- \*GOLDSTEIN, B., BUNTA, F., LANGE, J., RODRIGUEZ, J., AND BURROWS, L., 2010, The effects of measures of language experience and language ability on segmental accuracy in bilingual children. *American Journal of Speech-Language Pathology*, 19, 238-247.
- \*GOLDSTEIN, B. A., FABIANO, L., and WASHINGTON, P. S., 2005, Phonological skills in predominantly English-speaking, predominantly Spanish-speaking, and Spanish-English bilingual children. *Language, Speech, and Hearing Services in Schools*, 36, 201-218.
- \*GOLDSTEIN, B., and WASHINGTON, P. S., 2001, An initial investigation of phonological patterns in typically developing 4-year-old Spanish-English bilingual children. *Language, Speech, and Hearing Services in Schools*, 32, 153-164.

- \*GRECH, H., and DODD, B., 2008, Phonological acquisition in Malta: A bilingual language learning context. *International Journal of Bilingualism*, 12(3), 155-171.
- GRECH, H., and MCLEOD, S., 2012, Multilingual speech and language development and disorders. In D. Battle (Ed.), *Communication disorders and development in multicultural populations* (pp. 120-147) (St Louis, MI: Elsevier).
- \*HA, S., JOHNSON, C. J., and KUEHN, D. P., 2009, Characteristics of Korean phonology: Review, tutorial, and case studies of Korean children speaking English. *Journal of Communication Disorders*, 42(3), 163-179.
- \*HOLM, A., and DODD, B., 1999a, A longitudinal study of the phonological development of two Cantonese-English bilingual children. *Applied Psycholinguistics*, 20, 349-376.
- \*HOLM, A., and DODD, B., 1999b, Differential diagnosis of phonological disorder in two bilingual children acquiring Italian and English. *Clinical Linguistics and Phonetics*, 13(2), 113-129.
- \*HOLM, A., and DODD, B., 1999c, An intervention case study of a bilingual child with phonological disorder. *Child Language Teaching and Therapy*, 15, 139-158.
- \*HOLM, A., and DODD, B., 2006, Phonological development and disorder of bilingual children acquiring Cantonese and English. In Z. Hua and B. Dodd (Eds.), *Phonological development and disorders in children: A multilingual perspective* (Clevedon, UK: Multilingual Matters), pp. 286-325.
- \*HOLM, A., DODD, B., and OZANNE, A., 1997, Efficacy of intervention for a bilingual child making articulation and phonological errors. *International Journal of Bilingualism*, 1(1), 55-69.

- \*HOLM, A., DODD, B., STOW, C., and PERT, S., 1997, Speech disorders in bilingual children: Four case studies. *Osmania Papers in Linguistics*, 22-23, 46-64.
- \*HOLM, A., DODD, B., STOW, C., and PERT, S., 1999, Identification and differential diagnosis of phonological disorder in bilingual children. *Language Testing*, 16(3), 271-292.
- \*INGRAM, D., 1981, The emerging phonological system of an Italian-English bilingual child. *Journal of Italian Linguistics*, 2, 95-113.
- INGRAM, D., 2012, Prologue: Cross-linguistic and multilingual aspects of speech sound disorders in children. In S. McLeod, and B. Goldstein (Eds.), *Multilingual aspects of speech sound disorders in children*. (Bristol, UK: Multilingual Matters), pp. 3-12.
- \*JOHNSON, C., and LANCASTER, P., 1998, The development of more than one phonology: A case study of a Norwegian-English bilingual child. *International Journal of Bilingualism*, 2, 265-300.
- \*KESHAVARZ, M. H., and INGRAM, D., 2002, The early phonological development of a Farsi-English bilingual child. *International Journal of Bilingualism*, 6(3), 255-269.
- \*KHATTAB, G., 2006, Phonological acquisition by Arabic-English bilingual children. In Z. Hua and B. Dodd (Eds.), *Phonological development and disorders in children: A multilingual perspective* (Clevedon, UK: Multilingual Matters), pp. 383-412.
- KOHNERT, K., 2010, Bilingual children with primary language impairment: Issues, evidence and implications for clinical actions. *Journal of Communication Disorders*, 43, 456-473.
- \*KONEFAL, J. A., and FOKES, J., 1981, Voice onset time: The development of Spanish/English distinction in normal and language disordered children. *Journal of Phonetics*, 9, 437-444.

- KRITIKOS, E. P., 2003, Speech-language pathologists' beliefs about language assessment of bilingual/bicultural individuals. *American Journal of Speech-Language Pathology*, 12, 73-91.
- \*LIN, L. C. and JOHNSON, C. J., 2010, Phonological patterns in Mandarin-English bilingual children. *Clinical Linguistics and Phonetics*, 24(4-5), 369-386.
- \*MACLEOD, A., and MCCAULEY, R., 2003, The phonological abilities of bilingual children with specific language impairment: A descriptive analysis. *Journal of Speech Language Pathology and Audiology*, 27(1), 29-44.
- MARINOVA-TODD, S., ZHAO, J. and BERNHARDT, M., 2010, Phonological awareness skills in the two languages of Mandarin-English bilingual children. *Clinical Linguistics and Phonetics*, 24(4-5), 387-400.
- MARSHALL, J., GOLDBART, J., PICKSTONE, C. and ROULSTONE, S., 2011, Application of systematic reviews in speech-and-language therapy. *International Journal of Language and Communication Disorders*, 46(3), 261-272.
- McLEOD, S., and GOLDSTEIN, B., 2012, Multilingual aspects of speech sound disorders in children (Bristol, UK: Multilingual Matters).
- \*MUNRO, S. N., BALL, M. J., MULLER, N., DUCKWORTH, M., and LYDDY, F., 2005, Phonological acquisition in Welsh-English bilingual children. *Journal of Multilingual Communication Disorders*, 3(1), 24-49.
- \*NG, M. L., HSUEH, G. and LEUNG, C.-S. S., 2010, Voice pitch characteristics of Cantonese and English produced by Cantonese-English bilingual children. *International Journal of Speech-Language Pathology*, 12(3), 230-236.

- \*OLLER, J. K., EILERS, R. E., URBANO, R., and COBO-LEWIS, A. B., 1997, Development of precursors to speech in infants exposed to two languages. *Journal of Child Language*, 24, 407-425.
- PARADIS, J. and GENESEE, F., 1996, Syntactic acquisition in bilingual children: Autonomous or interdependent? *Studies in Second Language Acquisition*, 18, 1-25.
- PARADIS, J., 2001, Do bilingual two-year-olds have separate phonological systems? *International Journal of Bilingualism*, 5(1), 19-38.
- PARADIS, J., EMMERZAEL, K., and DUNCAN, T. S., 2010, Assessment of English language learners: Using parent report on first language development. *Journal of Communication Disorders*, 43, 474-497.
- PEÑA, E., GUTIÉRREZ-CLELLEN, V., IGLESIAS, A., GOLDSTEIN, B. and BEDORE, L., 2007, Bilingual English Spanish Assessment (BESA). Unpublished manuscript.
- \*RAY, J., 2002, Treating phonological disorders in a multilingual child: A case study. *American Journal of Speech-Language Pathology*, 11(3), 305-315.
- RESTREPO, M.A., 1998, Identifiers of predominantly Spanish-speaking children with language impairment. *Journal of Speech, Language, and Hearing Research*, 41, 1398.
- ROYAL COLLEGE OF SPEECH AND LANGUAGE THERAPISTS, 2007. Good practice for Speech and Language Therapists working with clients from linguistic minority communities. [http://www.rcslt.org/members/publications/linguistic\\_minorities](http://www.rcslt.org/members/publications/linguistic_minorities) (accessed 2nd April 2012).
- \*SATO, C., 1984, Phonological processing in second language acquisition: Another look at interlanguage syllable structure. *Language Learning*, 34(4), 43-58.



- \*SCNHITZER, M., and KRASINSKI, E., 1994, The development of segmental phonological production in a bilingual child. *Journal of Child Language*, 21, 585-622.
- \*SCNHITZER, M., and KRASINSKI, E., 1996, The development of segmental phonological production in a bilingual child: A contrasting second case. *Journal of Child Language*, 23, 547-571.
- \*SIMON, E., 2010, Child L2 development: A longitudinal case study on Voice Onset Times in word-initial stops. *Journal of Child Language*, 37(1), 159-173.
- SKAHAN, S. M., WATSON, M., and LOF, G. L., 2007, Speech-language pathologists' assessment practices for children with suspected speech sound disorders: Results of a national survey. *American Journal of Speech-Language Pathology*, 16, 246-259.
- SO, L. K. H., 1993, *Cantonese Segmental Phonology Test*. (Hong Kong: Bradford Publishing Company).
- STACKHOUSE, J., and WELLS, B., 1997, *Children's speech and literacy difficulties: A psycholinguistic framework* (Chichester: Whurr).
- STATE GOVERNMENT OF VICTORIA, 2009, *English as a second language in Victorian government schools*. (Melbourne: Department of Education and Early Childhood Development).
- STOW, C., and DODD, B., 2003, Providing an equitable service to bilingual children in the UK: A review. *International Journal of Language and Communication Disorders*, 38, 351–377.
- STOW, C., AND DODD, B., 2005, A survey of bilingual children referred for investigation of communication disorders: a comparison with monolingual children referred in one area in England. *Journal of Multilingual Communication Disorders*, 3, 1-23.

- \*STOW, C., and PERT, S., 2006, Phonological acquisition in bilingual Pakistani heritage children in England. In Zhu Hua and B. Dodd (Eds.), *Phonological development and disorders in children: A multilingual perspective*. (Clevedon, UK: Multilingual Matters).
- \*TROFIMOVISH, P., and BAKER, W., 2007, Learning prosody and fluency characteristics of second language speech: The effect of experience on child learners' acquisition for five suprasegmentals. *Applied Psycholinguistics*, 28, 251-276.
- \*VOGEL, I., 1975, One system or two-an analysis of a two year old Romania-English bilingual's phonology. *Papers and Reports on Child Language and Development*, 9, 43-62.
- WILLIAMS, C. J. & McLEOD, S., 2012, Speech-language pathologists' assessment and intervention practices with multilingual children. *International Journal of Speech-Language Pathology*, 14(3),
- \*WINITZ, H. GILLESPIE, B., and STARCEY, J., 1995, The development of English speech patterns of a 7-year-old Polish speaking child. *Journal of Psycholinguistic Research*, 24(2), 117-143.
- WINTER, K., 1999, Speech and language therapy provision for bilingual children: Aspects of the current service. *International Journal of Language and Communication Disorders*, 34, 85-98.
- WINTER, K., 2001, Numbers of bilingual children in speech and language therapy: Theory and practice of measuring their representation. *International Journal of Bilingualism*, 5, 465-495.
- \*YAVAŞ, M., 2002, Voice onset time patterns in bilingual phonological development. In F. Windsor, M. L. Kelly and N. Hewlett (Eds), *Investigations in clinical phonetics and linguistics* (Mahwah, NJ: Erlbaum), 341–350.

- \*YAVAŞ, M., 2006, Sonority and the acquisition of # sC clusters. *Journal of Multilingual Communication Disorders*, 4(3), 159-168.
- \*YAVAŞ, M., 2010, Acquisition of /s/-clusters in Spanish-English bilingual children with phonological disorders. *Clinical Linguistics and Phonetics*, 24(3), 188-198.
- \*YAVAŞ, M. and BARLOW, J.A., 2006, Acquisition of # sC clusters in Spanish-English bilingual children. *Journal of Multilingual Communication Disorders*, 4(3), 182-193.
- \*YAVAŞ, M. and BEAUBRUN, C., 2006, Acquisition of # sC clusters in Haitian Creole-English bilingual children. *Journal of Multilingual Communication Disorders*, 4(3), 194-204.
- \*YAVAŞ, M and GOLDSTEIN, B., 2006, Aspects of bilingual phonology: The case of Spanish-English bilingual children. In Z. Hua and B. Dodd (Eds.), *Phonological development and disorders in children: A multilingual perspective* (Clevedon, UK: Multilingual Matters), pp. 265-285.
- \*YAVAŞ, M. and SOMEILLAN, M., 2005, Patterns of acquisition of /s/-clusters in Spanish-English bilinguals. *Journal of Multilingual Communication Disorders*, 3(1), 50-55.
- ZEE, E., 1999, Chinese (Hong Kong Cantonese). In *Handbook of the International Phonetic Association*, 58-60 (Cambridge: Cambridge University Press).

**Table 1. Search terms**

| <i>Concepts</i>     | Speech                  | Acquisition      | Second                                    | Bilingualism                                  | Impairment                      |
|---------------------|-------------------------|------------------|---|---|---------------------------------|
| <i>Search words</i> | phon<br>speech<br>sound | Acqui<br>develop | second<br>two<br>dual<br>another<br>other | langu<br>bilingu<br>multilingu<br>multi-lingu | impairment<br>delay<br>disorder |

**Table 2. Studies of speech production in typically developing and disordered bilingual children where English was one of the languages spoken**

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| <b>Languages studied</b>                   |    |
|--|----|
| Spanish-English                            | 24 |
| Cantonese-English                          | 7  |
| Pakistani (Urdu, Mirpuri, Punjabi)-English | 5  |
| Welsh-English                              | 5  |
| Arabic-English                             | 2  |
| French-English                             | 2  |
| Italian-English                            | 2  |
| Korean-English                             | 2  |
| Dutch-English                              | 1  |
| Farsi-English                              | 1  |
| Hindi-Gujarati-English                     | 1  |
| Haitian Creole-English                     | 1  |
| Hebrew-English                             | 1  |
| Hungarian-English                          | 1  |
| Icelandic-English                          | 1  |
| Maltese-English                            | 1  |
| Mandarin-English                           | 1  |
| Norwegian-English                          | 1  |
| Polish-English                             | 1  |
| Romanian-English                           | 1  |
| Russian-English                            | 1  |
| Samoan-English                             | 1  |
| Vietnamese-English                         | 1  |
| *Mixed languages                           | 2  |

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\*Mixed bilingual studies: Anderson (2004) had participants from three language backgrounds: Korean-English, Russian-English and French-English; Crutchley *et al.* (1997) did not report languages spoken

**Table 3. Frequencies of designs used in studies investigating speech production in typically developing children and children with speech sound disorders.**

|                               | Typically<br>developing | Speech<br>Sound<br>Disorders | All studies |
|-------------------------------|-------------------------|------------------------------|-------------|
| Cohort<br>observation         | 37.5% (20)              | 15.4% (2)                    | 33.3% (22)  |
| Case control                  | 28.3% (15)              | 7.7% (1)                     | 24.2% (16)  |
| Single case                   | 26.4% (14)              | 23.1% (3)                    | 25.7% (17)  |
| Multiple case                 | 7.5% (4)                | 46.1% (6)                    | 15.1% (10)  |
| Retrospective case<br>control | 0                       | 7.7% (1)                     | 1.5% (1)    |
| <i>Total</i>                  | <i>53</i>               | <i>13</i>                    | <i>66</i>   |

**Table 4. Frequencies of studies addressing quality issues**

| <b>Quality issues</b>   | <b>%<br/>(frequency) of<br/>studies</b> |
|---|---|
| Aims of study clearly stated  | 89.3% (59)                              |
| <i>Sample information</i>   |   |
| Potential sample bias addressed (e.g., socio-economic status, language background, age) <i>excluding case studies</i>               | 38.4% (15)                              |
| Potential sample bias partially addressed (e.g. language background, age – not socio-economic status) <i>excluding case studies</i> | 10.3% (4)                               |
| Potential sample bias not addressed <i>excluding case studies</i>   | 51.3% (20)                              |
| Recruitment information / participation rates provided  | 3.0% (2)                                |
| Participants randomly selected  | 4.5% (3)                                |
| <i>Data collection tools</i>  |   |
| All tools were validated  | 45.5% (30)                              |
| Some tools were validated, some were developed as part of study   | 16.6% (11)                              |
| Tools were not validated or insufficient information  | 39.4% (26)                              |
| <i>Analyses</i>   |   |
| Data analysts blind to participants   | 4.5% (3)                                |
| Reliability of analyses were checked  | 56.1% (37)                              |

**Figure 1: Literature search flow diagram**

