Acceleration in the bilingual acquisition of phonological structure: Evidence from Polish-English bilingual children.

Abstract

This study examines the production of consonant clusters in simultaneous Polish-English bilingual children and in language-matched English monolinguals (aged 7;01- 8;11). Selection of the language pair was based on the fact that Polish allows a greater range of phonologically complex cluster types than English. A nonword repetition task was devised in order to examine clusters of different types (obstruent-liquid vs. s + obstruent) and in different word positions (initial vs. medial), two factors that play a significant role in repetition accuracy in monolingual acquisition (e.g. Kirk & Demuth, 2005). Our findings show that bilingual children outperformed monolingual controls in the word initial s + obstruent condition. These results indicate that exposure to complex word initial clusters (in Polish) can accelerate the development of less phonologically complex clusters (in English). This constitutes significant new evidence that the facilitatory effects of bilingual acquisition extend to structural phonological domains.

Keywords: bilingualism; acceleration; syllable structure; phonology

1. Introduction

Research on bilingual first language acquisition (BFLA) has shown that children differentiate between their two linguistic systems from an early age (e.g. Döpke, 1999; Genesee, 1989; Hulk & Muller, 2000; among many others). It is also generally accepted that the two linguistic systems of BFLA bilinguals may interact, a phenomenon known as *interdependence* (Paradis & Genesee, 1996) or *crosslinguistic influence* (Hulk & Muller, 2000). In particular, Paradis and Genesee (1996) identify three possible outcomes that interdependence or crosslinguistic influence may lead to, namely transfer, delay, and acceleration. Paradis and Genesee (1996) define transfer as “the incorporation of a grammatical property into one language from the other” (1996, p. 3). Hence, transfer typically leads to some ungrammatical utterances that depart from the typical path of monolingual acquisition, as the bilingual child produces non-adult structures that are syntactic calques of his/her other L1.

Delay, on the other hand, is the effect through which the overall rate of acquisition of a bilingual child decreases, allegedly due to the difficulty that bilingual children may have in dealing with two languages (although Paradis and Genesee, 1996, do not offer a detailed explanation for this claim). The third possible outcome of interdependence is acceleration. This refers to the possibility that a certain linguistic property may appear in the speech of a bilingual earlier than it does in monolinguals. The idea behind acceleration is that mastery of a particular structure in one of the two languages facilitates acquisition of the corresponding structure in the other language, thus enabling the bilingual child to outperform monolinguals in some linguistic domains.

2. Crosslinguistic Interaction in BFLA

There is a considerable body of research examining the ways in which the grammars of bilingual children interact and which particular linguistic areas are vulnerable to interdependence, with transfer being perhaps the most studied of the three potential outcomes. However, the vast majority of these studies are within the domain of syntax. For example, Müller and colleagues have reported transfer in subordinate clauses in German-French bilinguals (Müller, 1998) and object-drop in Dutch–French, German–French, and German–Italian bilinguals (Hulk & Müller, 2000; Müller & Hulk, 2001). Serratrice and colleagues have found transfer effects in the development of pronominals (Serratrice, Sorace, & Paoli, 2004; Sorace, Serratrice, Filiaci, & Baldo, 2009) and of anaphoric constructions (Serratrice, 2007) in English-Italian bilingual children. Delay has been observed in some areas of grammar such as the development of word form recognition in Welsh-English infants (Vihman, Lum, Thierry, Nakai, & Keren-Portnoy, 2006), in the acquisition of object pronouns in French-English bilinguals (Pérez-Leroux, Pirvulescu, & Roberge, 2009) and of copular constructions in Spanish-English bilinguals (Silva-Corvalán & Montanari, 2008). Acceleration seems to be much less common than either transfer or delay, though it has been reported on some occasions, notably in the acquisition of the determiner system in German-Italian and German-French children (Kupisch, 2005).

Although research on bilingual phonology is much less extensive, all three outcomes predicted by Paradis and Genesee (1996) have been attested. Paradis (2001) found transfer of stress patterns from French into English in French-English bilingual children, while Fabiano-Smith and Barlow (2010) reported bidirectional transfer across phonemic inventories in Spanish-English bilingual children: children produced Spanish-specific sounds when speaking English and English-specific sounds when speaking Spanish. Kehoe (2002) reported delay in the acquisition of the German vowel system (particularly vowel-length distinctions) in German-Spanish bilinguals, while Goldstein and Washington (2001) found that Spanish-English 4-year-old bilinguals were considerably less accurate than their monolingual peers in the rendition of spirants, flaps, and trills in Spanish. Evidence of acceleration is rather meagre, however, and as far as we know it has only been reported once within phonology, in relation to coda consonants in Spanish-German bilinguals (Lleó, Kuchenbrandt, Kehoe, & Trujillo, 2003). The Lleó et al. (2003) study is also one of very few that investigated phonological structure at the syllabic level, as most research on phonology in BFLA has focused either on prosodic or segmental aspects, particularly segmental transfer (i.e. transfer across phonemic inventories). Structural aspects of phonology in general, and consonant clusters in particular, have received relatively little attention, especially with regard to potential acceleration effects. As far as we are aware, the only two studies that have investigated consonant clusters in BFLA are those of Yavas and Barlow (2006) and Mayr, Jones, and Mennen (to appear). However, the former study restricted its focus to only #sC sequences, while the latter involved two languages with almost identical cluster phonotactics, a factor that virtually excluded the possibility of observing any crosslinguistic influence in this domain. The current study contributes towards filling this research gap by investigating non-word repetition performance in bilingual children whose two languages differ greatly as to the types of clusters they allow. The purpose of the study is twofold. Firstly, to test for potential acceleration effects in cases where children simultaneously acquire two languages that differ in the levels of complexity of the consonant clusters they allow. Secondly, to test two competing views of phonological organisation that make conflicting predictions as to whether and where acceleration of cluster structures should occur. The focus of the study will be on word-initial and word-medial onset clusters.

3. Consonant Clusters in English and Polish

It is well known that languages differ according to their phonotactic requirements which, among other things, pose limits on what consonants may cluster and in which position. Consonant clusters are typically categorised according to their *sonority profile*, which is in turn based on the *sonority scale*. The sonority scale classifies segments based on how sonorous they are, a property that depends on the degree of opening involved in their articulation (Clements, 1990; Kent, 1993; Selkirk, 1984), sometimes also classified as "loudness" (Ladefoged, 1982). A representation of the 5-point sonority scale is given in figure 1:

/figure 1 about here/

As can be seen from figure 1, vowels are the most sonorous segments, while plosives – which involve complete obstruction of the vocal tract – are the least sonorous. Following the sonority scale, clusters involving two consonants can have one of three profiles: rising sonority, as in an obstruent-liquid cluster (e.g. [pl]), falling sonority, as is the case for a fricative-plosive cluster, such as [st], or they can constitute a sonority plateau, as in plosive-plosive clusters (e.g. [pt]).

Languages may therefore differ on two dimensions, namely which sonority profile(s) they allow (rising, falling, or plateau) and in which position. English and Polish are examples of languages that show differences across these dimensions, with Polish allowing all three sonority profiles both word-initially (e.g. [pr]osić, “ask”; [vd]owa, “widow”; [pt]ak, “bird”) and word-medially (e.g. kro[pl]a “drop”; pro[zb]a, “request”; klo[tk]a, “padlock”) while English allows all three profiles only word-medially[1] (e.g. a[pl]y; po[st]er; se[kt]or) and only two of the three profiles word-initially (e.g. [pl]an; [sk]ate). In other words, the clustering patterns of English are a proper subset of the clustering patterns we find in Polish. Given that acceleration is motivated by the child having achieved a “more advanced level of […] complexity in one language than in the other” (Paradis & Genesee, 1996, p. 3), the question arises as to what this subset relation means in terms of potential complexity levels across the two languages. Addressing this question will enable us to identify what forms of acceleration might be expected in the acquisition of word-level phonology in Polish-English BFLA.

4. Consonant clusters and complexity

Phonological theories can be broadly distinguished on the basis of their representational formats. On the one hand, structural perspectives view sounds as segments belonging to a structural unit, typically the syllable (though other types of structural abstractions have also been proposed, e.g. Lowenstamm, 1996). On this view, clusters can be of different types depending on whether the consonants that constitute them belong to the same syllable (tautosyllabicity) or to two adjacent yet separate syllables (i.e. heterosyllabicity).

In standard onset-rhyme theories, syllable membership is decided based on a principle known as the Sonority Sequencing Generalisation (Clements, 1990; henceforth SSG) according to which a well-formed syllable involves an increase in sonority towards the peak and a decrease towards the edges (e.g. Selkirk, 1984; Steriade, 1982). The two consonants in a cluster are therefore taken to belong to the same syllable if they exhibit a rising sonority slope. These tautosyllabic clusters are straightforwardly represented as cases of onset branching, independently of whether they occur word-initially or word-medially[2].

/figure 2 about here/

On the other hand, clusters of non-rising sonority such as stop-stop and stop-fricative clusters violate the SSG, and are therefore treated as heterosyllabic. Moreover, they are treated differently depending on the position they occupy within a word. While they are typically assumed to be coda-onset sequences when appearing word-medially, word-initial instances are treated as somewhat special cases involving an adjunct or extrasyllabic segment (Booij & Rubach, 1990; Davies, 1990; Halle & Vergnaud, 1980; Kenstowicz, 1994; Rochoń, 2000; Steriade 1982; *inter alia*).

/figure 3 about here/

This structural taxonomy neatly captures typological alternations whereby a language like Spanish (e.g. Harris, 1969) may allow branching onsets (i.e. the structure in fig 2) but disallow extrasyllabic consonants (i.e. the structure in fig. 3a), while some other language (e.g. Korean, Sohn, 1986) may allow coda-onset clusters (i.e. the structure in fig. 3b) but ban branching onsets (i.e. the structure in fig. 2). In relation to English and Polish, figures 2 and 3 show that the two languages allow the very same levels of complexity, as both permit all possible structures, namely onset branching (figure 2), adjunction (figure 3a), and coda-onset sequences (figures 3b). The fact that English does not allow sonority plateaus word-initially does not affect its complexity level, as onset-rhyme theories treat all clusters of non-rising sonority as cases of adjunction, regardless of whether they involve plateaus or falling slopes, thus putting English on a par with Polish in terms of structural complexity. Consequently, following an onset-rhyme view of CC clusters we may hypothesise that no acceleration may occur between Polish and English either word-initially or word-medially, as the two languages allow the same levels of structural complexity in both positions.

A radically different perspective on phonological organization is presented by domain-general theories, such as exemplar based or usage-based phonology (e.g. Bybee, 2003; Pierrehumbert, 2003) which take the view that structural abstractions such as syllables are redundant. According to this view, linguistic knowledge involves memorising phonetic tokens of individual lexical items together with associated meanings and situational cues. It is from this information that phonological patterns may later emerge. Complexity is thus dictated by richer and more varied loops or network relations (Johnson, 2007), which give the speaker the ability to establish increasingly more fine-grained phonetic categories (e.g. Blumenfeld & Marian, 2009; Pierrehumbert, 2003). Within a system of this type, advanced levels of complexity are equivalent to entrenching of forms, which is in turn directly proportional to frequency in the input (e.g. Edwards, Beckman, & Munson, 2004; Frisch *et al.*, 2001). In the case of consonant clusters, complexity becomes a function of the number of possible consonantal combinations a language allows in each position. Complexity is therefore a language-specific rather than a structure-dependent matter. This has two important consequences in the case of Polish and English. Firstly, the Polish system is more complex than the English system overall, as it allows 709 tautomorphemic CC clusters (Bargiełówna, 1950 [cited in Zydorowicz, 2010]; Bertinetto, Scheuer, Dziubalska-Kołaczyk, & Agonigi, 2006) compared to the 180 available in (British) English (Hammond, 1999; McLeod, Doorn, & Reed, 2001)[3]. Secondly, the gap in complexity between Polish and English clusters is larger for the word-initial #CC category than it is for the word-medial CC category, where the ratios are 7.2 : 1 (225/31) and 3.2 : 1 (484/149) respectively.

/table 1 about here/

As consonant clusters are more prevalent in Polish than in English, it follows that the linguistic knowledge of a Polish-English bilingual will feature more entrenched representations in the Polish system than in the English counterpart. Therefore, if the two systems communicate at the level of phonological organisation, the Polish system of a Polish-English bilingual may offer a higher level of entrenchment with which to aid the development of the English system. Following domain-general views of phonology we may therefore hypothesise that Polish-English bilingual children would perform better than their monolingual English peers in cluster production in English both word-initially and word-medially, since both positions are more regularly occupied by clusters and are thus more highly entrenched in Polish than they are in English. Further, we may hypothesise that acceleration should occur with a stronger propensity word-initially due to the fact that the word-initial position provides a higher ratio of difference across the two languages.

In the remainder of the paper we investigate these hypotheses together with the hypothesis arising from the onset-rhyme view (i.e. that no acceleration should occur in any position) by analysing the English nonword repetition performance of Polish-English bilingual children word-initially and word-medially and comparing it with that of monolingual English-speaking children.

4.2 Method

Participants

Sixteen Polish-English bilingual children (11 female, 5 male, aged 7;1 to 8;11) were tested in this experiment. Sixteen monolingual English children of the same age range (9 female, 7 male, aged 7;1 to 8;11) also participated in the experiment as control group. All participants were administered the expressive vocabulary, sentence structure, and word structure tests of the Clinical Evaluation of Language Fundamentals-4 (CELF, Semel, Wiig and Secord, 2003). Participant selection was based on achieving expressive vocabulary scores within normal ranges. Each child from the bilingual group was individually matched to a child from the monolingual group based on raw scores from the sentence structure and word structure components of the test. Information on the participants and their scores on the CELF is given in appendix 1. Children were recruited and tested in schools within the Nottinghamshire and Derbyshire areas of the UK. All children were reported by school staff as exhibiting typical linguistic and cognitive development and no hearing difficulties or learning disabilities.

Design

Nonwords were manipulated for two repeated measures independent variables: cluster position (word initial or word-medial) and cluster type (obstruent-liquid vs. s + obstruent). Participant group (monolingual or bilingual) was also manipulated between subjects. The dependent variable was the repetition of the nonword.

Materials

Children were tested through a nonword repetition task (NWRT). NWRTs are widely used as a measure of phonological ability and phonological memory capacity in both typical and atypical language development (e.g. Coady & Evans, 2008; Gathercole, 2006). The task involves instructing participants to repeat nonsense words that contain the structures to be investigated. For the current study, 36 trisyllabic nonwords were devised. As the aim of the study is to investigate whether knowledge of Polish affects performance in English, the nonwords were specifically developed so that they could be potential English words while being highly unlikely (or even impossible) Polish words. This was done by ensuring that the nonwords followed the phonotactics of English while violating Polish patterns both at the segmental and at the prosodic level. At the segmental level, each non-word contained a schwa (unstressed position) as well as one long vowel or oral diphthong (e.g. [ɔː],[ɜː], [eɪ], [aʊ]), both of which are not possible Polish phonemes (Gussmann, 2007). At the prosodic level, each word followed a strong-weak-strong stress pattern (primary stress - zero stress-secondary stress), a pattern that is not only typical of English phonology (especially in trisyllabic English nouns, see Burzio, 1994; Hammond, 1999) but also rare in Polish, a language in which stress is almost invariably penultimate (e.g. Jassem, 2003)[4]. This, together with the fact that the experimenter addressed the children in English, ensured as much as possible that the children would carry out the task in a monolingual English mode (Grosjean, 1989; Soares & Grosjean, 1984).

Each nonword contained one consonant cluster in either word initial or word medial position. The cluster was either an obstruent-liquid or s + obstruent sequence. The clusters involved were /pl/, /fl/, /bl/ for the obstruent-liquid (OL) condition, and /st/, /sp/, /sk/ for the s + obstruent (sO) condition. Adequate assessment of the production of each consonant cluster was achieved by repeating each cluster three times within each condition, while changing the surrounding phonological context (i.e. while the cluster was repeated, the remainder of the nonword changed). To ensure as far as possible that any pattern of performance would be due to the actual cluster type rather than its frequency of occurrence within the English language, all clusters were matched for frequency, as was the surrounding phonological context, as shown in the example below. Frequency of occurrence was calculated using the Children's Printed Word Database (Masterson, Stuart, Dixon & Lovejoy, 2010). The complete list of stimuli can be found in appendix 2.

- **Clusters**: /pl/ = 6680 – /sk/ = 7211
  /fl/ = 4059 – /sp/ = 4438
- **Non-words:** /ˈplɪkəˌriːdʒ/ = 4876.71 – /ˈsketəˌrɔːn/ = 4804.43

The 36 nonwords were recorded onto a Sony ICD-MX20 digital voice dictaphone by a researcher native to the Nottingham area, and subsequently converted into MP3 format using Sony Digital Voice Editor, v. 3.1. The nonwords were recorded in a randomised order, and each nonword was followed by 3 seconds of silence.

Procedure

The children were visited at their school following informed written consent from parents and were assessed on a one-to-one basis in a quiet room away from their classroom. Testing was carried out over two separate sessions on consecutive weeks. In order to maintain the child's attention, the nonword repetition test was divided across the two sessions in a counterbalanced manner. In addition to an NWRT in each session, session 1 also administered the test of Expressive Vocabulary from the CELF4. The second session administered the other core tests from the CELF: the test of Sentence Structure and the test of Word Structure. Children heard the stimuli through a Sony ICD-MX20 digital voice dictaphone with Creative TravelDock 900 Portable speakers, and spoke their responses into another of the same device.

Nonwords were transcribed in their phonemic form by one of the authors. A random sample of 20% were transcribed by a second researcher not associated with this project, and phoneme-by-phoneme inter-rater reliability was 91%. Disagreements between the two transcriptions were resolved through discussion.

5. Results

The percentage of correct responses per condition for each participant group are presented in Figure 4.

/figure 4 about here/

A 2 (cluster position: initial or medial) X 2 (cluster type: obstruent-liquid or s + obstruent) X 2 (participant group: bilingual or monolingual) mixed-design ANOVA revealed no significant main effects of cluster position, cluster type or participant group: *F*(1,30) = 3.005, *p* = .093, *F*(1,30) = 1.625, *p* = .212, *F*(1.30) = 0.847, *p* = .365 respectively. There was a significant interaction between cluster type and cluster position *F*(1,30) = 81.678, *p* < .001, no interaction between cluster type and participant group: *F*(1,30) = 0.150, *p* = .693, and a near significant interaction between cluster position and participant group: *F*(1,30) = 4.009, *p* = .054. A significant cluster position X cluster type X participant group interaction was also found: *F*(1,30) = 5.964, *p* = .021.

A by-items analysis showed exactly the same effects. There were no effects of cluster position (F(1,32) = .478, p = .495), cluster type (F(1,32) = .478, p = .495) or participant group (F(1.32) = 1.117, p = .299), a significant interaction between cluster type and cluster position (F(1,32) = 5.554, p = .025), no interaction between cluster type and participant group (F(1,32) = .005, p = .994) and no interaction between cluster position and participant group (F(1,32) = 2.189, p = .149). Once again there was a significant cluster position X cluster type X participant group interaction (F(1,32) = 4.174, p = .049).

Follow up analysis, in the form of ANOVAs performed within each of the two cluster types revealed a significant effect of cluster position for obstruent-liquid clusters, such that more errors were made word initially than word medially: *F*(1,30) = 56.228, *p* < .001 and a significant effect of cluster position for s + obstruent clusters, such that more errors were made word medially for this cluster type: *F*(1,30) = 24.803, p < .001. There was no effect of participant group for either cluster type: *F*(1,30) = 1.003, *p* = .325 for obstruent-liquid, *F*(1,30) = 0.216, *p* = .645 for s + obstruent, and no significant cluster position X participant group interaction for the former cluster type: *F*(1,30) = 1.003, *p* = .325. However, a significant cluster position X participant group interaction was found for s + obstruent clusters: *F*(1,30) = 9.810, *p* = .004. We subsequently performed paired-samples two-tailed *t*-tests within each group for the s + obstruent conditions. These revealed significantly more correct responses in the word initial s+ obstruent condition (compared to the corresponding word-medial condition) for the bilingual group, but not for the monolingual group: *t*(15) = -6.895, *p* < .001, *t*(15) = -1.143, *p* = .271 respectively.

Finally, a series of independent samples *t*-tests revealed a significant difference in the word initial s + obstruent condition, such that bilinguals performed better than monolinguals on this condition: *t*(30) = 2.314, *p* = .028, while no other comparisons reached significance: word initial obstruent-liquid clusters *t*(30) = 0.552, *p* = .585, word medial obstruent-liquid clusters *t*(30) = 1.196, *p* =.241, word medial s + obstruent clusters *t*(30) = -1.406, *p* = .170.

6. Discussion

This study was aimed at investigating an under-researched area of bilingual development: accuracy of consonant cluster production in word-initial and word-medial position. The central goal of the study was to determine whether bilingual Polish-English children are at an advantage compared to English monolinguals. Further, we wished to test predictions that arise from competing views that subscribe to either a domain-specific or a domain-general perspective of phonological knowledge.

Our study provides evidence of acceleration in the production of consonant clusters. As far as we know, this is only the second time that crosslinguistic influence has been reported at the level of syllabic structure (cf. Lleó et al., 2003), and the first time it has been found to affect consonant clusters involving onset positions. Moreover, the present study also revealed that the bilingual advantage targets one specific type of cluster (s + obstruent) in one specific word position (word-initial). This pattern cannot be explained by a domain-general view, since consonant clusters are more frequent in Polish than in English in all positions (cf. table 1), leading to the prediction that acceleration should have been found both word-initially and word-medially, albeit with a particularly strong presence word-initially. This is not what we find. Our results are in line with findings from a study on the acquisition of Polish morphology by Krajewski, Theakston, Lieven, & Tomasello who reported that frequency was “not a decisive factor” (2011, p. 830) in determining children’s performance on their nonword repetition task.

However, onset-rhyme theory also fails to explain the results, as it leads to the hypothesis that no acceleration would take place, due to the fact that Polish and English are supposedly equivalent as far as structural syllabic complexity is concerned.

Additional assumptions are therefore needed for both the domain-specific and the domain-general hypothesis if they are to be reconciled with the data above. One of these additional assumptions could be some form of “sonority markedness” (Berent, Steriade, Lennertz, & Vaknin, 2007), according to which speakers have tacit knowledge of which cluster types are more marked. The idea of markedness is tightly linked to that of complexity, and in many cases the two are essentially equivalent, as marked structures are also harder to acquire (e.g. Major, 1996; Major & Faudree 1996; Mazurkewich, 1984; *inter alia*), besides being dispreferred crosslinguistically (Blevins, 1995; Greenberg, 1978). Berent et al. (2007, p. 597) suggest that the following markedness relations hold between consonant cluster types:

(1)

a. Small sonority rises in the onset are more marked than large rises.

b. Sonority plateaus in the onset are more marked than rises.

c. Sonority falls in the onset are more marked than plateaus.

This only applies to word-initial clusters, as word-medial clusters of non-rising sonority are treated as coda-onset sequences rather than as onset clusters, and are therefore all equally marked regardless of the sonority slope involved (see also figure 3b above). If, following the spirit of this proposed hierarchy, we assume that a large sonority fall in the onset is more marked than a small sonority fall (i.e. a more fine-grained version of 1c above), our data would be successfully captured. This is because Polish includes both small and large sonority falls (e.g. [sp] and [mʃ]), while English only includes small sonority falls (e.g. [sp]) which – according to the markedness hierarchy just discussed – makes the phonological structure of Polish more marked (and thus more complex) than that of English. Importantly, the hierarchy only applies to onsets, and therefore the complexity relation does not hold word-medially, predicting that acceleration will only occur word-initially, the desired result.

However, as the hierarchy in (1) expresses phenomenological preferences rather than a formal account of linguistic structure (Berent et al., 2007), the question remains as to how it could be integrated in the two accounts at issue. For the domain-specific view this is unlikely to be problematic, as markedness relations have been routinely integrated into domain-specific phonological theories (De Lacy, 2002; Prince & Smolensky, 1993/2004; Sheer, 2004), though not necessarily into onset-rhyme theory itself. The domain-general view, on the other hand, may not easily lend itself to this type of hierarchy whose roots are in the domain-specific tradition (e.g. Kean, 1975) and which has its basis in allegedly innate constraints (Berent et al., 2007; Wright, 2004). Nevertheless, the domain-general view could account for the observed difference between word-initial and word-medial clusters if it were extended as to include some form of sonority hierarchy, together with some type of featural encoding that allows distinctions to be made between obstruents and sonorants as well as other higher-level distinctions that go beyond the encoding of individual phonetic segments (see also Davidson, 2006 on this point). This development would then lead to the right result, since English word-initial obstruent-obstruent clusters (in the form of #sC) account for only 10% of the total CC clusters available (3 out of 31, cf. table 1), while in Polish they account for 45% of the total (101 out of a possible 225 CC cluster types involve two obstruents). Word-medially, on the other hand, the gap between the two languages is negligible, with obstruent-obstruent clusters accounting for about 19% of the total CC sequences found in English (based on Hammond, 1999) and 17% of the total CC sequences of Polish (based on Rochoń, 2000). This leads to the desired result: as Polish involves four times as many types of obstruent-obstruent clusters word initially, it is therefore expected that English-Polish bilinguals will display acceleration, performing better than English monolinguals on word-initial obstruent-obstruent clusters. Further, it is now correctly expected that the same English-Polish bilinguals will have no advantage on word-medial obstruent-obstruent clusters, since the two languages differ only very marginally in this respect. Crucially, however, for this explanation to go through, the domain-general system must be endowed with the ability to distinguish high-level features such as ‘obstruent’, ‘sonorant’ and ‘liquid’, as well as with knowledge of the sonority hierarchy.

A potential alternative to the views just discussed comes from a competitor of the onset-rhyme theory, namely CVCV theory (Scheer, 2004). Developed within the domain-specific tradition, CVCV theory makes a principled distinction between obstruent-liquid, s + obstruent, and other obstruent-obstruent clusters, a fact that allows it to capture the patterns observed in our findings without the need for additional assumptions. In a parametric application of CVCV theory based on data from monolingual acquisition, Sanoudaki (2010) suggests that the parameter settings for acquiring word-initial s + obstruent clusters is a proper subset of the parameter settings needed for the acquisition of other word-initial obstruent-obstruent clusters. All remaining clusters (i.e. all word-medial clusters as well as word-initial obstruent-liquid) do not form a parametric intersection, and are therefore structurally independent from each other as far as complexity relations are concerned. On this view, it is therefore expected that acceleration in Polish-English bilinguals would only affect word-initial s + obstruent clusters. While the only word-initial obstruent clusters found in English involve s + obstruent, Polish also has other word-initial obstruent -obstruent clusters. According to the parametric relation developed within CVCV theory, this means that the word-initial clusters found in Polish are more complex than those available in English. It therefore follows that exposure to the Polish clusters would facilitate acquisition of the simpler s + obstruent English clusters. Importantly, acceleration is predicted to be limited to word-initial s + obstruent clusters, as these are the only cluster types for which Polish possesses a more complex counterpart.

7. Conclusions

This study provided evidence of acceleration in the production of consonant clusters in children simultaneously acquiring Polish and English as first languages. Our findings revealed that the bilingual advantage targets one specific type of cluster, namely s + obstruent, in one specific word position (word-initial). Obstruent-liquid clusters were unaffected, as were s + obstruent clusters in word-medial position. This pattern indicates that the interaction between sub-segmental information and the sonority hierarchy is an important aspect of phonological knowledge that is prone to being transferred across the two developing phonologies of BFLA bilinguals. Neither the domain-general nor the domain-specific view initially presented here could straightforwardly capture the findings. Nevertheless, it was suggested that the domain-specific view can be more easily extended to include additional assumptions (i.e. the sonority hierarchy and encoding of sub-segmental features), as these are rooted in the domain-specific tradition and may not naturally fit a domain-general perspective. It was then suggested that CVCV theory, a further theory also grounded in the domain-specific tradition, independently provides the apparatus necessary in order to account for our findings without the need for further assumptions.

Importantly, our study shows how investigating the development of phonology in BFLA can inform phonological theory, as well as provide evidence for what specific phonological properties are prone to crosslinguistic influence. The current study is a first step in providing evidence that crosslinguistic influence is not limited to the segmental or phonemic level, thus lending explanatory power to theoretical accounts based on the representation of sub-segmental information and their interaction with overarching structural configurations.

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Appendix 1

Participants raw scores for the CELF

	gender	age	Expressive Vocabulary	Sentence Structure	Word Structure
BILINGUALS					
	m	7;1	41	24	29
	m	7;5	39	24	26
	f	7;6	44	24	30
	f	7;6	27	25	28
	f	7;6	42	25	28
	f	7;7	42	24	30

	f	8;1	38	24	28
	f	8;4	34	23	27
	m	8;5	34	24	30
	m	8;5	49	26	31
	f	8;5	40	25	30
	m	8;7	48	25	30
	m	8;9	32	24	30
	m	8;1	47	25	30
	f	8;1	38	24	26
	f	8;1	37	26	31
MONOLINGUALS					
	f	7;1	41	24	30
	m	7;7	28	20	24
	f	7;8	40	24	28
	f	7;8	42	25	31
	m	7;8	47	25	30
	f	7;1	30	24	27
	f	8;1	33	24	26
	f	8;3	34	25	29
	f	8;4	42	23	27
	f	8;5	41	25	29
	m	8;8	45	25	30

f	8;9	42	25	27
f	8;1	43	25	31
m	8;1	44	26	31
f	8;1	50	26	31
m	8;1	38	26	29

Appendix 2: Experimental stimuli

a) Nonword stimuli containing obstruent-liquid clusters

WORD-INITIAL	WORD-MEDIAL
ˈplɪkəˌriːdʒ	ˈriːdʒəˌplɪk
ˈpletʃəˌdɜːf	ˈdɜːfəˌpletʃ
ˈplɪgəˌneɪv	ˈneɪvəˌplɪg
ˈflɪsəˌθiːn	ˈθiːnəˌflɪs
ˈflekəˌtɜːʃ	ˈtɜːʃəˌflek
ˈflɪʃəˌmɜːp	ˈmɜːpəˌflɪʃ
ˈbletʃəˌdɜːf	ˈdɜːfəˌbletʃ

ˈblɪkəˌriːdʒ	ˈriːdʒəˌblik
ˈbleʃəˌtaʊg	ˈtaʊgəˌbleʃ

b) Nonword stimuli containing s + obstruent clusters

WORD-INITIAL	WORD-MEDIAL
ˈstetʃəˌveɪb	ˈveɪbəˌstetʃ
ˈstebəˌtʃɜːk	ˈtʃɜːkəˌsteb
ˈsteθəˌgaʊd	ˈgaʊdəˌsteθ
ˈsketəˌruːn	ˈruːnəˌsket
ˈskepəˌriːg	ˈriːgəˌskep
ˈskeθəˌneɪf	ˈneɪfəˌskeθ
ˈspɪdʒəˌmaʊd	ˈmaʊdəˌspɪdʒ
ˈspɪʃəˌdɜːb	ˈdɜːbəˌspɪʃ
ˈspɪvəˌfaʊʃ	ˈfaʊʃəˌspɪv

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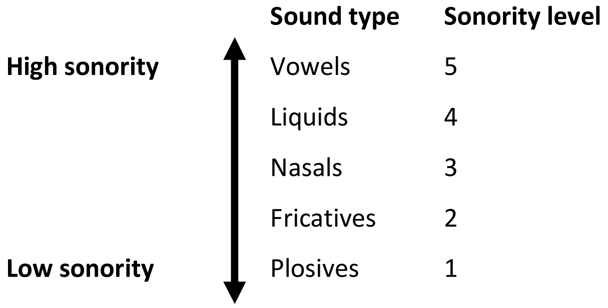
[1] Both English and Polish also allow word-final CC clusters. We will not consider these here as they are beyond the scope of this paper.

[2] Word-medial cases are also influenced by a second principle known as Maximal Onset (at least since Pulgram, 1970). We will not discuss this here as it is not directly relevant to the point at hand which is that – in terms of syllabic structure – clusters of rising sonority are generally given a single theoretical treatment regardless of their position within a word. The same does not hold for clusters of falling sonority and sonority plateaus, as discussed below.

[3] This count includes only “native” and “nativised” clusters that are systematically present in each language.

[4] Only borrowings and non-native words may sometimes have antepenultimate (and thus word-initial) stress. However, these tend to be high-register technical terms or foreign proper names and thus less likely to be an integral part of a child’s vocabulary.

Figure 1 . A 5-point sonority scale.



	Sound type	Sonority level
High sonority	Vowels	5
	Liquids	4
	Nasals	3
	Fricatives	2
Low sonority	Plosives	1

Figure 2: onset-rhyme treatment for clusters of rising sonority exemplified with the English words “plan” and “supply” and the Polish words “kra” (‘ice float’) and “dobry” (‘good’) . Both obstruent-liquid sequences are cases of branching onsets.

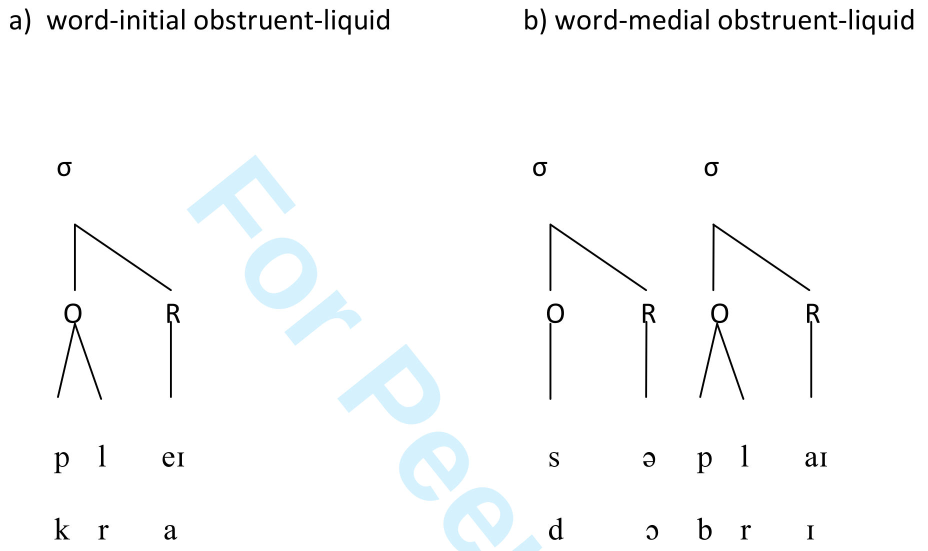
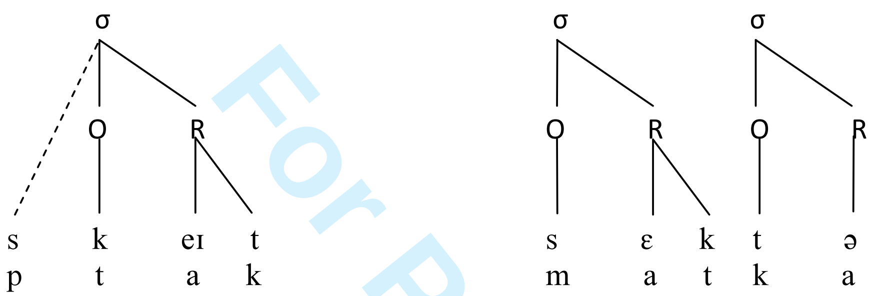


Figure 3: onset-rhyme treatment for clusters of non-rising sonority exemplified with the English words “skate” and “sector” and the Polish words “ptak” (‘bird’) and “matka” (‘mother’). The (a) set contains an extrasyllabic segment while the (b) set involves a coda-onset sequence.



a) Non-rising sonority word-initiallly b) Non-rising sonority word-medially

Figure 4. Percentage of correct responses per condition for each participant group. OL indicates obstruent-liquid and sO indicates s + obstruent. Error bars indicate standard error.

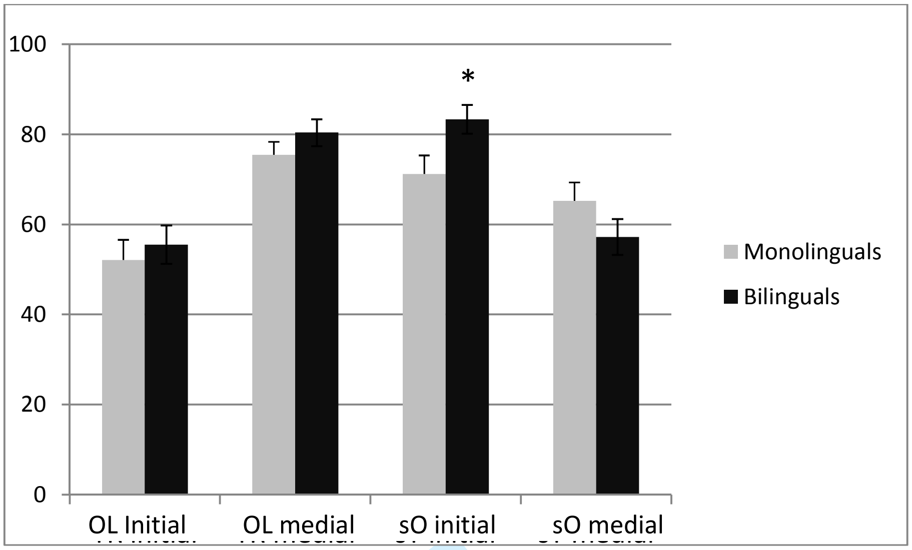


Table 1. *Number of tautomorphemic CC cluster types allowed in English (Hammond, 1999; McLeod, Doorn, & Reed, 2001) and Polish (Bargiełówna, 1950 [cited in Zydorowicz, 2010]; Bertinetto et al., 2006).*

	Polish	**English**
Word-initial #CC	225	31
Word-medial CC	484	149

Acceleration in the bilingual acquisition of phonological structure: Evidence from Polish-English bilingual children.

Abstract

This study examines the production of consonant clusters in simultaneous Polish-English bilingual children and in language-matched English monolinguals (aged 7;01- 8;11). Selection of the language pair was based on the fact that Polish allows a greater range of phonologically complex cluster types than English. A nonword repetition task was devised in order to examine clusters of different types (obstruent-liquid vs. s + obstruent) and in different word positions (initial vs. medial), two factors that play a significant role in repetition accuracy in monolingual acquisition (e.g. Kirk & Demuth, 2005). Our findings show that bilingual children outperformed monolingual controls in the word initial s + obstruent condition. These results indicate that exposure to complex word initial clusters (in Polish) can accelerate the development of less phonologically complex clusters (in English). This constitutes significant new evidence that the facilitatory effects of bilingual acquisition extend to structural phonological domains.

Keywords: bilingualism; acceleration; syllable structure; phonology

1. Introduction

Research on bilingual first language acquisition (BFLA) has shown that children differentiate between their two linguistic systems from an early age (e.g. Döpke, 1999; Genesee, 1989; Hulk & Muller, 2000; among many others). It is also generally accepted that the two linguistic systems of BFLA bilinguals may interact, a phenomenon known as *interdependence* (Paradis & Genesee, 1996) or *crosslinguistic influence* (Hulk & Muller, 2000). In particular, Paradis and Genesee (1996) identify three possible outcomes that interdependence or crosslinguistic influence may lead to, namely transfer, delay, and acceleration. Paradis and Genesee (1996) define transfer as "the incorporation of a grammatical property into one language from the other" (1996, p. 3). Hence, transfer typically leads to some ungrammatical utterances that depart from the typical path of monolingual acquisition, as the bilingual child produces non-adult structures that are syntactic calques of his/her other L1.

Delay, on the other hand, is the effect through which the overall rate of acquisition of a bilingual child decreases, allegedly due to the difficulty that bilingual children may have in dealing with two languages (although Paradis and Genesee, 1996, do not offer a detailed explanation for this claim). The third possible outcome of interdependence is acceleration. This refers to the possibility that a certain linguistic property may appear in the speech of a bilingual earlier than it does in monolinguals. The idea behind acceleration is that mastery of a particular structure in one of the two languages facilitates acquisition of the corresponding structure in the other language, thus enabling the bilingual child to outperform monolinguals in some linguistic domains.

2. Crosslinguistic Interaction in BFLA

There is a considerable body of research examining the ways in which the grammars of bilingual children interact and which particular linguistic areas are vulnerable to interdependence, with transfer being perhaps the most studied of the three potential outcomes. However, the vast majority of these studies are within the domain of syntax. For example, Müller and colleagues have reported transfer in subordinate clauses in German-French bilinguals (Müller, 1998) and object-drop in Dutch–French, German–French, and German–Italian bilinguals (Hulk & Müller, 2000; Müller & Hulk, 2001). Serratrice and colleagues have found transfer effects in the development of pronominals (Serratrice, Sorace, & Paoli, 2004; Sorace, Serratrice, Filiaci, & Baldo, 2009) and of anaphoric constructions (Serratrice, 2007) in English-Italian bilingual children. Delay has been observed in some areas of grammar such as the development of word form recognition in Welsh-English infants (Vihman, Lum, Thierry, Nakai, & Keren-Portnoy, 2006), in the acquisition of object pronouns in French-English bilinguals (Pérez-Leroux, Pirvulescu, & Roberge, 2009) and of copular constructions in Spanish-English bilinguals (Silva-Corvalán & Montanari, 2008). Acceleration seems to be much less common than either transfer or delay, though it has been reported on some occasions, notably in the acquisition of the determiner system in German-Italian and German-French children (Kupisch, 2005).

Although research on bilingual phonology is much less extensive, all three outcomes predicted by Paradis and Genesee (1996) have been attested. Paradis (2001) found transfer of stress patterns from French into English in French-English bilingual children, while Fabiano-Smith and Barlow (2010) reported bidirectional transfer across phonemic inventories in Spanish-English bilingual children: children produced Spanish-specific sounds when speaking English and English-specific sounds when speaking Spanish. Kehoe (2002) reported delay in the acquisition of the German vowel system (particularly vowel-length distinctions) in German-Spanish bilinguals, while Goldstein and Washington (2001) found that Spanish-English 4-year-old bilinguals were considerably less accurate than their monolingual peers in the rendition of spirants, flaps, and trills in Spanish. Evidence of acceleration is rather meagre, however, and as far as we know it has only been reported once within phonology, in relation to coda consonants in Spanish-German bilinguals (Lleó, Kuchenbrandt, Kehoe, & Trujillo, 2003). The Lleó et al. (2003) study is also one of very few that investigated phonological structure at the syllabic level, as most research on phonology in BFLA has focused either on prosodic or segmental aspects, particularly segmental transfer (i.e. transfer across phonemic inventories). Structural aspects of phonology in general, and consonant clusters in particular, have received relatively little attention, especially with regard to potential acceleration effects. As far as we are aware, the only two studies that have investigated consonant clusters in BFLA are those of Yavas and Barlow (2006) and Mayr, Jones, and Mennen (to appear). However, the former study restricted its focus to only #sC sequences, while the latter involved two languages with almost identical cluster phonotactics, a factor that virtually excluded the possibility of observing any crosslinguistic influence in this domain. The current study contributes towards filling this research gap by investigating non-word repetition performance in bilingual children whose two languages differ greatly as to the types of clusters they allow. The purpose of the study is twofold. Firstly, to test for potential acceleration effects in cases where children simultaneously acquire two languages that differ in the levels of complexity of the consonant clusters they allow. Secondly, to test two competing views of phonological organisation that make conflicting predictions as to whether and where acceleration of cluster structures should occur. The focus of the study will be on word-initial and word-medial onset clusters.

3. Consonant Clusters in English and Polish

It is well known that languages differ according to their phonotactic requirements which, among other things, pose limits on what consonants may cluster and in which position. Consonant clusters are typically categorised according to their *sonority profile*, which is in turn based on the *sonority scale*. The sonority scale classifies segments based on how sonorous they are, a property that depends on the degree of opening involved in their articulation (Clements, 1990; Kent, 1993; Selkirk, 1984), sometimes also classified as “loudness” (Ladefoged, 1982). A representation of the 5-point sonority scale is given in figure 1:

/figure 1 about here/

As can be seen from figure 1, vowels are the most sonorous segments, while plosives – which involve complete obstruction of the vocal tract – are the least sonorous. Following the sonority scale, clusters involving two consonants can have one of three profiles: rising sonority, as in an obstruent-liquid cluster (e.g. [pl]), falling sonority, as is the case for a fricative-plosive cluster, such as [st], or they can constitute a sonority plateau, as in plosive-plosive clusters (e.g. [pt]).

Languages may therefore differ on two dimensions, namely which sonority profile(s) they allow (rising, falling, or plateau) and in which position. English and Polish are examples of languages that show differences across these dimensions, with Polish allowing all three sonority profiles both word-initially (e.g. [pr]osić, “ask”; [vd]owa, “widow”; [pt]ak, “bird”) and word-medially (e.g. kro[pl]a “drop”; pro[zb]a, “request”; klo[tk]a, “padlock”) while English allows all three profiles only word-medially[1] (e.g. a[pl]y; po[st]er; se[kt]or) and only two of the three profiles word-initially (e.g. [pl]an; [sk]ate). In other words, the clustering patterns of English are a proper subset of the clustering patterns we find in Polish. Given that acceleration is motivated by the child having achieved a “more advanced level of […] complexity in one language than in the other” (Paradis & Genesee, 1996, p. 3), the question arises as to what this subset relation means in terms of potential complexity levels across the two languages. Addressing this question will enable us to identify what forms of acceleration might be expected in the acquisition of word-level phonology in Polish-English BFLA.

4. Consonant clusters and complexity

Phonological theories can be broadly distinguished on the basis of their representational formats. On the one hand, structural perspectives view sounds as segments belonging to a structural unit, typically the syllable (though other types of structural abstractions have also been proposed, e.g. Lowenstamm, 1996). On this view, clusters can be of different types depending on whether the consonants that constitute them belong to the same syllable (tautosyllabicity) or to two adjacent yet separate syllables (i.e. heterosyllabicity).

In standard onset-rhyme theories, syllable membership is decided based on a principle known as the Sonority Sequencing Generalisation (Clements, 1990; henceforth SSG) according to which a well-formed syllable involves an increase in sonority towards the peak and a decrease towards the edges (e.g. Selkirk, 1984; Steriade, 1982). The two consonants in a cluster are therefore taken to belong to the same syllable if they exhibit a rising sonority slope. These tautosyllabic clusters are straightforwardly represented as cases of onset branching, independently of whether they occur word-initially or word-medially[2].

/figure 2 about here/

On the other hand, clusters of non-rising sonority such as stop-stop and stop-fricative clusters violate the SSG, and are therefore treated as heterosyllabic. Moreover, they are treated differently depending on the position they occupy within a word. While they are typically assumed to be coda-onset sequences when appearing word-medially, word-initial instances are treated as somewhat special cases involving an adjunct or extrasyllabic segment (Booij & Rubach, 1990; Davies, 1990; Halle & Vergnaud, 1980; Kenstowicz, 1994; Rochoń, 2000; Steriade 1982; *inter alia*).

/figure 3 about here/

This structural taxonomy neatly captures typological alternations whereby a language like Spanish (e.g. Harris, 1969) may allow branching onsets (i.e. the structure in fig 2) but disallow extrasyllabic consonants (i.e. the structure in fig. 3a), while some other language (e.g. Korean, Sohn, 1986) may allow coda-onset clusters (i.e. the structure in fig. 3b) but ban branching onsets (i.e. the structure in fig. 2). In relation to English and Polish, figures 2 and 3 show that the two languages allow the very same levels of complexity, as both permit all possible structures, namely onset branching (figure 2), adjunction (figure 3a), and coda-onset sequences (figures 3b). The fact that English does not allow sonority plateaus word-initially does not affect its complexity level, as onset-rhyme theories treat all clusters of non-rising sonority as cases of adjunction, regardless of whether they involve plateaus or falling slopes, thus putting English on a par with Polish in terms of structural complexity. Consequently, following an onset-rhyme view of CC clusters we may hypothesise that no acceleration may occur between Polish and English either word-initially or word-medially, as the two languages allow the same levels of structural complexity in both positions.

A radically different perspective on phonological organization is presented by domain-general theories, such as exemplar based or usage-based phonology (e.g. Bybee, 2003; Pierrehumbert, 2003) which take the view that structural abstractions such as syllables are redundant. According to this view, linguistic knowledge involves memorising phonetic tokens of individual lexical items together with associated meanings and situational cues. It is from this information that phonological patterns may later emerge. Complexity is thus dictated by richer and more varied loops or network relations (Johnson, 2007), which give the speaker the ability to establish increasingly more fine-grained phonetic categories (e.g. Blumenfeld & Marian, 2009; Pierrehumbert, 2003). Within a system of this type, advanced levels of complexity are equivalent to entrenching of forms, which is in turn directly proportional to frequency in the input (e.g. Edwards, Beckman, & Munson, 2004; Frisch *et al.*, 2001). In the case of consonant clusters, complexity becomes a function of the number of possible consonantal combinations a language allows in each position. Complexity is therefore a language-specific rather than a structure-dependent matter. This has two important consequences in the case of Polish and English. Firstly, the Polish system is more complex than the English system overall, as it allows 709 tautomorphemic CC clusters (Bargiełówna, 1950 [cited in Zydorowicz, 2010]; Bertinetto, Scheuer, Dziubalska-Kołaczyk, & Agonigi, 2006) compared to the 180 available in (British) English (Hammond, 1999; McLeod, Doorn, & Reed, 2001)[3]. Secondly, the gap in complexity between Polish and English clusters is larger for the word-initial #CC category than it is for the word-medial CC category, where the ratios are 7.2 : 1 (225/31) and 3.2 : 1 (484/149) respectively.

/table 1 about here/

As consonant clusters are more prevalent in Polish than in English, it follows that the linguistic knowledge of a Polish-English bilingual will feature more entrenched representations in the Polish system than in the English counterpart. Therefore, if the two systems communicate at the level of phonological organisation, the Polish system of a Polish-English bilingual may offer a higher level of entrenchment with which to aid the development of the English system. Following domain-general views of phonology we may therefore hypothesise that Polish-English bilingual children would perform better than their monolingual English peers in cluster production in English both word-initially and word-medially, since both positions are more regularly occupied by clusters and are thus more highly entrenched in Polish than they are in English. Further, we may hypothesise that acceleration should occur with a stronger propensity word-initially due to the fact that the word-initial position provides a higher ratio of difference across the two languages.

In the remainder of the paper we investigate these hypotheses together with the hypothesis arising from the onset-rhyme view (i.e. that no acceleration should occur in any position) by analysing the English nonword repetition performance of Polish-English bilingual children word-initially and word-medially and comparing it with that of monolingual English-speaking children.

4.2 Method

Participants

Sixteen Polish-English bilingual children (11 female, 5 male, aged 7;1 to 8;11) were tested in this experiment. Sixteen monolingual English children of the same age range (9 female, 7 male, aged 7;1 to 8;11) also participated in the experiment as control group. All participants were administered the expressive vocabulary, sentence structure, and word structure tests of the Clinical Evaluation of Language Fundamentals-4 (CELF, Semel, Wiig and Secord, 2003). Participant selection was based on achieving expressive vocabulary scores within normal ranges. Each child from the bilingual group was individually matched to a child from the monolingual group based on raw scores from the sentence structure and word structure components of the test. Information on the participants and their scores on the CELF is given in appendix 1. Children were recruited and tested in schools within the Nottinghamshire and Derbyshire areas of the UK. All children were reported by school staff as exhibiting typical linguistic and cognitive development and no hearing difficulties or learning disabilities.

Design

Nonwords were manipulated for two repeated measures independent variables: cluster position (word initial or word-medial) and cluster type (obstruent-liquid vs. s + obstruent). Participant group (monolingual or bilingual) was also manipulated between subjects. The dependent variable was the repetition of the nonword.

Materials

Children were tested through a nonword repetition task (NWRT). NWRTs are widely used as a measure of phonological ability and phonological memory capacity in both typical and atypical language development (e.g. Coady & Evans, 2008; Gathercole, 2006). The task involves instructing participants to repeat nonsense words that contain the structures to be investigated. For the current study, 36 trisyllabic nonwords were devised. As the aim of the study is to investigate whether knowledge of Polish affects performance in English, the nonwords were specifically developed so that they could be potential English words while being highly unlikely (or even impossible) Polish words. This was done by ensuring that the nonwords followed the phonotactics of English while violating Polish patterns both at the segmental and at the prosodic level. At the segmental level, each non-word contained a schwa (unstressed position) as well as one long vowel or oral diphthong (e.g. [ɔː],[ɜː], [eɪ], [aʊ]), both of which are not possible Polish phonemes (Gussmann, 2007). At the prosodic level, each word followed a strong-weak-strong stress pattern (primary stress - zero stress-secondary stress), a pattern that is not only typical of English phonology (especially in trisyllabic English nouns, see Burzio, 1994; Hammond, 1999) but also rare in Polish, a language in which stress is almost invariably penultimate (e.g. Jassem, 2003)[4]. This, together with the fact that the experimenter addressed the children in English, ensured as much as possible that the children would carry out the task in a monolingual English mode (Grosjean, 1989; Soares & Grosjean, 1984).

Each nonword contained one consonant cluster in either word initial or word medial position. The cluster was either an obstruent-liquid or s + obstruent sequence. The clusters involved were /pl/, /fl/, /bl/ for the obstruent-liquid (OL) condition, and /st/, /sp/, /sk/ for the s + obstruent (sO) condition. Adequate assessment of the production of each consonant cluster was achieved by repeating each cluster three times within each condition, while changing the surrounding phonological context (i.e. while the cluster was repeated, the remainder of the nonword changed). To ensure as far as possible that any pattern of performance would be due to the actual cluster type rather than its frequency of occurrence within the English language, all clusters were matched for frequency, as was the surrounding phonological context, as shown in the example below. Frequency of occurrence was calculated using the Children's Printed Word Database (Masterson, Stuart, Dixon & Lovejoy, 2010). The complete list of stimuli can be found in appendix 2.

- **Clusters**: /pl/ = 6680 – /sk/ = 7211
  /fl/ = 4059 – /sp/ = 4438
- **Non-words:** /ˈplɪkəˌriːdʒ/ = 4876.71 – /ˈsketəˌrɔːn/ = 4804.43

The 36 nonwords were recorded onto a Sony ICD-MX20 digital voice dictaphone by a researcher native to the Nottingham area, and subsequently converted into MP3 format using Sony Digital Voice Editor, v. 3.1. The nonwords were recorded in a randomised order, and each nonword was followed by 3 seconds of silence.

Procedure

The children were visited at their school following informed written consent from parents and were assessed on a one-to-one basis in a quiet room away from their classroom. Testing was carried out over two separate sessions on consecutive weeks. In order to maintain the child's attention, the nonword repetition test was divided across the two sessions in a counterbalanced manner. In addition to an NWRT in each session, session 1 also administered the test of Expressive Vocabulary from the CELF4. The second session administered the other core tests from the CELF: the test of Sentence Structure and the test of Word Structure. Children heard the stimuli through a Sony ICD-MX20 digital voice dictaphone with Creative TravelDock 900 Portable speakers, and spoke their responses into another of the same device.

Nonwords were transcribed in their phonemic form by one of the authors. A random sample of 20% were transcribed by a second researcher not associated with this project, and phoneme-by-phoneme inter-rater reliability was 91%. Disagreements between the two transcriptions were resolved through discussion.

5. Results

The percentage of correct responses per condition for each participant group are presented in Figure 4.

/figure 4 about here/

A 2 (cluster position: initial or medial) X 2 (cluster type: obstruent-liquid or s + obstruent) X 2 (participant group: bilingual or monolingual) mixed-design ANOVA revealed no significant main effects of cluster position, cluster type or participant group: *F*(1,30) = 3.005, *p* = .093, *F*(1,30) = 1.625, *p* = .212, *F*(1.30) = 0.847, *p* = .365 respectively. There was a significant interaction between cluster type and cluster position *F*(1,30) = 81.678, *p* < .001, no interaction between cluster type and participant group: *F*(1,30) = 0.150, *p* = .693, and a near significant interaction between cluster position and participant group: *F*(1,30) = 4.009, *p* = .054. A significant cluster position X cluster type X participant group interaction was also found: *F*(1,30) = 5.964, *p* = .021.

A by-items analysis showed exactly the same effects. There were no effects of cluster position (F(1,32) = .478, p = .495), cluster type (F(1,32) = .478, p = .495) or participant group (F(1.32) = 1.117, p = .299), a significant interaction between cluster type and cluster position (F(1,32) = 5.554, p = .025), no interaction between cluster type and participant group (F(1,32) = .005, p = .994) and no interaction between cluster position and participant group (F(1,32) = 2.189, p = .149). Once again there was a significant cluster position X cluster type X participant group interaction (F(1,32) = 4.174, p = .049).

Follow up analysis, in the form of ANOVAs performed within each of the two cluster types revealed a significant effect of cluster position for obstruent-liquid clusters, such that more errors were made word initially than word medially: *F*(1,30) = 56.228, *p* < .001 and a significant effect of cluster position for s + obstruent clusters, such that more errors were made word medially for this cluster type: *F*(1,30) = 24.803, p < .001. There was no effect of participant group for either cluster type: *F*(1,30) = 1.003, *p* = .325 for obstruent-liquid, *F*(1,30) = 0.216, *p* = .645 for s + obstruent, and no significant cluster position X participant group interaction for the former cluster type: *F*(1,30) = 1.003, *p* = .325. However, a significant cluster position X participant group interaction was found for s + obstruent clusters: *F*(1,30) = 9.810, *p* = .004. We subsequently performed paired-samples two-tailed *t*-tests within each group for the s + obstruent conditions. These revealed significantly more correct responses in the word initial s+ obstruent condition (compared to the corresponding word-medial condition) for the bilingual group, but not for the monolingual group: *t*(15) = -6.895, *p* < .001, *t*(15) = -1.143, *p* = .271 respectively.

Finally, a series of independent samples *t*-tests revealed a significant difference in the word initial s + obstruent condition, such that bilinguals performed better than monolinguals on this condition: *t*(30) = 2.314, *p* = .028, while no other comparisons reached significance: word initial obstruent-liquid clusters *t*(30) = 0.552, *p* = .585, word medial obstruent-liquid clusters *t*(30) = 1.196, *p* =.241, word medial s + obstruent clusters *t*(30) = -1.406, *p* = .170.

6. Discussion

This study was aimed at investigating an under-researched area of bilingual development: accuracy of consonant cluster production in word-initial and word-medial position. The central goal of the study was to determine whether bilingual Polish-English children are at an advantage compared to English monolinguals. Further, we wished to test predictions that arise from competing views that subscribe to either a domain-specific or a domain-general perspective of phonological knowledge.

Our study provides evidence of acceleration in the production of consonant clusters. As far as we know, this is only the second time that crosslinguistic influence has been reported at the level of syllabic structure (cf. Lleó et al., 2003), and the first time it has been found to affect consonant clusters involving onset positions. Moreover, the present study also revealed that the bilingual advantage targets one specific type of cluster (s + obstruent) in one specific word position (word-initial). This pattern cannot be explained by a domain-general view, since consonant clusters are more frequent in Polish than in English in all positions (cf. table 1), leading to the prediction that acceleration should have been found both word-initially and word-medially, albeit with a particularly strong presence word-initially. This is not what we find. Our results are in line with findings from a study on the acquisition of Polish morphology by Krajewski, Theakston, Lieven, & Tomasello who reported that frequency was “not a decisive factor” (2011, p. 830) in determining children’s performance on their nonword repetition task.

However, onset-rhyme theory also fails to explain the results, as it leads to the hypothesis that no acceleration would take place, due to the fact that Polish and English are supposedly equivalent as far as structural syllabic complexity is concerned.

Additional assumptions are therefore needed for both the domain-specific and the domain-general hypothesis if they are to be reconciled with the data above. One of these additional assumptions could be some form of “sonority markedness” (Berent, Steriade, Lennertz, & Vaknin, 2007), according to which speakers have tacit knowledge of which cluster types are more marked. The idea of markedness is tightly linked to that of complexity, and in many cases the two are essentially equivalent, as marked structures are also harder to acquire (e.g. Major, 1996; Major & Faudree 1996; Mazurkewich, 1984; *inter alia*), besides being dispreferred crosslinguistically (Blevins, 1995; Greenberg, 1978). Berent et al. (2007, p. 597) suggest that the following markedness relations hold between consonant cluster types:

(1)

a. Small sonority rises in the onset are more marked than large rises.

b. Sonority plateaus in the onset are more marked than rises.

c. Sonority falls in the onset are more marked than plateaus.

This only applies to word-initial clusters, as word-medial clusters of non-rising sonority are treated as coda-onset sequences rather than as onset clusters, and are therefore all equally marked regardless of the sonority slope involved (see also figure 3b above). If, following the spirit of this proposed hierarchy, we assume that a large sonority fall in the onset is more marked than a small sonority fall (i.e. a more fine-grained version of 1c above), our data would be successfully captured. This is because Polish includes both small and large sonority falls (e.g. [sp] and [mʃ]), while English only includes small sonority falls (e.g. [sp]) which – according to the markedness hierarchy just discussed – makes the phonological structure of Polish more marked (and thus more complex) than that of English. Importantly, the hierarchy only applies to onsets, and therefore the complexity relation does not hold word-medially, predicting that acceleration will only occur word-initially, the desired result.

However, as the hierarchy in (1) expresses phenomenological preferences rather than a formal account of linguistic structure (Berent et al., 2007), the question remains as to how it could be integrated in the two accounts at issue. For the domain-specific view this is unlikely to be problematic, as markedness relations have been routinely integrated into domain-specific phonological theories (De Lacy, 2002; Prince & Smolensky, 1993/2004; Sheer, 2004), though not necessarily into onset-rhyme theory itself. The domain-general view, on the other hand, may not easily lend itself to this type of hierarchy whose roots are in the domain-specific tradition (e.g. Kean, 1975) and which has its basis in allegedly innate constraints (Berent et al., 2007; Wright, 2004). Nevertheless, the domain-general view could account for the observed difference between word-initial and word-medial clusters if it were extended as to include some form of sonority hierarchy, together with some type of featural encoding that allows distinctions to be made between obstruents and sonorants as well as other higher-level distinctions that go beyond the encoding of individual phonetic segments (see also Davidson, 2006 on this point). This development would then lead to the right result, since English word-initial obstruent-obstruent clusters (in the form of #sC) account for only 10% of the total CC clusters available (3 out of 31, cf. table 1), while in Polish they account for 45% of the total (101 out of a possible 225 CC cluster types involve two obstruents). Word-medially, on the other hand, the gap between the two languages is negligible, with obstruent-obstruent clusters accounting for about 19% of the total CC sequences found in English (based on Hammond, 1999) and 17% of the total CC sequences of Polish (based on Rochoń, 2000). This leads to the desired result: as Polish involves four times as many types of obstruent-obstruent clusters word initially, it is therefore expected that English-Polish bilinguals will display acceleration, performing better than English monolinguals on word-initial obstruent-obstruent clusters. Further, it is now correctly expected that the same English-Polish bilinguals will have no advantage on word-medial obstruent-obstruent clusters, since the two languages differ only very marginally in this respect. Crucially, however, for this explanation to go through, the domain-general system must be endowed with the ability to distinguish high-level features such as ‘obstruent’, ‘sonorant’ and ‘liquid’, as well as with knowledge of the sonority hierarchy.

A potential alternative to the views just discussed comes from a competitor of the onset-rhyme theory, namely CVCV theory (Scheer, 2004). Developed within the domain-specific tradition, CVCV theory makes a principled distinction between obstruent-liquid, s + obstruent, and other obstruent-obstruent clusters, a fact that allows it to capture the patterns observed in our findings without the need for additional assumptions. In a parametric application of CVCV theory based on data from monolingual acquisition, Sanoudaki (2010) suggests that the parameter settings for acquiring word-initial s + obstruent clusters is a proper subset of the parameter settings needed for the acquisition of other word-initial obstruent-obstruent clusters. All remaining clusters (i.e. all word-medial clusters as well as word-initial obstruent-liquid) do not form a parametric intersection, and are therefore structurally independent from each other as far as complexity relations are concerned. On this view, it is therefore expected that acceleration in Polish-English bilinguals would only affect word-initial s + obstruent clusters. While the only word-initial obstruent clusters found in English involve s + obstruent, Polish also has other word-initial obstruent -obstruent clusters. According to the parametric relation developed within CVCV theory, this means that the word-initial clusters found in Polish are more complex than those available in English. It therefore follows that exposure to the Polish clusters would facilitate acquisition of the simpler s + obstruent English clusters. Importantly, acceleration is predicted to be limited to word-initial s + obstruent clusters, as these are the only cluster types for which Polish possesses a more complex counterpart.

7. Conclusions

This study provided evidence of acceleration in the production of consonant clusters in children simultaneously acquiring Polish and English as first languages. Our findings revealed that the bilingual advantage targets one specific type of cluster, namely s + obstruent, in one specific word position (word-initial). Obstruent-liquid clusters were unaffected, as were s + obstruent clusters in word-medial position. This pattern indicates that the interaction between sub-segmental information and the sonority hierarchy is an important aspect of phonological knowledge that is prone to being transferred across the two developing phonologies of BFLA bilinguals. Neither the domain-general nor the domain-specific view initially presented here could straightforwardly capture the findings. Nevertheless, it was suggested that the domain-specific view can be more easily extended to include additional assumptions (i.e. the sonority hierarchy and encoding of sub-segmental features), as these are rooted in the domain-specific tradition and may not naturally fit a domain-general perspective. It was then suggested that CVCV theory, a further theory also grounded in the domain-specific tradition, independently provides the apparatus necessary in order to account for our findings without the need for further assumptions.

Importantly, our study shows how investigating the development of phonology in BFLA can inform phonological theory, as well as provide evidence for what specific phonological properties are prone to crosslinguistic influence. The current study is a first step in providing evidence that crosslinguistic influence is not limited to the segmental or phonemic level, thus lending explanatory power to theoretical accounts based on the representation of sub-segmental information and their interaction with overarching structural configurations.

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Appendix 1

Participants raw scores for the CELF

	gender	age	Expressive Vocabulary	Sentence Structure	Word Structure
BILINGUALS					
	m	7;1	41	24	29
	m	7;5	39	24	26
	f	7;6	44	24	30
	f	7;6	27	25	28
	f	7;6	42	25	28
	f	7;7	42	24	30

	f	8;1	38	24	28
	f	8;4	34	23	27
	m	8;5	34	24	30
	m	8;5	49	26	31
	f	8;5	40	25	30
	m	8;7	48	25	30
	m	8;9	32	24	30
	m	8;1	47	25	30
	f	8;1	38	24	26
	f	8;1	37	26	31
MONOLINGUALS					
	f	7;1	41	24	30
	m	7;7	28	20	24
	f	7;8	40	24	28
	f	7;8	42	25	31
	m	7;8	47	25	30
	f	7;1	30	24	27
	f	8;1	33	24	26
	f	8;3	34	25	29
	f	8;4	42	23	27
	f	8;5	41	25	29
	m	8;8	45	25	30

f	8;9	42	25	27
f	8;1	43	25	31
m	8;1	44	26	31
f	8;1	50	26	31
m	8;1	38	26	29

Appendix 2: Experimental stimuli

a) Nonword stimuli containing obstruent-liquid clusters

WORD-INITIAL	WORD-MEDIAL
ˈplɪkəˌriːdʒ	ˈriːdʒəˌplɪk
ˈpletʃəˌdɜːf	ˈdɜːfəˌpletʃ
ˈplɪgəˌneɪv	ˈneɪvəˌplɪg
ˈflɪsəˌθiːn	ˈθiːnəˌflɪs
ˈflekəˌtɜːʃ	ˈtɜːʃəˌflek
ˈflɪʃəˌmɜːp	ˈmɜːpəˌflɪʃ
ˈbletʃəˌdɜːf	ˈdɜːfəˌbletʃ

ˈblɪkəˌriːdʒ	ˈriːdʒəˌblik
ˈbleʃəˌtaʊg	ˈtaʊgəˌbleʃ

b) Nonword stimuli containing s + obstruent clusters

WORD-INITIAL	WORD-MEDIAL
ˈstetʃəˌveɪb	ˈveɪbəˌstetʃ
ˈstebəˌtʃɜːk	ˈtʃɜːkəˌsteb
ˈsteθəˌgaʊd	ˈgaʊdəˌsteθ
ˈsketəˌruːn	ˈruːnəˌsket
ˈskepəˌriːg	ˈriːgəˌskep
ˈskeθəˌneɪf	ˈneɪfəˌskeθ
ˈspɪdʒəˌmaʊd	ˈmaʊdəˌspɪdʒ
ˈspɪʃəˌdɜːb	ˈdɜːbəˌspɪʃ
ˈspɪvəˌfaʊʃ	ˈfaʊʃəˌspɪv

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[1] Both English and Polish also allow word-final CC clusters. We will not consider these here as they are beyond the scope of this paper.

[2] Word-medial cases are also influenced by a second principle known as Maximal Onset (at least since Pulgram, 1970). We will not discuss this here as it is not directly relevant to the point at hand which is that – in terms of syllabic structure – clusters of rising sonority are generally given a single theoretical treatment regardless of their position within a word. The same does not hold for clusters of falling sonority and sonority plateaus, as discussed below.

[3] This count includes only “native” and “nativised” clusters that are systematically present in each language.

[4] Only borrowings and non-native words may sometimes have antepenultimate (and thus word-initial) stress. However, these tend to be high-register technical terms or foreign proper names and thus less likely to be an integral part of a child’s vocabulary.