How much exposure to English is necessary for a bilingual toddler to perform like a monolingual peer in language tests?

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Abstract

Background: Bilingual children are under-referred due to an ostensible expectation that they lag behind their monolingual peers in their English acquisition. The recommendations of the RCSLT state that bilingual children should be assessed in both the languages known by the children. However, despite these recommendations, a majority of speech and language professionals report that they assess bilingual children only in English as bilingual children come from a wide array of language backgrounds and standardised language measures are not available for the majority of these. Moreover, even when such measures do exist, they are not tailored for bilingual children.

Aims: We asked whether a cut-off exists in the proportion of exposure to English at which one should expect a bilingual toddler to perform as well as a monolingual on a test standardised for monolingual English-speaking children.

Methods & Procedures: Thirty-five bilingual 2½-year-olds exposed to British English plus an additional language and thirty-six British monolingual toddlers were assessed on the auditory component of the Preschool Language Scale, British Picture Vocabulary Scale and an object-naming measure. All parents completed the Oxford Communicative Development Inventory (Oxford CDI) and an exposure questionnaire which assessed the proportion of English in the language input. Where the CDI existed in the bilingual's additional language, this data was also collected.

Results: Hierarchical regression analyses found the proportion of exposure to English to be the main predictor of the performance of bilingual toddlers. Bilingual toddlers who received 60% exposure to English or more performed like their monolingual peers on all measures. K-means cluster analyses and Levene variance tests confirmed the estimated English exposure cut-off at 60% for all language measures. Finally, for one additional language for which we had multiple participants, additional language CDI production scores were significantly inversely related to the amount of exposure to English.

Conclusions & Implications: Typically-developing 2½ -year-olds who are bilingual in English and an additional language and who hear English 60% of the time or more, perform equivalently to their typically-developing monolingual peers.

What is known about this subject?

Bilingual children have a smaller vocabulary in each of their two languages than monolingual children and also take a little longer to reach the same levels as monolinguals on various grammatical tasks. The relative amount of exposure to each language is strongly related to the children's rate of development in those languages.

What this paper adds

A questionnaire which measures the proportion of exposure to English in the child's input for use by health professionals involved in screening and referral for language assessment. With the use of the English exposure questionnaire, professionals should be able to interpret the performance of a bilingual toddler on a standardised monolingual test more accurately. Most importantly, if a bilingual child hears English 60% of the time or more, professionals should expect this child to perform as well as monolingual children and should use the same criteria for referral as they would for a monolingual child.

Introduction

The bilingual population is increasing worldwide. According to the Office for National Statistics (ONS, 2011) the number of births to non-UK born mothers in England and Wales has seen a marked rise over the last decade. These births accounted for 25.1 per cent of all live births in 2010 compared with 15.5 per cent in 2000. This proportion has increased every year since 1990, when it was just under 12 per cent.

Given the variability of the bilingual population, the focus of this paper is towards infant or simultaneous bilingual children, i.e. children acquiring two languages from birth or very early in their life, coming from a wide array of linguistic backgrounds. It is well-established that simultaneous bilingual children may have smaller vocabularies in each of their two languages when compared to monolinguals learning one of those languages in isolation (Bialystok, 2009). They also take a little longer to reach the same level as monolinguals on various grammatical tasks (cf. Gathercole, 2007; Nicholls, Eadie & Reilly, 2011). However, they make up for this in terms of advanced meta-linguistic awareness (cf. Bialystok, 2007) and earlier development of executive functions (cf. Bialystok, 2009; Kovacs & Mehler, 2009; Poulin-Dubois, Blaye, Coutya, & Bialystok, 2011; but see also Baker, 2011 chapter 7, for a good discussion on positive vs. negative effects of bilingualism on cognition). Nonetheless, amongst the general population the impression remains that one should expect bilingual children to be delayed – even quite dramatically delayed – in early acquisition of language (Stow & Dodd, 2003) and later development of grammar (Nicholls *et al.*, 2011).

Assessing children for early language development is particularly problematic in the UK as children do not have regular access to a paediatrician. Rather each child is seen once at 12 months and once at around 2½ years by a ‘health visitor’, who is a Specialist Community Public Health Nurse within the Nursing and Midwifery Council trained to carry out and interpret a general assessment of motor, social and language development. In addition, children are referred to SLPs (Speech and Language Professionals) if either their parents or their 'nursery' (i.e. kindergarten) teachers flag issues with language development. Unfortunately in the UK, early years' workers (health visitors and early years' practitioners) are not required to receive specific training in what to expect in language development from monolingual let alone bilingual children.

Since 2013 all early years' workers are legally required to judge whether each 2-3-year-old in their care is at an age-appropriate level for a number of developmental criteria including language. Health visitors are now legally required to assess 24-month-olds on general developmental questionnaires which include language sub-components, such as the revised Ages and Stages Questionnaires (ASQ, Squires & Bricker, 2009). Regrettably, none of the new measures take bilingual children into account. While early identification is desirable, concern has been expressed that bilingual children with delays or disorders relating to or including language development may be at risk of under-referral in the UK (e.g. Bedore & Peña, 2008; Crutchley, 2000; Stow & Dodd, 2003). Under-referrals can occur for a variety of developmental disorders including pervasive disorders (ASD), sensory (hearing impairment) and also specific language impairment (SLI), i.e. language impairment that cannot be accounted for in terms of general intellectual disorder, hearing loss or environmental deprivation (e.g. Bishop, 2006). Crutchley (2000) found in parent interviews that the proportion of bilingual parents (45%) who stated that professionals had initially failed to diagnose their child's difficulties or take note of the parents' worries was far larger than for monolingual parents (18%). Under-referral has potentially more serious consequences than over-referral since most professionals agree that early identification of at-risk children, even without an intervention (in a watch-and-see approach, see Paul, 1996), is a necessary step to prepare for an intervention (see also Ellis Weismer, 2000).

Procedures available to SLPs for assessment of bilingual children

When bilingual pre-schoolers are referred, the official guidelines of both the Royal College of Speech and Language Therapists (RCSLT, 2007) in the UK and the American Speech-Language-Hearing Association (ASHA, 1999) in the USA are for them to be assessed in both of their languages (see also Peña & Halle, 2011). However, two real-world facts make this principle untenable. Firstly, bilingual pre-schoolers, particularly those of low socioeconomic status and / or first-time parents will not be referred if early years' workers in the UK are not provided with an easily applicable means for determining whether a particular bilingual child is in need of referral. Secondly, even when bilingual toddlers are referred to SLPs, the official guidelines are usually not followed because assessment in the child's 'other' language is challenging for a number of reasons.

We briefly review the evidence that the assessment of bilingual pre-schoolers in predominantly English-speaking countries, not only in the UK, is problematic even for SLPs. SLPs are frequently faced with children for whom no standardised tests are available in the additional language. Moreover, even when standardised tests exist in the additional language, the monolingual norms of either English or the additional language cannot be directly applied to bilingual children as they have been found to underperform monolinguals on these language tests (e.g. Camilleri & Law, 2007; Hemsley, Holm & Dodd, 2010; Hoff, Core, Place, Rumiche, Senor & Parra, 2012; Restrepo & Silverman, 2001).

One proposal is to use a composite scoring assessment (or conceptual vocabularies), i.e. the total number of semantic concepts for which a child has a lexical form, regardless of which language it is in (Junker & Stockman, 2002; Pearson, Fernandez & Oller, 1993). Modern online translation plus the availability of relevant software for calculating composite vocabularies can make this a quick option. However, research into composite methodology on bilingual children has produced mixed results (Bedore, Peña, García and Cortez, 2005; Hemsley, Holm & Dodd, 2010; Pearson *et al*., 1993; Thordardottir, Rothenberg, Rivard & Naves, 2006). Thordardottir *et* *al*. (2006), for example, found that the conceptual vocabulary of a bilingual group with balanced exposure to both languages was in fact significantly lower than that of the monolingual English group. Pearson *et al*. (1993), in contrast, found that the composite expressive vocabulary of Spanish-English bilingual children was equal to that of a monolingual group. Recently, Hemsley *et al.* (2010) carried out a longitudinal investigation of language development in sequential Samoan-English bilingual children during their first year at school. The bilingual composite receptive vocabulary scores were comparable to the monolingual scores but the bilingual composite expressive scores were significantly below the scores of monolingual peers.

In sum, the procedure of composite scores has great potential for SLPs but with such mixed findings firm conclusions cannot be drawn regarding a language disorder particularly when the composite score of a bilingual child is lower than that of monolingual peers. Crucially, with the exception of the CDI parent reports (Communicative Developmental Inventories, e.g. Fenson, Dale, Reznick, Thal, Bates, Hartung, *et al*., 2007; Hamilton, Plunkett & Shafer, 2000), the availability of standardised assessment tools in languages other than English is limited.

Another option is to work with an interpreter. This has its pitfalls as translation styles may vary from the general to the literal word-for-word (Stow & Dodd, 2003) and result in data that are hard to interpret. Such informal, ad-hoc procedures would be considered inappropriate as the sole or main source of information on a child's language level for a monolingual child (Thordardottir *et al*., 2006). For this reason, one recent stream of thought puts a great deal of weight on asking the parents of bilingual children to assess how well they think their child is progressing. For instance, Paradis, Emmerzael and Duncan (2010) developed a parental questionnaire for parents of children aged 4;9 – 9;0, which is designed for use with bilingual children from any language background along with guidelines for scoring in a clinical setting. However, it was found that some parents were unable to assess their children's sentence comprehension and did not even understand the questions pertaining to this.

One of the most promising methods is that of dynamic assessment (e.g., Camilleri & Law, 2007; Gutiérrez-Clellan & Peña, 2001; Hasson, Camilleri, Jones, Smith & Dodd, 2013; Hasson & Joffe, 2007). The most common method is test-teach-retest, where the difference between initial score and later score is compared, after an intervention has been carried out, thus revealing a particular child's potential to learn. If a child initially performs significantly below the mean because of a reduced exposure to a language, his or her intact learning capacity should be revealed by a large difference in pre- and post-test scores compared to a child with a reduced language learning capacity. While this method appears suitable, its critical drawback is the time and thus the cost involved for the SLPs.

Recently, with the intention of reducing time and cost, the Dynamic Assessment of Preschoolers' Proficiency in Learning English (DAPPLE) was developed in the UK to respond to the clinical need to distinguish between disorder and bilingualism due to a child's language learning context (Hasson *et al*., 2013). The DAPPLE assessment takes less than 60 minutes to administer and it examines the children's ability to learn vocabulary, sentence structure and phonology. This battery of language skills assessments sounds promising as a pre-diagnostic tool but is not designed for children younger than 42 months.

Reality of use of the official procedures for assessing bilingual children

Probably in part because of the time and cost constraints that SLPs face on the ground, the reality of the procedures currently used to assess bilingual children in English-speaking countries is that the official recommendations are not strictly followed by professionals. Caesar and Kohler (2007) surveyed 409 SLPs in USA, and found that 130 of these had at least one bilingual child on their caseload within an age range from mid-preschool years up to secondary school. While 63% of the respondents mentioned Spanish as one of the second languages, they also listed 33 other languages. Only 48% mentioned using interpreters some of the time. Some mentioned taking language samples, but these were predominately samples of the children's spoken English and not of their additional language. The predominant method of assessing bilingual children was through formal standardised procedures and 75% said that English was the language of the test or procedure they used most frequently. The Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997) and the Clinical Evaluation of Language Fundamentals 3 (CELF; Wiig, Secord & Semel, 1992) were the most frequently mentioned tests and very few reported using the Spanish adaptation of the PPVT or any other test with norms in the child's additional language or with bilingual norms.

Stow and Dodd (2003) painted a similar picture of referral and therapy for bilingual children in the UK. In Australia, the situation is by no means different (Williams & McLeod, 2012). On a questionnaire returned by 128 SLPs, English was reported to be the primary language for assessment and intervention; three quarters of them assessed the children using only English standardised tests. Like the American SLPs study, many of them assessed children's speech (77%) and language (34%) without assistance from an interpreter or a family member. Although about half of the Australian SLPs in the sample had at least minimal competence in a language other than English, the languages spoken by these SLPs rarely matched the primary languages spoken by the children on the SLPs' caseload.

Aims

Considering all the aforementioned obstacles, and given that the waiting list in the UK to see a SLP, even after referral, is up to 12 months in some regions, a move towards basic screening by non-SLP professionals would seem a pragmatic move. Our starting idea was to develop a measure with which an early years' worker would be able, through discussion with the parent, to determine, firstly, the percentage of time the child hears English and secondly, the child's performance on the British English version of the MacArthur-Bates CDI (Fenson, *et al*., 2007).

Our working hypothesis was that simultaneous English-dominant bilinguals might be expected to score within monolingual norms on the CDI. Therefore a bilingual child who is a) dominant in English and b) performing significantly below the monolingual norms would be in need of a referral to SLPs. That would constitute a first step towards an early identification of bilinguals at risk (excluding at this stage the case of those who are non-English dominant – which will be addressed in the general discussion). This practical approach would enable the development of a systematic language measure easily used by early years' workers, who can then, if necessary, refer to SLPs. These would hopefully have reduced caseloads as a result of not having to carry out the initial screening process which would free up their time to implement intervention methods such as dynamic assessment.

The first step was to develop a questionnaire which estimates the percentage of time a bilingual child hears English. Bilingual children do not hear and use each of their languages as frequently as monolingual peers who speak one language, and bilingual children have different experiences with their two languages that could lead to different outcomes. Indeed, it has been established that the relative amount of exposure in each language is strongly related to the children's rate of development in those languages (Gathercole & Thomas, 2009; Hoff *et al.*, 2012; Pearson, Fernández, Lewedeg, & Oller, 1997; Scheele, Leseman, & Mayo, 2010; Thordardottir, 2011). The variable of amount of exposure has often been described in terms of the languages spoken at home versus in the school. Recent attempts have been made to calculate the English input of 2 year old children by gathering more detail, for example using a prospective Language Diary (De Houwer, 2009; Hoff *et al.*, 2012; Parra, Hoff & Core, 2011; Place & Hoff, 2011). In this document, caregivers kept a log diary over a course of seven days which measured the percentage of 30-minute periods when the child heard each of the two languages, the type of interaction context and the number of speakers. Thordardottir (2011) chose to calculate relative amount of language exposure through a detailed questionnaire completed by parents to assess the child's exposure to each language in situations with potential communicative interactions, with data spanning a continuum of bilingual exposure. In the current study, we developed our own questionnaire which obtains precise calculations of the percentage of language exposure of a child (see Appendix 1).

Our second step was to include simultaneous bilingual toddlers from a variety of language backgrounds, as long as one of their languages was English, as that is the situation which SLPs face in the UK, USA, Australia and Canada (e.g. Caesar & Kohler, 2007; Paradis *et al*., 2010; Stow & Dodd, 2003; Williams & McLeod, 2012). We focused on simultaneous bilingual children who use two languages in either the receptive and expressive modality. Finally, we restricted our focus to children aged between 28 and 32 months, which is the earliest age at which children are referred to speech therapy in most areas of the UK.

The third step was to establish empirically what level of English language development should be expected, given the proportion of time a given bilingual toddler hears English. We investigated whether the scores of UK bilingual children on various production and comprehension measures could be predicted by the proportion of exposure to English (as compared to the additional language) experienced during a typical week. The crucial question was whether one could identify a minimal cut-off point of English exposure above which the group of bilingual children would perform similarly to monolingual peers, and over which at-risk children could be easily identified.

We compared our sample of bilingual children to a sample of monolingual children matched on age, gender ratio, parental occupational and educational level. Our rationale was firstly to replicate previous findings that bilingual 2½ -year-olds as a group will indeed differ from their monolingual peers on language assessment tests, if tested on one language only. Secondly we wished to provide a direct benchmark for determining the language exposure threshold above which bilinguals are comparable to monolinguals.

Methods

Participants

Eighty-six children living in Plymouth, East Kent and the Birmingham area were recruited through the University databases of the Plymouth Baby Lab, Kent Child Development Unit and Birmingham Infant and Child Laboratory. Forty-two were native British monolingual English-speaking and 44 were simultaneous bilingual children born in the UK. There were two sets of exclusion criteria. The first set, which applied equally to monolingual and bilingual children, resulted in the exclusion of 8 children: parents reported a diagnosis of hearing impairments or a speech delay (2 children); premature birth (1 child); children either did not cooperate or their parents intervened during the test (2 children); children did not complete three or more assessment measures (3 children). The second set of exclusion criteria applied only to bilingual children. These resulted in 4 children being excluded because their parents did not fill in the English exposure questionnaire and an additional 3 were excluded because their parents rated them as having nearly 100% input in one language.

The final sample comprised 36 British monolingual (21 girls) and 35 bilingual (17 girls) children aged 28-32 months (for monolingual children: *M* = 30.47, SD = 1.2; and for bilinguals: M = 30.21, SD = 1.2). Most of the children were first (60%) or second (30%) born, whilst the remaining children were third (7%) or fourth (3%) born. Socioeconomic status of families was calculated by educational achievement of each parent as well as by parental occupation rated on the 9-point scale proposed by Hollingshead (1975, as cited in Bornstein, Hahn, Suwalsky & Haynes, 2003). The educational level of most families was high (81%; i.e. degree and above) or middle (16%, i.e. completion of secondary school) status[1]. Information about occupational status appeared more discriminating as the scores ranged from 3 to 9 with a mean at 7.6. The latter did not differ between the two groups. There was no difference between the bilingual and monolingual households in the distribution of mothers or fathers across the levels of occupational status and education ($t(67) = 1.51$, $p = .14$ and $t(67) = 1.20$, $p = .23$, respectively).

The bilingual children were all born and raised in England and were exposed to no more than two languages. Among the bilingual children, 20 had both parents speaking the same additional language to the child, 9 had only the father and 6 had only the mother speaking the additional language. The additional languages spoken were Arabic (13), French (3), Punjabi (2), Italian (2), Spanish (2), Catalan, German, Greek, Irish Gaelic, Dutch, Finnish, Polish, Albanian, Czech, Kurdish, Afrikaans, Swahili, and Mandarin.

English exposure questionnaire

We used a self-report English exposure questionnaire devised to obtain an objective estimate of the average proportion of the time a child hears English and the additional language during a typical week that did not involve holiday periods such as Christmas break during the last year of the life of the child. In Appendix 1 the example questionnaire has been filled out by a French speaking mother and an English father with a 30 month-old girl.

Section A identifies the number of language/s spoken at home[2] and accordingly directs the respondent to subsection B or C or D, which are similar with the exception of the initial question. Section B assesses bilingual children whose parents both speak the same additional language at home (e.g. mother and father both speak Russian). Section C is addressed to the families in which one parent speaks English to the child and the other parent speaks an additional language.

These sections ask questions about the average number of hours per week a child spends in an English speaking childcare environment (nursery, day care, preschool, child-minder, relative or friend) and the number of hours the child spends sleeping per 24 hours. Other questions ask how often the mother and the father talk to the child in English as opposed to the additional language when on their own with the child using a five-point ordinal scale (e.g. always, usually, half the time); who speaks more to the child when the two carers are together; and the number of hours per week that a child spends time with each parent individually. Parents are asked to report the number of hours they spend with their child rather than being asked to estimate the percentage of time their child hears English. Indeed it has been found that people fail to keep detailed records of who is talking to the child in what language and in fact parents are rather poor estimators of their own efforts and abilities (see e.g. Kruger & Dunning, 1999).

Based on this information, calculations (see the computations in Appendix 2) estimate the number of English-hearing hours per week. Scale responses (e.g. whether the mother speaks English to the child always, most of the time, half/half, rarely or never) are converted into percentages (here, 100, 75. 50, 25 and 0%) which are used to recalculate the number of English hours. For example if the mother spends 10 hours a week on her own with her child, and speaks to her mostly in English, then these ten hours will become 7.5 hours of English and 2.5 hours of the additional language.

The last section D was filled in by both monolingual and bilingual parents and provides details of the date and place of birth of the child, the highest qualification of the mother and of the father along with their current occupations, the length of time living in the UK and the presence and number of younger or older siblings. It also assesses any known developmental issues such as being born six or more weeks prematurely, hearing difficulties or more general developmental delays.

Language skill tests

The British Picture Vocabulary Scale III (BPVS III, Dunn, Dunn and NFER, 2009*).* The BPVS III is a receptive vocabulary test for Standard British English between 2 years 6 months and 16 years 11 months. It is the British version of the American equivalent the PPVT-III which has been found to be one of the most frequently used tools for diagnosis of bilingual children in the USA (Caesar & Kohler, 2007). Each item consists of four colour illustrations on a plate and the task of the children is to select the picture that illustrates the meaning of a word said by the test administrator. The test ends at the ceiling set that is established when a child made eight or more consecutive errors within a subset. The scores are calculated as the number of correct responses.

The auditory component of the Preschool Language Scale 4 (PLS 4; Zimmerman et al., 2009). This test, which covers a range of English language skills normed for monolingual children between birth and 6 years, is designed to identify children with a language disorder. The PLS 4 consists of two components, an auditory and a production component. The auditory component contains sentence processing items along with some vocabulary items. The PLS 4 is frequently used by SLPs in the UK and USA with this age-group.

Object naming sub-task (*adapted English SETK-2*). The language test Sprachentwicklungstest-2 (SETK-2, Grimm, 2000) was originally designed and standardised in German to measure receptive and expressive language skills in 24-36 months-old German children, and is divided into four sub-tests, of which only the object naming sub-task (see Appendix 3 for the English translation)[3] was used. This object-naming task consists of 30 items, of which the first six are actual objects. The latter are matched to the original items in the German version. The remaining 24 items are colour pictures, which were photocopied from the German test, except the item ‘petrol station’ which has been replaced as it did not look like an English petrol station. For each item, the children were asked ‘What’s this?’ and were given a score of 1 if the child offered any of the English words given as options for that item. If the child gave a response which was not on the list (e.g. ‘egg’ for ball or ‘apple’ for ‘pear’) or in the other language, this was scored as 0.

Oxford Communicative Development Inventory (Oxford CDI, Hamilton *et al*., 2000). This measure uses parental report to assess comprehension and production of 416 early English words. Since our ultimate long-term goal is to be able to establish a level of English development using a basic language measure usable by early years' workers in consultation with parents, an ideal measure would have been a previously standardised British version of the American MacArthur-Bates Communicative Development Inventory (Fenson *et al*., 2007) which not only asks parents about their child's vocabulary but also about their child's expressive morphology and multi-clause utterances. Unfortunately, to date there is no standardised British version of this tool. We therefore chose the Oxford CDI since results using this version have been published (Hamilton *et al*., 2000).

Additional language CDI. For the assessment of vocabulary size in the additional language a version of the additional language CDI-tool, where available, was handed to the parent. The rationale for this is to examine whether there is an (inverse) correlation between vocabulary development in English and in the additional language, and importantly whether the amount of exposure to English predicts the vocabulary scores in both CDI versions.

The additional language CDIs included versions in Arabic (Safi, Dashash, & Ba-Saffar, in progress, personal communication), French (Kern, 2007), Italian (Caselli & Casadio, 1995), Spanish (López Ornat, Gallego, Gallo, Karousou, Mariscal & Martínez, 2005), Catalan (Serrat Sellabona, in progress, personal communication), German (Szagun Stumper, & Schramm, 2009), Gaelic Irish (O'Toole & Fletcher, 2010), Dutch (Zink & Lejaegere, 2002), Finnish (Lyytinen, 1999), Polish (Smoczynska, in progress, personal communication), Slovak (Kapalková, Slančová, Bónová, Kesselová, & Mikulajová, 2010)[4], and Mandarin (Tardif, Fletcher, Zhang, Liang, & Zuo, 2008) languages. For the two Punjabi bilingual children, the Punjabi-English bilingual tester translated the Oxford CDI into Punjabi[5].

Procedure

Almost all children were seen twice by monolingual British English-speaking research assistants with no more than ten days between the two visits. Prior to the first visit, all parents were sent the Oxford CDI (and the CDI in the additional language when available) to be filled in at home and asked to observe their child for a few days. During the first visit the children were assessed on the PLS 4 Auditory Comprehension test. During the second visit, the parents returned the Oxford CDI and the self-report English exposure questionnaire (which was discussed with the researcher on the day of the testing), whilst the children were assessed on the BPVS III and English SETK-2. Each testing session lasted 30 minutes, and if testing was not completed during this time, the parent and child returned for a third visit.

Results

Table 1 presents the mean values and standard deviations of the bilingual and monolingual groups in terms of demographic data (age, gender, birth rank, parental occupation and education) and language assessment measures (BPVS III, PLS 4, English SETK-2, Oxford CDI). Raw scores were obtained as measures for the BPVS III, PLS 4, and English SETK-2, and transformed into z-scores for all analyses, although for clarity, some figures and tables are presented with raw scores. Z-score transformations were carried out by subtracting the mean value on a language test of the whole group of children from the individual child score; this difference was then divided by the group standard deviation. This means that z scores for all the children are on the same scale and hence that z scores from bilingual and monolingual children can be meaningfully compared. Standardised normative scores were not used for the BPVS III and PLS 4 since the normative data for BPVS III start from 36 months which is above the age of our children. On the PLS 4 our children fell right in between the age bands for the standardised norms, which in this test are grouped separately for 24-29 and 30-35 months. Therefore, if normative scores had been used the youngest children would have achieved higher scores than our oldest children.

Finally, for the CDIs Comprehension and Production in English and the additional languages, percentage scores were used, mainly because it was not possible to transform the scores on the CDIs in the additional language into z-scores due to the small sample in each particular additional language and also because of the variability in the total number of items for each language (see below for discussion).

Insert Table 1 here

Comparison between monolingual and bilingual children

Before we discuss the main analyses which look at the English language development of bilinguals as a function of the proportion of English in the input, we first present global comparisons between the monolingual control group and the bilingual children with all input levels conflated. Independent two-sample t-tests were conducted to compare the scores of the English monolingual children and the bilingual children on the English receptive and expressive language assessments (with equal variances not assumed; we shall come back to this later in the analyses).

As can be seen in Table 1, bilingual children's receptive vocabularies in English as assessed by the BPVS III were on average significantly lower than those of the monolingual children, $t(56.4) = 3.94$, $p < .001$; mean diff. = .89, Cohen's d = .98. Similarly, the expressive vocabulary scores as assessed by the English SETK-2 were significantly lower for the bilingual group as a whole than for the monolingual controls, $t(33.4) = 4.36$, $p < .001$; mean diff. = 1.0, d = 1.12. Both the Oxford CDI comprehension and production scores were also significantly lower for the bilingual children than for the monolingual children, $t(35.3) = 3.93$, $p < .001$; mean diff. =

86.82, d = .95 and $t(42.0) = 5.36$, $p < .001$; mean diff. = 130.1, d = 1.30, for word comprehension and production respectively. Finally, for the PLS 4 test, which assesses English comprehension, the bilingual children scored lower on average than the monolingual children but this difference was not significant, $t(40.9) = 1.29$, $p = .2$; mean diff. = 0.37).

Our finding that as a group, bilingual children scored lower than monolinguals in terms of lexical knowledge, when assessed on one of their languages, is not surprising and fits with the previous literature (e.g. Junker & Stockman, 2002; Hoff *et al*., 2012; Gathercole, 2002; Thordardottir *et al*., 2006). Furthermore, on all measures, bilingual toddlers displayed higher variances than monolingual ones. This would be expected from a participant sample whose language development depends on additional characteristics as compared to monolinguals (including, as we will see, the amount of exposure to each language). In addition, for some measures (Oxford CDI comprehension and SETK-2), some monolingual toddlers might have reached the ceiling levels, as reflected not only in higher scores but also in lower associated variance as compared to bilinguals.

A more interesting question, however, is the degree to which their performance depends on the proportion of their English input. We examined how the amount of English exposure would predict the scores on the language assessment tests, once corrected for the effect of demographic variables such as gender, age, birth order and SES.

Relationship between English vocabulary skills, demographic variables and English exposure

Bilingual children spanned the full range of the proportion of English in the input which can be found amongst bilingual toddlers in modern Britain: the proportion of English in their input ranged between 5% and 98% in a typical week during the last year of the life of the child ($M = 58.23$; $SD = 26.67$).

Hierarchical regression analyses were carried out for each language measure to determine whether English exposure could be used to predict the vocabulary skills of bilingual children, after accounting for demographic data[6]. In the first block, predictor variables comprised the age in months, birth rank in the family, gender of child, parent's education and occupation scores. In the second block, percentage of exposure to English was introduced. Table 2 displays the percentage of variance explained in each block for each language measure together with the parameters of the regression equations.

For the regression analyses performed on the language comprehension/auditory measures tests (BPVS III, PLS 4 and CDI Comprehension), the demographic measures did not account for a significant proportion of variance, but in the second block the proportion of English exposure was a significant predictor (marginally for PLS 4 though; see Table 2 and also Figure 1) and explained a significant amount of variance (an additional 24.1% for the BPVS III, 11.6% for the PLS 4, and 26.4% for the CDI Comprehension). The regression analyses for the two tests of lexical production (the English SETK-2 and the Oxford CDI Production) both revealed a significant impact of demographic variables in the first block (43.2% variance explained for the SETK-2 and 36% for the CDI Production), mainly due to the age variable (SETK-2: standardised $\beta = .47$, $t(22) = 2.84$, $p = .009$; CDI Production: standardised $\beta = .51$, $t(26) = 3.13$, $p = .004$). In the second block, proportion of exposure to English significantly explained an additional 15.9% (SETK-2) and 30.4% (CDI Production) of the variance.

Insert Table 2 and Figure 1 here

Identifying the percentage amount of English exposure needed to perform within a monolingual range

In summary, so far the proportion of English in the language input to a bilingual 2½ -year-old predicts his or her performance in the five English assessment measures used in this study (marginally in the case of the PLS 4), once demographic data including age, birth order, gender, and parents' occupation and education scores have been accounted for. This brings us to the crucial question as to whether there is a cut-off point in terms of the proportion of a child's English input above which an early years' worker can treat that child as monolingual for purposes of assessment for referral; and if yes, what is the percentage of exposure to English above which bilingual children achieve similar scores to monolingual children?

In order to determine this, a two-stage cluster analysis was carried out, as recommended by Milligan and Sokol (1980; see also Punj & Stewart, 1983). A first approximation of the data grouping was obtained via a hierarchical cluster analysis, which was then refined by a k-means analysis (see Steinley, 2006, for a review of k-means cluster analyses methods). For the initial hierarchical cluster analysis Ward's minimum variance method was used (Ward, 1963), together with squared Euclidian distance as the similarity measure for each language assessment test (BPVS III, English SETK-2, Oxford CDI comprehension and Oxford CDI production). Each child's score (z-score or raw score depending on the measure, see above) was entered without the information about his/her linguistic background (monolingual or bilingual) and without information about their amount of exposure to English. This was followed by a K-means cluster analysis to optimise the results.

From the hierarchical cluster analyses, dendograms for each of the four measures show that a 2-clusters solution divides the entire population in two groups. For example for the BPVS III, 19 participants were assigned to Cluster 1 and 46 to Cluster 2. Out of the 19 assigned to Cluster 1, 14 were bilinguals and 5 monolinguals (with low scores on the BPVS III). Cluster 2 consisted of 29 monolinguals and 17 bilinguals (with high scores on the BPVS III). Inspection of the amount of exposure of bilinguals (N=31) assigned to Cluster 1 or 2 shows that most of those with less than 60% exposure to English were found in Cluster 1 (12 children out of 15) and most of those with more than 60% of English were found in Cluster 2 (14 out of 16). Then the k-means cluster analysis (see Table 3) confirmed and refined this result by assigning 12 bilinguals with exposure under 60%, 2 bilinguals with exposure above 60% and 6 monolinguals to Cluster 1, while Cluster 2 was made of 3 bilinguals with exposure under 60%, 14 bilinguals with exposure above 60% and 28 monolinguals. Table 3 clearly illustrates that for each language assessment measure, the cluster solution divides children into two groups: most monolinguals and the bilinguals with more than 60% exposure to English in one group, and most bilinguals with less than 60% exposure to English in the other group.

Insert Table 3 here

Further analyses were run to corroborate this first classification of the children's scores into two broad categories. First, the bilingual children were ranked according to their amount of English exposure from 5 to 98%. Then we performed independent-samples t-tests with unequal variance assumed[7] between the 35 bilingual children and the 36 monolingual children on each of the following tests: BPVS III, English SETK-2, Oxford CDI Comprehension and Oxford CDI Production[8]. The two groups of children systematically differed on these tests. Then, the bilingual child with the lowest amount of exposure to English (5%) was removed and the analysis was re-run. Again the monolingual and the bilingual scores were significantly different. The bilingual child with the lowest amount of exposure to English was progressively removed until there was no longer any significant difference between the bilingual and the monolingual groups. This stage was reached when bilingual children with exposure to English above 54% were compared to the monolinguals for the BPVS III measure, above 58% for the English SETK-2, above 53% for the Oxford CDI Comprehension and above 62% for the Oxford CDI Production[9]. In other words, a bilingual child with a percentage of exposure to English at 60% (as a rounded cut-off point) or above is very likely to score similarly to a monolingual child on all four measures, whereas a child exposed to English less than 60% of the time is likely to score less than a monolingual child on the four standardised tests.

As a subsequent step, the data on Table 4 are included to provide an illustration of the ranked individual bilingual and monolingual children on the different measures (percentage of exposure to English, PLS 4 Auditory, BPVS III, English SETK-2, Oxford CDI Comprehension and Production). The purpose of this table is to highlight children whose performance may be considered outlying relative to the distribution seen in monolingual children. To do this we use the mean and SD derived from the monolingual distribution. More specifically, we have highlighted in light grey all the values that fall under 1 SD and in dark grey the values that fall under 2 SD below the average of the monolingual children for that measure. As can be seen, outliers are found randomly across monolinguals and bilinguals with an exposure above 60%, but are much more common for bilinguals with exposure under 60%.

Insert Table 4 here

An interesting additional point is that variability was higher in the 18 bilingual children with less 60% exposure to English than in the 17 children with 60% or above (see Table 4 and Figure 1), suggesting a higher homogeneity of children's performances with higher English exposure. Levene tests confirmed that variance in children's performances with 60% exposure or above was lower than in bilinguals with less exposure to English for the CDI Comprehension ($F(1, 32) = 33.55$, $p < .001$), and the CDI Production ($F(1, 32) = 6.86$, $p = .01$), and marginally lower for the English SETK-2 ($F(1, 28) = 3.87$, $p = .059$). Thus, it would appear that beyond a critical amount of input in a particular language, the vast majority of children have the ability to acquire that language in a relatively similar way.

Finally, it was also verified that the distribution of scores in the bilingual children with exposure to English above 60% was similar to that of the monolingual children in terms of variance by using Levene tests to compare the two groups for each language measure. Levene tests were non-significant for all measures, with F values below 1 for the BPVS III, the CDI Comprehension and Production and the PLS 4, and F value slightly higher for the English SETK-2 ($F(1, 47) = 2.37$, $p = .13$). This confirms that the variance was similar in monolinguals and bilinguals with exposure to English above 60% for all measures.

The Additional language CDI-tool

Up to this point we have only examined the English abilities of the bilingual children. However, the parents of 29 of the 35 bilingual children also completed a version of the CDI in the additional language which had been adapted, or was in the process of being adapted or, in the case of Punjabi, translated for the purposes of this study. As the proportion of exposure to English was the main predictor variable for the total expressive vocabulary of the Oxford CDI, we investigated if the inverse pattern would be found for the additional language CDI (see also Pearson, *et al.*, 1997).

Although a bivariate Pearson correlation analysis carried out on the percentage of the total number of words produced in each additional language CDI of bilingual children did show a trend towards a linear negative relationship with the English exposure, $r = -.27$, $p = .15$, (see Figure 2), this was not significant (a hierarchical regression analysis as above shows that the amount of exposure explains an additional amount of variance when introduced after demographical data, but not significantly so). One reason for this might be the unfortunate diversity across CDI adaptations in terms of the number of words included, meaning that some

CDIs tested a broader range of vocabulary including less frequent words than others, leading to variation in exposure percentages and making the cross-linguistic comparison difficult. To illustrate, whereas the Mandarin version contains a broad sample of vocabulary of 767 words, the Arabic version contains only 416, i.e. almost half the words.

Insert Figure 2 here

We then focused on the 13 Arabic-English bilingual participants, a population which is more highly represented in our sample, and looked at the correlation between the amount of English exposure and their score on the Arabic CDI. Although the norms for monolingual Arabic speakers do not yet exist for the Arabic CDI and although we are aware that there exists a variety of Arabic dialects, at least all our Arabic-English participants were assessed with the same tool, so any trend towards one direction or the other is meaningful. Once corrected for demographic data i.e. age, birth order, gender, parental education and occupation scores, the amount of exposure explained an additional 40.7% of the variance ($F(1, 6) = 6.62$, $p = .042$) and the Arabic CDI scores were significantly inversely related to the amount of exposure to English (standardised $\beta = -0.87$).

Discussion

The current study investigated whether the scores of a sample of UK simultaneous bilingual toddlers on various production and comprehension measures could be predicted by the proportion of exposure to English as compared to the additional language, as measured by our English Exposure Questionnaire. The crucial question was whether one could identify a cut-off point above which simultaneous bilingual toddlers as a group would perform similarly to monolinguals, and over which at-risk toddlers could be easily identified. Our long-term goal underlying this pilot study was to develop an assessment method for bilingual two-year-olds which could be carried out by early years' workers in consultation with parents. The ideal measure for this would be a standardised British version of the CDI in conjunction with an objective measure of the proportion of the toddler's English input.

Since the MacArthur-Bates CDI is not standardised in the UK, we firstly assessed 35 simultaneous bilingual 28-32 month-olds on the Oxford CDI and 36 monolinguals matched for age and socioeconomic status. We also assessed both groups on two measures standardised for monolinguals (BPVS III and PLS 4) as well as an object-naming test (English SETK-2). When possible, the bilingual toddlers were also assessed on the additional language CDI.

Cut-off point of exposure to English

We indeed found in hierarchical regression analyses that, after accounting for demographic variables including age, birth order, gender, parent's occupation and education scores, the proportion of exposure to English was the strongest (and for comprehension the only) predictor of the performance of bilingual toddlers on the CDI for both lexical comprehension and production and accounted for 11-26% of the variance. Moreover, two-stage cluster analyses suggested a 60% exposure-to-English cut-off point above which the bilingual toddlers performed like their matched monolingual control group. Thus, for CDI comprehension all monolinguals and all the bilinguals for whom English composed 60% or more of their exposure fell into the same cluster, whereas the bilinguals for whom English comprised less than 60% of their exposure mostly fell into another cluster.

These data are further supported by the fact that not only did the proportion of exposure to English predict performance of the same toddlers on the BPVS III and the English SETK-2, but also that the cut-off point in terms of proportion of English in the input for these other two tests was highly similar to that for the CDI. That said, on the PLS 4 Auditory component, the only test which assessed the comprehension of mixed processing skills of vocabulary and sentences, bilingual toddlers as a group could not be distinguished significantly from their monolingual peers, although marginal significance was found for regression analysis of the relationship between proportion of exposure to English and performance on the PLS 4. However, the majority of the bilingual toddlers did not complete the PLS 4 and those who did predominantly heard English more than 60% of the time.

Another caveat is that whilst the cluster analyses identified two distinct groupings at an English input proportion of 60% for all four measures, the iterative t-test identified an English input proportion cut-off of 53-54% for the two comprehension measures but 58-64% for the two production measures. Nonetheless all thresholds these are similar and indeed tie in with the study of Thordardottir (2011) in which the critical input level was proposed to be 40-60% exposure for receptive vocabulary and 60% for expressive vocabulary for bilingual children to score similarly to monolingual children. Clearly, if an alternative estimate of the proportion of exposure to English were used, then one would probably not end up with exactly 60% as some kind of magic number. However, the conclusion would still hold that bilingual toddlers who are dominant in English can be assessed in English only and thus need to be referred if their English test scores are 1.5 – 2 SD below the monolingual means.

Amount of exposure to English predicting early language development: The view of language dominance

Simultaneous bilingual toddlers have fewer opportunities relative to their monolingual peers to hear multiple tokens of the same word in one given language, which would allow them to build up a robust lexical entry. It is therefore not surprising that the amount of exposure to the two languages has a direct influence on their receptive and expressive vocabularies. However, the amount of exposure seems to have a catastrophic rather than a linear effect on the process of language acquisition, the term catastrophic here being taken in its mathematical sense. That is, when the Additional language is the minority language of the community and when exposure to English is somewhat greater than that to the additional language, English seems to be optimally acquired.

The cut-off of 60% suggested by our data, and above which bilingual children seem to acquire English very similarly to their monolingual counterparts, could correspond to the value which determines their dominant language. In addition to providing some quantification of the amount of exposure necessary for one language to become dominant, our data also suggest a strong view of dominance, in which performance in the dominant language becomes indistinguishable from that of a monolingual child. That is, a child who is exposed to English above 60% of the time is able to acquire a lexical competence in English equal to that of a monolingual child, alongside a lexical competence in the additional language which is more unpredictable.

Bilingual children with less than 60% exposure to English

Our current results do not provide a direct solution for those bilingual toddlers for whom English composes less than 60% of their input. While we did ask the parents to complete the CDI in the additional language, where this CDI was available, overall there was no significant relationship between exposure to English and the scores in the additional language. This was mainly due to the variability created by the use of CDIs from different languages which had a large degree of variability in the total word scores. However, when we only look at a sample of Arabic-English toddlers who were all assessed with the same CDI tool in Arabic, a significant negative relationship did indeed emerge. Thus one tentative suggestion emerging from our study is to promote the use – where possible – of the CDIs which have been standardised for the additional languages. In fact, in personal communication, we have heard that SLPs in various regions of the UK are asking interpreters to translate the USA MacArthur CDIs.

The omission of productive syntax measure

The original intention was to pilot a measure which early years' workers could easily be trained to carry out and we thought this would be unlikely for measures such as the analysis of language samples or carrying out the expressive component of the PLS 4. On reflection, for a larger scale follow-up we would prefer to use the Lincoln-UK version of the Toddler CDI (Meints & Woodford, 2011), although unstandardised, as it is closer to the original USA MacArthur-Bates CDI in also having measures of morphology and syntax. That said, almost all primary-school aged SLI children score at least 1 SD below the mean on vocabulary measures (Conti-Ramsden, Crutchley & Botting, 1997), no matter which 'sub-group' of disorder they fall under. And, further, almost all children with SLI have a history of initial language delay, which manifests itself in delayed and protracted receptive and expressive lexical acquisition. Although not all toddlers with delayed vocabulary development later receive a diagnosis of SLI, Dale, Price, Bishop and Plomin (2003) found that typically-developing 2-year-olds who scored below the 10th percentile on the MacArthur-Bates Short Form CDI in production were significantly more likely to fall into the category of language-impairment in the 3-4 year-old age-range. Only a tiny proportion of the 6500+ children who scored above the 10th percentile for vocabulary production at two years went on to have difficulties in grammatical development at 3 and 4 years of age.

Grammatical development has been found to be highly intercorrelated with lexical development not only in normally-developing monolingual children but also in normally-developing bilingual children, possibly as a result of underlying general maturational processes. That is, a Spanish-English bilingual child's grammatical development in Spanish is predicted by his or her lexical development in Spanish (and not by his or her lexical development in English) and vice versa (Conboy & Thal, 2006; Marchman, Martinez-Sussman & Dale, 2004). Thus, we do not consider measurement of lexical comprehension and production to be at all irrelevant in an initial assessment of two-year-old bilinguals who may have a language, hearing or other developmental disorder.

Validity of English exposure questionnaire

There are a number of critiques that one could make about our questionnaire. One might argue that detailed diary data collected by the parent on when and how much a particular language is spoken (see e.g. Hoff *et al*., 2012; Place & Hoff, 2011; but see also Paradis, 2010 with older children) might lead to a more accurate estimate of the proportion of English in the input although there is suggestion that humans are poor at indicating the frequency with which they carry out certain actions (see e.g. Schwarz, Bless, Bohner, Harlacher & Kellenbenz, 1991).

One might also quibble with the fact that the English exposure questionnaire gives more weight to maternal than to paternal input; the quality of exposure to English was evaluated by assigning more weight to the mother than to the father (2/3 versus 1/3) given the same amount of time spent alone with their child. However, fathers generally produce less verbal output than mothers to their child. They spend a greater proportion of their time interacting with their children in play activities, and their play is more physical than that of mothers, therefore directly impacting on the amount of exposure to English and the additional language (e.g. Pancsofar & Vernon-Feagans, 2006; Place & Hoff, 2011).

Furthermore, it could be argued that the English exposure questionnaire did not evaluate the quality of any exposure to English when the non-English parent spoke to the child, the type of language spoken between the parents in presence of the child, how much the parents talk to English friends or the amount of time spent watching television in English versus the additional language. Also, the potential co-occurring intra-sentential mixing or mixed language input within the same speaker should ideally be explicitly measured to disentangle its frequency and its effects from those of co-occurring dual language input.

Notwithstanding these potential problems with our exposure questionnaire, the data from our questionnaire accounted for a significant amount of variance in all the language tests we used. The fact that the proportion of exposure to English was a significant predictor for all the regression analyses (albeit marginally so for the PLS) indicates that our instrument was at least roughly estimating the proportion of exposure to English. Therefore, independent of whether our English exposure questionnaire or a future alternative is used as an instrument for early years' workers, at the very least our instrument indicates a potential way forward for assessing bilingual toddlers living in Britain and in the cognate English speaking countries (USA, Canada, Australia, New Zealand and South Africa).

Clinical implications

Since 2013 early years' workers in the UK are required to check all 2 year-olds in their care. In addition, health visitors are required to screen children using the Ages and Stages Questionnaire (ASQ) which consists of 30 questions, of which 6 pertain to the communication/language area (Squires & Bricker, 2009). However, in a systematic review of paediatric language screening in the US, Nelson, Nygren, Walker & Panoscha (2006) noted that the language component of the ASQ had not been independently validated. Moreover, they pointed out that there has been no study to date which has systematically compared the relative validity of two or more language screening instruments even for monolingual children. Most importantly, the ASQ does not include suggestions for bilingual children.

The results of our study indicate that in principle early identification is possible if bilingual children who hear English 60% of the time or more are assessed using only English tools which are standardised for monolingual children. These indications should have potential positive implications since in principle early years' workers could screen in English approximately half of the bilingual children, i.e. those who are above 60% on English exposure. This would also constitute a step forward for the issue of under-referral (Crutchley, 2000) as that the waiting list for SLPs would consist primarily of children who have a language delay.

On the other hand, the children with less than 60% exposure to English would also require an assessment in the additional language which, in turn, would be their dominant language. It would be necessary to check whether the language scores match with the monolingual scores on the additional language CDI. In a large number of cases, the CDI in the additional language could be available on-line as an assessment tool. Once a child at-risk for language delay has been referred to a SLP, she/he may find it helpful, particularly for the expressive tasks, to obtain a composite vocabulary score of the CDIs to assess if these scores are equal or lower to monolingual scores as some literature on bilingual children has suggested (for a discussion cf. Bedore & Peña, 2008; Hemsley *et al*., 2010). Alternatively, more in-depth follow-up assessments may be carried out such as dynamic assessment to determine the existence and nature of any disorder. The suggestion that these children could be assessed by exploiting the recent development of a relatively fast and non-costly dynamic assessment procedure (Hasson *et al*., 2013) is intriguing, and ideally this should be adapted for younger children.

Research involving a diversity of languages in the bilingual group

The heterogeneity of additional languages included in the study could be seen as a weakness in the field of developmental bilingualism as we did not consider the different degrees of linguistic proximity to English, as well as the differences in the social prestige of the additional language (e.g. Welsh in Wales as compared to Punjabi in Plymouth). However, we hold that it is in fact a strength of the current study, firstly because early years' workers in the UK do not usually see bilingual toddlers learning one particular additional language. Rather, they encounter a multitude of different additional languages. Secondly, any variability that this heterogeneity causes should lead to weaker relationships between the exposure to English and performance on language tests. Thus, the fact that we found significant relationships is a point in favour of our approach.

We argue that it is counterproductive to restrict the comparative study to one particular homogeneous additional language versus English language, particularly if this produces an extremely large number of dual language comparisons resulting from the thousands of languages spoken in the world (Katzner, 2002). Indeed, it does seem possible to consider the child as an English learner with a particular amount of exposure. Our work suggests that the data collected from children with one homogeneous additional language pattern in the same way as data from children with a variety of additional languages. Overall, this approach offers the prospect of a new way of thinking about the early assessment of bilingual two-and-a-half-year-olds. For two-year-and-a-half-olds who are dominant in one of their two languages, assessment in one language only and with simple tools seems possible. This could allow early years' workers to make an early evaluation regarding a child's language at 30 months of age, allowing those who need it to be referred early and eliminating those who are not in need of referral from the waiting lists.

Conclusions

The current study provides unprecedented information regarding bilingual language development relating to the challenges faced by SLPs in the UK in the clinical assessment of diverse children speaking a vast array of languages. Not surprisingly, we found that simultaneous bilingual children as a group underperformed their English monolingual peers (matched with regards to demographic characteristics) in English proficiency. This study showed that children's achievement in English was not influenced by general factors such as gender, birth order or educational and occupational scores. Rather, the extent of English language mastery was strongly predicted by the amount of exposure to English after the demographic variables were accounted for. Although there is a general consensus that it is usually invalid to compare bilingual children to monolingual norms, this study clearly showed that at and above 60% of exposure to English, bilingual children are comparable to their monolingual peers and can be assessed using the monolingual norms so that a child with language disorder can be identified. For the children with less than 60% of exposure to English, the findings are less clear given the variability of the CDIs available in the other languages. Nevertheless, the Arabic CDI data gathered from the sub-sample of Arabic-English children showed that the amount of exposure to English was again a strong (but inversely related) predictor of Arabic language performance.

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Tables

Table 1. Mean values of demographic variables together with mean raw scores and z-scores, when appropriate, for the BPVS III, auditory PLS 4, English SETK-2, Oxford CDI word comprehension and word production scores of English monolingual and bilingual children (standard deviations are given in parentheses). Parents' occupation is provided on a scale from 1 to 9 following Hollingshead (1975, as cited by Bornstein, Hahn, Suwalsky & Haynes, 2003) and parental education on a 3 point scale between 1 and 3. Missing values are due to unavailable data (parents failing to provide a questionnaire or child refusing to participate).

	Monolingual			***Bilingual***		
	Raw scores (SD)	**z-scores (SD)**	**N**	**Raw scores (SD)**	**z-scores (SD)**	**N**
Age (months)	30.21 (1.16)		36	30.21 (1.16)		35
Proportion of girls	58.3%		35	48.6%		35
Birth rank	1.36 (0.59)		34	1.71 (0.87)		35
Parent's occupation	7.86 (1.26)		34	7.35 (1.49)		35
Parents' education	2.71 (0.46)		34	2.85 (0.50)		35
BPVS III	37.68 (9.88)	0.42 (0.78)	34	26.45 (12.76)	-0.47 (1.03)	31
PLS 4 Auditory	41.19 (6.02)	0.15 (0.96)	31	38.90 (6.48)	-0.21 (1.03)	21
English SETK-2	25.70 (2.48)	0.48 (0.35)	33	18.63 (8.54)	-0.52 (1.21)	30
Oxford CDI Comprehension	399.29 (24.20)		35	312.47 (126.67)		34
Oxford CDI Production	372.71 (50.26)		35	242.62 (132.69)		34

Table 2. Summary of the hierarchical regression analyses for the BPVSIII, PLS 4 Auditory, English SETK-2, Oxford CDI word comprehension and word production scores of bilingual children. For each block of variables entered in the regression and for each measure the value of the β coefficient is given with the p-value for the associated t-test. For each block the resulting R^2 with its F value and level of significance is also provided. P-values more than 0.10 are reported as ns (non-significant) and values <= to 0.05 are in bold.

		BPVSIII		PLS 4		SETK-2		CDI Comp		CDI Prod	
		Coef. (SE Coef)	**p**	**Coef. (SE Coef)**	**p**	**Coef. (SE Coef)**	**p**	**Coef. (SE Coef)**	**p**	**Coef. (SE Coef)**	**p**
Block 1	**Age**	0.34 (0.41)	**0.04**	0.27 (0.31)	ns	0.47 (0.47)	**0.009**	29.23 (0.27)	ns	56.86 (0.51)	**0.004**
	Birth rank	-0.18 (-0.15)	ns	-0.05 (-0.03)	ns	-0.44 (-0.31)	0.065	-17.85 (-0.12)	ns	-39.21 (-0.25)	ns
	Gender	-0.17 (-0.08)	ns	0.16 (0.08)	ns	0.04 (0.02)	ns	2.54 (0.01)	ns	-42.27 (-0.16)	ns
	Education	-0.13 (-0.06)	ns	0.53 (0.25)	ns	0.32 (0.14)	ns	46.81 (0.22)	ns	14.32 (0.06)	ns
	Occupation	0.14 (0.19)	ns	0.22 (0.41)	ns	0.17 (0.22)	ns	-0.37 (-0.004)	ns	13.95 (0.16)	ns
	R^2	0.207		0.482		0.431		0.154		0.36	
	F	F(5,30) = 1.31	ns	F(5, 19) = 2.61	0.072	F(5, 28) = 3.49	**0.017**	F(5, 32) < 1	ns	F(5, 32) = 3.04	**0.026**
Block 2	**Age**	0.25 (0.31)	0.07	0.29 (0.34)	0.09	0.37 (0.37)	**0.019**	18.56 (0.17)	ns	45.09 (0.40)	**0.003**
	Birth rank	-0.05 (-0.04)	ns	0.02 (0.01)	ns	-0.27 (-0.19)	ns	9.01 (0.06)	ns	-9.49 (-0.06)	ns
	Gender	-0.32 (-0.15)	ns	0.19 (0.09)	ns	0.03 (0.01)	ns	-9.47 (-0.04)	ns	-55.56 (-.21)	0.082
	Education	-0.41 (-0.20)	ns	-0.15 (-0.07)	ns	-0.02 (-0.01)	ns	18.15 (0.07)	ns	-28.46 (-0.11)	ns
	Occupation	0.01 (0.02)	ns	0.27 (0.50)	0.09	0.11 (0.15)	ns	-6.71 (-0.08)	ns	6.94 (0.08)	ns
	Exposure	0.02 (0.57)	**0.003**	0.02 (0.43)	0.07	0.02 (0.47)	**0.008**	2.79 (0.59)	**0.002**	3.09 (0.63)	**<.0001**
	R^2	0.448		0.598		0.591		0.418		0.664	
	F	F(6, 30) = 3.25	**0.018**	F(6, 19) = 3.23	**0.036**	F(6, 28) = 5.29	**0.002**	F(6, 32) = 3.11	**0.02**	F(6, 32) = 8.55	**<.0001**

Table 3. Number of children within each exposure category assigned to each cluster arising from K-means cluster analysis on children's scores on the BPVS III, English SETK-2, CDI word comprehension and word production. The last column shows the mean distance between the two clusters for each measure.

		Bilingual <60%	Bilingual >60%	Monolingual = 100%	Distance between clusters
BPVS III	Cluster 1	12	2	5	22.13
	Cluster 2	3	14	29	
English SETK-2	Cluster 1	9	1	0	17.3
	Cluster 2	5	15	32	
CDI Comprehension	Cluster 1	9	0	0	266.7
	Cluster 2	9	16	35	
CDI Production	Cluster 1	14	1	2	243.5
	Cluster 2	4	15	33	

Table 4. Individual raw scores of all children (bilingual and monolingual) assessed on the five English assessment measures, ranked as a function of their amount of exposure to English (from 5% to 100%). The score for the additional language CDI production is expressed as a percentage of the total amount of words for that particular CDI. Pale grey cells correspond to values which are under 1 SD below the mean of the monolinguals for this measure. Highlighted in dark grey cells are values under 2 SD from the monolingual values. For example, the average score of the monolinguals for the BPVS III is 37.7, with a SD 9.88. Therefore all outliers scores smaller than 27.8 are coloured in pale grey in this column, and those smaller than 17.9 are in dark grey. The black row marks the limit of 60% of English exposure above which bilingual children are not distinguishable from monolingual children.

	English exposure %	PLS 4 Auditory	BPVS III	English SETK-2	CDI Comprehension	CDI Production	Other CDI Production
1	5		9	1	133	44	56.7
2	7	28	38	14	317	214	
3	14	36			413	210	25.4
4	21		3		0	0	69.7
5	27		21		65	31	45.4
6	31		18		301	297	9.6
7	33		18	9	181	80	37
8	34		4	12	63	45	8.2
9	37		25	19	416	252	32.9
10	37		38	23	264	212	21.4
11	40		4	10	58	1	5.8
12	44	35	17	7	217	65	64.7
13	48		19	5	162	161	18
14	53		16	12	414	247	44
15	54	46	32	21	401	371	73.6
16	57	32		17	415	140	3.5
17	58	24		2	242	228	72.8
18	58		20	25	289	157	27.4
19	62	37	31	20	403	293	64.2
20	67		41	28	416	403	10.6
21	69	36	30	24	381	361	
22	70	35	23	27	366	342	45.8
23	74	42	44	23	368	363	9
24	75	40	31	21	386	327	1.4
25	78	46		24	400	400	1
26	78		4	6	389	112	26.7

27	82	48	36	27	381	316	34
28	83	35	32	26	382	349	22.2
29	85	45	33				
30	85	38	35	26	411	394	
31	89	39	39	25	393	355	23.9
32	94	39	37	26	409	344	
33	94	48	45	28	411	398	44.7
34	97	47	42	27	395	395	
35	98	41	35	24	382	342	2.8
36	monolingual	40	36	28	383	370	
37	monolingual	38	36	28	399	359	
38	monolingual	34	36	25	359	305	
39	monolingual	42	32	24	403	401	
40	monolingual	47	41	24	405	384	
41	monolingual	31	35	23	416	394	
42	monolingual	46	37	29	416	384	
43	monolingual	39	33	27	380	349	
44	monolingual	43	37	26	415	399	
45	monolingual	44	22	25	407	367	
46	monolingual	44	28	26	416	414	
47	monolingual	32	52	25	408	394	
48	monolingual	38	29	28	382	351	
49	monolingual	43	43	24	410	398	
50	monolingual	48	46	28	409	399	
51	monolingual	42	26	28	409	363	
52	monolingual	45	30	27	412	412	
53	monolingual	33	22	18	403	342	
54	monolingual	41	42	29			
55	monolingual	49	31	24	402	394	
56	monolingual	51	43	24	416	369	
57	monolingual	48	55	28	416	405	
58	monolingual	50	57		402	398	
59	monolingual	41	53		408	370	
60	monolingual	37	38		408	408	
61	monolingual	24		21	395	276	
62	monolingual	39	42	26	392	369	
63	monolingual			24	295	212	
64	monolingual	41	34	28	406	404	
65	monolingual	44	46	28	416	416	
66	monolingual	40	40	24	418	414	
67	monolingual	43	52	26	407	407	

68	monolingual		17	23	345	215	
69	monolingual		43	29	413	411	
70	monolingual		24	26	397	392	
71	monolingual		43	25	407	400	

Figure captions

Fig. 1. Relationship between percentage of English exposure and the English language assessments: BPVS III (n = 31), English SETK-2 (n = 30), PLS 4 Auditory (n = 21), Oxford CDI Comprehension (n = 34) and Production (n = 34).

Fig. 2. Relationship between percentage of English exposure and the proportion of words that bilingual children (n = 30) produce in each CDI (in their additional language: diamonds; in English: squares).

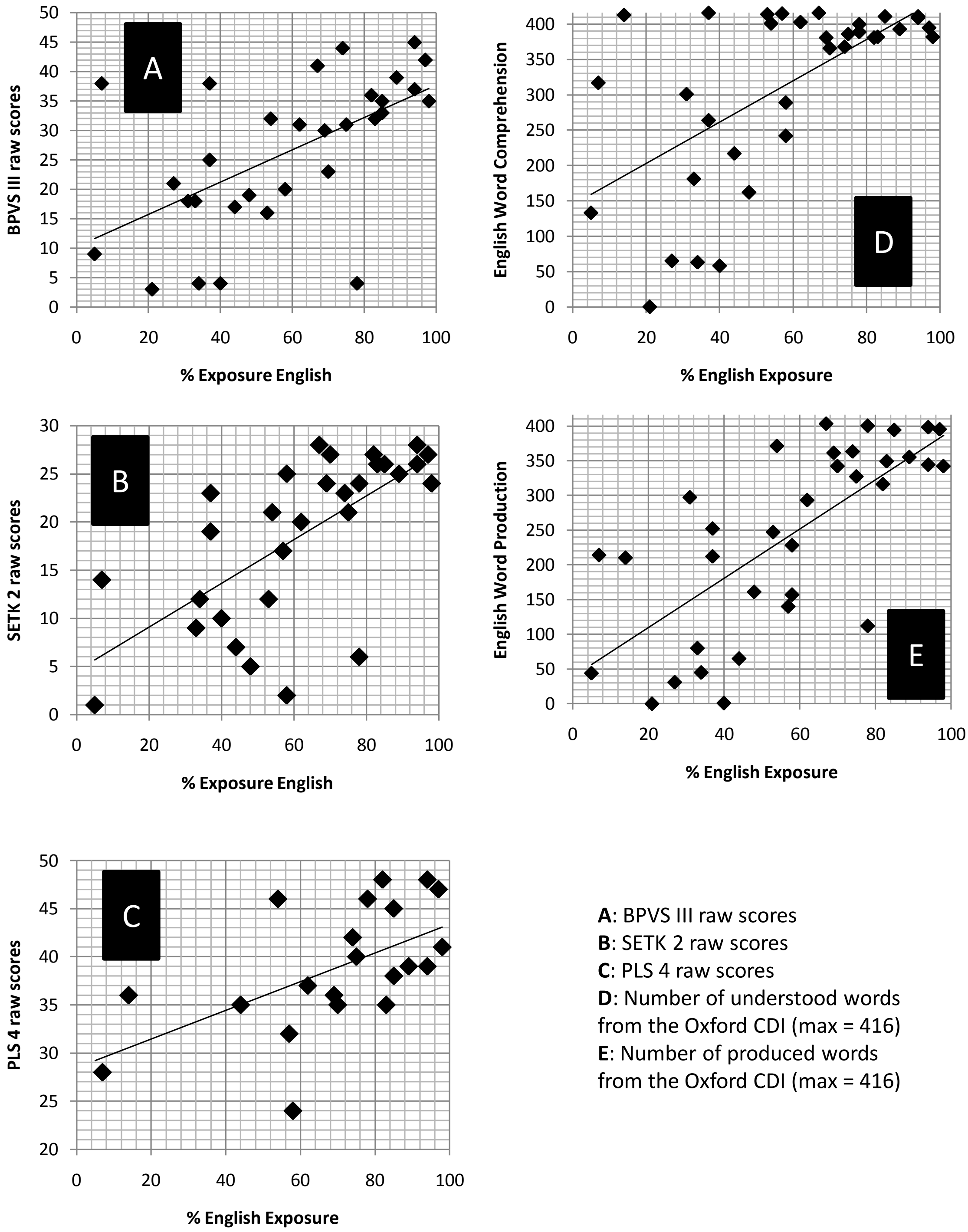
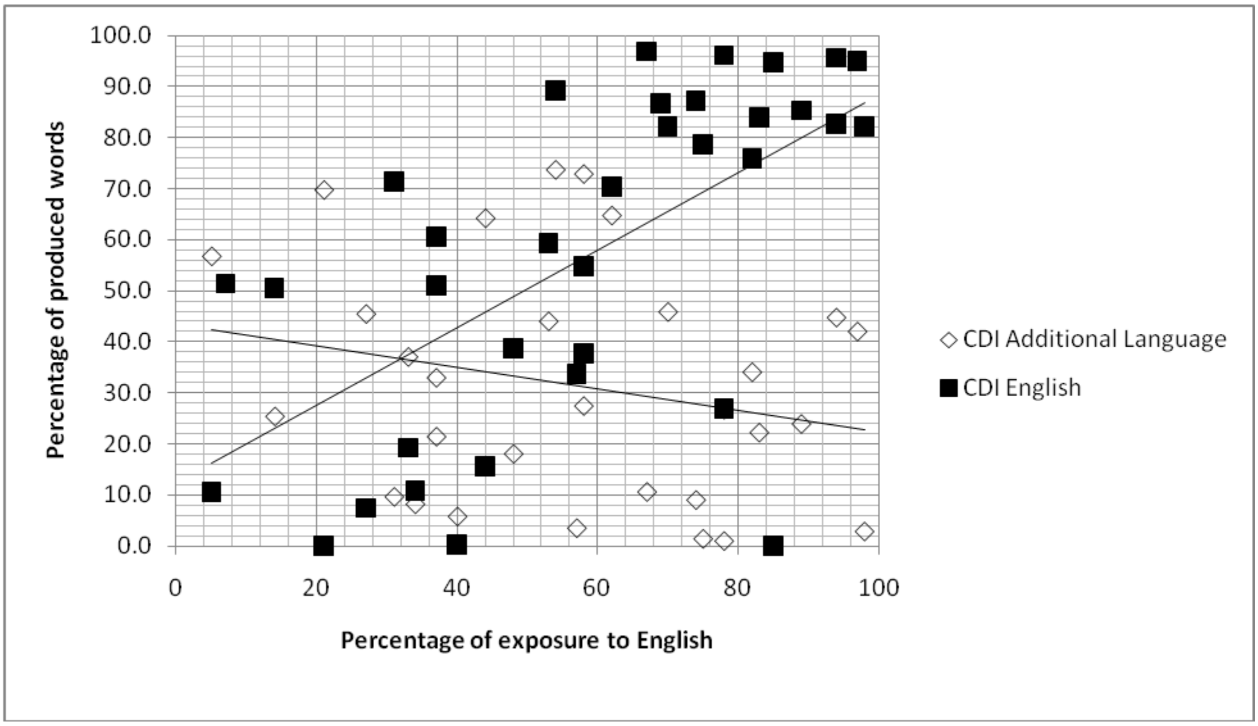

A
BPVS III raw scores
% Exposure English
D
English Word Comprehension
% English Exposure
B
SETK 2 raw scores
% Exposure English
E
English Word Production
% English Exposure
C
PLS 4 raw scores
% English Exposure
A: BPVS III raw scores
B: SETK 2 raw scores
C: PLS 4 raw scores
D: Number of understood words from the Oxford CDI (max = 416)
E: Number of produced words from the Oxford CDI (max = 416)

Figure 1



100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Percentage of produced words
0
20
40
60
80
100
Percentage of exposure to English
CDI Additional Language
CDI English

Figure 2

Appendix 1

English exposure questionnaire: Calculating percentage of English and non-English input

Evaluation of the amount of exposure to English and to an additional language

INSTRUCTIONS

Each parent will take a different route through this part of the questionnaire.
Can you write the answers in column C next to the answer which is correct for this particular child

Section A:	**Language(s) spoken in the home**

Do you and your partner….? *(Can you circle your situation and go to the section indicated)*

a)	This child hears 1 language, English.	**Go to Section D**
b)	This child hears 2 languages, because **<u>both parents</u>** speak to her using another language (for example, they both speak Russian).	**Go to Section B**
c)	This child hears 2 languages, because **<u>one of the parents</u>** speaks to her using another language (for example, Mum speaks Spanish and Dad speaks English).	**Go to Section C**
d)	This child hears 3 languages, because each parent speaks a different language to the child (for example, Mum speaks Spanish and Dad Russian).	**Go to Section D**
e)	This child hears 3 languages, because Mum and Dad speak another language to the child, but also because another person (a grandparent or a childminder for example) speaks a third language (for instance, Mum and Dad speak Spanish and the child has a French nanny).	**Go to Section D**

Section B:	**Both parents speak the same additional language to the child (let's refer to it as additional language)**

1	Can you please write here what is the additional language (e.g. Spanish)	
2	Write the number of hours a week in average your child spends in an **<u>English speaking</u>** nursery/day care/preschool/childminder/relative or friend.	

3	Write the number of hours in average your child spends sleeping per 24 hours	
4	Does the mother of this child … (please write 1 in the corresponding cell)	
a)	always speak additional language to your child	
b)	usually speak additional language to your child	
c)	speak English to your child about half the time	
d)	usually speak English to your child	
e)	always speak English to your child	
5	Does the father of this child…(please write 1 in the corresponding cell)	
a)	always speaks additional language to your child	
b)	usually speaks additional language to your child	
c)	speaks English to your child about half the time	
d)	usually speaks English to your child	
e)	always speaks English to your child	
6	When you and your partner are together with this child, who speaks most to the child? (please write 1 in the appropriate cell)	
a)	Mother	
b)	Father	
c)	we both speak to this child an equal amount	
7	If there are certain days or parts of certain days in a typical week when only you or your partner are with your child (e.g. father always takes care of child on Saturday afternoons).	
	Write the number of hours per week when your child is with her mother only.	
	Write the number of hours per week when your child is with her father only	
	Percentage of exposure to English	
	Please go to Section D	

Section C:	**One parent speaks English, the other parent speaks an additional language to the child (let's refer to it as additional language)**

1	Can you please write here what is the additional language (e.g. Spanish)	French
2	Who speaks English? Please write 1 if it is the mother and 2 if it is the father.	2
3	Write the number of hours a week in average your child spends in an **English speaking** nursery/day care/preschool/childminder/relative or friend.	21

4	Write the number of hours in average your child spends sleeping per 24 hours	11
5	The English speaking parent….(please write 1 in the corresponding cell)	
a)	always speaks English to your child	1
b)	usually speaks English to your child	
c)	speaks additional language to your child about half the time	
d)	usually speaks additional language to your child	
e)	always speaks additional language to your child	
6	The additional language speaking parent…(please write 1 in the corresponding cell)	
a)	always speaks additional language to your child	1
b)	usually speaks additional language to your child	
c)	speaks English to your child about half the time	
d)	usually speaks English to your child	
e)	always speaks English to your child	
7	When you and your partner are together with this child, who speaks most to the child? (please write 1 in the appropriate cell)	
a)	The English speaking parent	
b)	The additional language speaking parent	1
c)	we both speak to this child an equal amount	
8	If there are certain days or parts of certain days in a typical week when only you or your partner are with your child (e.g. father always takes care of child on Saturday afternoons).	
	Write the number of hours per week when your child is with the English speaking parent only.	10
	Write the number of hours per week when your child is with the additional language speaking parent only.	15
	Percentage of exposure to English	**0.35**

Please go to Section D

Section D	**All parents, please fill in this section**

1	What is the mother's highest educational qualification? Please write 1 after the corresponding case.	
	No qualifications	
	Below standard for a pass on the school-leaving examination	
	O-levels	
	A-levels	

	Tertiary vocational qualifications	
	An undergraduate degree	
	A postgraduate degree	1
2	What is the father's highest educational qualification? Please write 1 after the corresponding case.	
	No qualifications	
	Below standard for a pass on the school-leaving examination	
	O-levels	
	A-levels	
	Tertiary vocational qualifications	
	An undergraduate degree	1
	A postgraduate degree	
3	What is the mother's occupation?	Teacher
4	What is the father's occupation?	Estate Agent
5	Does your child have older siblings? Please write the ages of the older siblings:	Age
	Sibling 1	4
	Sibling 2	
	Sibling 3	
	Sibling 4	
6	Please enter your child's date of birth:	01/01/2008
	Please enter today's date:	30/06/2010
7	Please enter your child's gender (1 = girl, 2 = boy):	1
8	Does your child have any identified hearing problem? (1 if yes, and please write more below)	
9	Was your child more than 6 weeks premature? (1 if yes)	
10	Does your child have any identified developmental delay? (1 if yes, and please write more below)	
11	Where was your child born?	UK
12	How long have you been living in an English-speaking country for?	4 years
	Identification code (internal use)	

Appendix 2

Details of the calculation of percentage of English exposure in a typical week of a toddler in the last year of life

A. Input from the parents:

Number of hours a week in English-speaking nursery/childminder/playgroup = N

Number of sleeping hours per night = S

Does the Mother always speak the additional language (AL) to the Child, or usually, or equally often English and the AL, or usually English, or always English (5 possible responses) = M

Does the Father always speak the additional language to the Child, or usually, or equally often English and the AL, or usually English, or always English (5 possible responses) = F

When together, who speaks most to the child? Mother, Father or Both = Most

Number of hours per week spent with Mother only = HM

Number of hours per week spent with Father only = HF

B. What does the calculation entail:

1. **Assign a percentage to M and F, to estimate the proportion of English in each parent's input to the child.**

If M (or F) = Always AL then ME (or FE) = 100

If M (or F) = Usually AL then ME (or FE) = 75

If M (or F) = Equally AL and English then ME (or FE) = 50

If M (or F) = usually English then ME (or FE) = 25

If M (or F) = always English then ME (or FE) = 0

2. **Correct HM and HF to give more weight to the time spent with the Mother, as it is found usually that fathers tend to produce less verbal output to their child, therefore directly impacting on the amount of exposure in English and the additional language (e.g. Pancsofar & Vernon-Feagans, 2006).**

Corrected time with Mother = CHM = HM*4/3

Corrected time with Father = CHF = HF*2/3

3. **Assign a value (MI to Most), to give more weight to the Mother's input. What is obtained corresponds to the percentage of the Mother's input during the time when both parents are with the child.**

If Most = Mother then MI = 90

If Most = Father then MI = 50

If Most = Both then MI = 70

4. **Calculate the number of hours per week with both parents together**
   $TBP = 7(24 - S) - N - HM - HF$
5. **Calculate the total number of hours of English exposure in a week (E) with the following formula:**

E = English from mother when mother alone + English from father when father alone + English from mother when both parents together + English from father when both parents together + English from nursery or equivalent

$E = \frac{CHM(100\text{-}ME)}{100} + \frac{CHF(100\text{-}FE)}{100} + N + 0.01*TBP*\frac{MI(100\text{-}ME)}{100} + 0.01*\frac{TBP(100\text{-}MI)(100\text{-}FE)}{100}$ With

English from mother when mother alone = CHM(100-ME)/100

English from father when father alone = CHF(100-ME)/100

English from mother when both parents together = 0.01*TBP*MI(100-ME)/100

English from father when both parents together = 0.01*TBP(100-MI)(100-FE)/100

6. **Calculate the percentage of exposure to English**

$$P = \frac{E}{7(24 - S)}$$

Appendix 3

Adapted English SETK-2

	Objects
1	Key
2	doll, dolly, baby, child
3	knife
4	ball, football
5	pencil, pen, felt tip, crayon, colourer
6	book, picture book,
	Pictures
7	Car, types of car, e.g. VW
8	Chair, seat
9	house, hut, villa, home, flat
10	clock, alarm clock, tick tock
11	Swing
12	Tree
13	Apple
14	Fork
15	Scissors, snip snip
16	Eyes, eye
17	duck, goose, quack quack
18	cup, beaker
19	pig, oink oink, piglet, sow
20	Bus
21	butterfly
22	pear
23	comb
24	star
25	cake, muffin, bun
26	bear, teddy, teddy bear, polar bear
27	train,
28	brush
29	fridge
30	petrol station, garage

FOOTNOTES

[1] When parents differed with respect to their educational background, the highest level attained was considered (Bello, Giannantoni, Pettenati, Stefanini and Caselli, 2012; Caselli, Paqualetti and Stefanini, 2007; Doblhammer, Hoffmann, Muth, Westphal, and Kruse, 2009).

[2] During extensive piloting and in this study, we did not encounter any cases of families in which English is the only language spoken at home with an additional language being spoken in a nursery for example; therefore it was not included in the calculations. However, if during the conversation with the experimenter this had emerged, the child would have been excluded from participation. It would be very easy to include an additional question in a future version of the English exposure questionnaire. In addition, for reasons of simplicity at this stage, we did not provide calculations for families in which more than two languages are spoken.

[3] The translation of the German test was initially piloted at the Universities of Manchester and Leipzig, and equivalent performance was found in the raw scores for 30 month-old German and English children (Dittmar, unpublished doctoral dissertation).

[4] One parent was a Czech speaker but understood Slovak, which is a dialectal variant and was thus instructed to check off if the child said the Czech equivalent of any of the Slovak words.

[5] The Punjabi translation of the Oxford CDI was only used for the analysis in the additional language.

[6] Similar regression analyses carried out using the raw scores for the BPVS III, PLS 4 and English SETK-2 reported equal outcomes.

[7] The variance differed until the cut-off point was reached, i.e. between the group of toddlers with less than 60% exposure to English on one hand and on the other hand, the monolingual children plus the bilingual toddlers with 60% or above exposure to English.

[8] This particular analysis for the PLS 4 scores was not carried out, as 15 of 36 bilingual toddlers did not complete this test.

[9] To make sure that this effect was not due to chance, we also carried out the procedure, removing children's data one by one, until there were only 10 bilingual toddlers left. No significant t-test value was observed.