The Bilingual Paradox:

How signing-speaking bilingual children help us resolve bilingual issues and teach us about the brain's mechanisms underlying all language acquisition

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INTRODUCTION

Paradoxical views have surrounded the development of language in young bilinguals, with some viewing their early language learning as effortful (characterized by language delay and language confusion) and others viewing their language learning as relatively trouble-free. We explore the roots of these conflicting views, which we call the "bilingual paradox," by studying five bilingual children. These included two hearing children (both girls) acquiring two spoken languages (French and English) and three hearing children (two girls, one boy) acquiring a signed and a spoken language (Langue des Signes Québécoise and French) from birth, beginning within ages 7 and 20 months.

We found that all of the children achieved all early language milestones in *each* of their languages on the same time course, and one that is the same as monolingual. Indeed, young bilinguals are not language delayed. Remarkably, none of these very young bilinguals showed evidence of being language confused, as all children possessed a hefty number of words that had corresponding semantic meanings in each of their two languages (termed "translation equivalents"). We discuss the powerful insights that bilingual children acquiring a signed and spoken language provide and articulate how they shed new understanding into why the bilingual paradox prevails in our public perception. On a practical level, we suggest that knowledge of how young bilingual children develop two languages can be an invaluable aid to K-8 teachers with bilingual children in their classroom, as well as foreign language teachers. We further offer a brain-based explanation of how bilingual language acquisition is possible in our species.

The "bilingual paradox" is a term we coined to name an intriguing phenomenon that presented itself many times during our studies of young children learning two or more languages in early life. On the one hand, we freely marvel at the seemingly effortless ways that young bilinguals can acquire two or more languages if exposed to them early in life. On the other, we also fear that exposing a child to two languages, too early, may cause developmental language delay and, worse, language confusion. Parents visiting our laboratory often worry about whether it would be better to establish one language firmly before exposing their children to the family's other language so as to avoid confusing them. They worry that very early bilingual language exposure may cause their child to be language delayed, or only partially competent in either language, and that early bilingualism could even handicap the child's cognitive growth (Hakuta, 1986).

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Here we expand upon an earlier study that we conducted in which we empirically examined bilingual language acquisition in young children acquiring two spoken languages and, crucially, in young children acquiring a spoken and a signed language (see Petitto, Katerelos, Levy, Gauna, Tétrault, Ferraro, 2001, for an extensive report of this work). Our goal in studying these two key populations is to shed new light on the knowledge underlying very early childhood bilingualism, to resolve the paradoxical views surrounding it, and to investigate young bilingual acquisition as a new microscope into the mechanisms that underlie all human language acquisition. Though we articulate the findings from our basic research, we hope to provide K-8 teachers with bilingual children in their classroom with practical facts about the normal linguistic development of a young bilingual's two languages in early life. Such developmental facts indeed form the foundation of dual language mastery in later life, which we further hope will prove relevant to foreign language teachers. It is also our goal that the present work will add to the body of knowledge on how all children achieve the remarkable feat of learning language.

Scientists, as people, understandably have harbored similar paradoxical views to those espoused by parents and educators. This is especially evident in the divergent views found in contemporary research on childhood bilingualism. Two general classes of scientific hypotheses have prevailed, first termed the "unitary" and "differentiated" language system hypotheses by Genesee (1989). Researchers holding views subsumed under the "unitary language system" hypothesis suggest that children exposed to two languages first have a single fused linguistic representation, and it is only by age 3;0 that they begin to differentiate their two native languages (e.g., Redlinger & Park, 1980; Vihman, 1985; Volterra & Taeschner, 1978). One idea implicit here is the notion that such children undergo a protracted period of early language development relative to monolinguals, which is also an idea that is commensurate with the public perception of language delay in young bilinguals (for an important discussion of this link between public and scientific perceptions in Oller, Eilers, Urbano, & Cobo-Lewis, 1997; see also Chiocca, 1998; Pearson, Fernandez, & Oller, 1993; Watson, 1996). Further, some researchers have taken the young bilingual's language "mixing," whereby they combine elements from their two languages in conversation, as additional evidence that they may be confused and have two linguistic systems fused into one (e.g., Redlinger & Park, 1980; Vihman, 1985).

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Those adhering to the "differentiated language system" hypothesis question the above accounts (e.g., Deuchar & Quay, 1999; Genesee, 1989; Genesee, Nicoladis, & Paradis, 1995; Lanza, 1992; Meisel, 1989). They suggest that the language mixing seen in bilingual children exhibits regular grammatical patterns and is directly influenced by sociolinguistic factors. Therefore, these researchers assert that bilingual children have distinct representations of their two input languages from an early age. But the key unanswered questions are precisely when does it occur and at what age. Almost all such studies have focused on bilingual children's multi-word combinations from around 19 months and older, which is after important early language milestones have already passed or are in progress (e.g., first-word, first 50-words, and first two-word combinations).

Crucial facts do exist, however, which can help resolve two facets of the bilingual paradox. First is the young bilingual's timing of the achievement of early linguistic milestones in each language—because this provides insight into the issue of possible developmental language delay. Second is the child's early lexical knowledge in each of the languages being acquired, because this provides insight into the issue of possible representational or semantic confusion. Such studies also clarify the important question of what age language differentiation begins in the young bilingual.

Following from the logic inherent in the view that young bilinguals initially begin with a unitary linguistic system is the testable premise that human language acquisition is neurologically "set" at birth for monolingual language acquisition. In this view, the ostensible neurological "preference" for one language would suffer some "insult" with dual or multiple language exposure, possibly due to the extra time required to establish additional neural pathways for the processing of two rather than one language (Petitto, Katerelos et al., 2001). This leads to the following predictions: The timing of the achievement of linguistic milestones in each of a bilingual baby's two languages should be *different* if the neural mechanisms underlying human language acquisition are initially set to one language and *similar* if they are not (Petitto, Katerelos, et al., 2001). Note that a child's regular achievement of particular language milestones on a particular timetable is key in early monolingual language development and thought to be an indication that the said milestone is under biological control. Specifically, there is widespread agreement that monolingual babies achieve the first word milestone in production by around age 1;0, range 0;9 to 1;2 (e.g., Capute, Palmer, Shapiro, Wachtel, Schmidt, & Ross,1986; Vihman & McCune, 1994), first two-word combinations, by around age 1;6, range 1;5 to 2;2 (e.g., Bloom, Lightbown, & Hood, 1975; Brown, 1973; Petitto, 1987), first 50-words (types) on average around age 1;7 (e.g., Charron & Petitto, 1991; Nelson, 1973; Petitto, 1987). These ages are not modifiable to any great extent by the environment, such as through the presence of intensive instruction or drilling.

Petitto and her students (1985, 1988; Petitto & Marentette, 1990) first got a glimpse that the above neurological prediction about young bilinguals might be wrong when studying bilingual *deaf* babies exposed to *two signed languages*—especially when one of their hearing control groups did something remarkable (ages 0;8 through 2;0): bilingual hearing babies acquiring spoken French and spoken English. Contrary to the general public perception of linguistic delay in very young bilinguals, these earlier studies showed that our young bilingual French-English controls consistently achieved the classic early linguistic milestones (first-word, first 50-words, and first two-word milestones) on an similar time table in each of their two languages, and on a time table that was fundamentally similar to monolingual children.

Recently, Pearson and her colleagues (1993), and Pearson and Fernandez (1994) asked parents to fill out a vocabulary checklist (MacArthur Communicative Development Inventory, CDI; Fenson et al., 1991) and found that English and Spanish bilingual children (ages 0;8-2;6) acquire their languages on the same timetable as monolingual children. They progress at the same rate, and they exhibit the same vocabulary spurt as monolingual children. Despite the fact that a child's production of words in any one of their languages was on average less than that seen in monolingual children, this was not a statistically significant difference. Here, what was most important was that if both of their word lists were combined, it would equal the same as what is observed in the monolingual child.

A second testable hypothesis exists concerning the protracted process of neurological differentiation implied by the unitary language view: it predicts other higher cognitive disruptions in the form of young bilinguals' inability to differentiate between their two early lexicons. Conversely, an ability to differentiate the words in their earliest lexicons would support the proposal that they possess dual language representations. Indeed, it had been assumed for decades that bilingual children do not (and cannot) produce a word in one language, and a word in the other, to refer to the identical referent during the same time period (i.e., Volterra & Taeschner, 1978). If young bilinguals have a single fused linguistic system, the prediction is that they should reject the acquisition of cross-language synonyms or "translation equivalents," ("TEs") because they would view, for example, the English word "cup" and the French word "tasse" (cup) as being synonyms in the same language. Pearson, Fernandez and Oller (1995), however, found that on average 30% of children's early vocabularies consisted of translation equivalents, and Holowka, Brosseau-Lapré, and Petitto (2002) found a similar percentage. Overall, the researchers concluded that their findings provide evidence against there being a single fused lexicon in the young bilingual (see Nicoladis, 1998; Quay, 1995, each of whom also report the existence of translation equivalents). Eve Clark's (1987) "principle of contrast" in monolingual children is especially intriguing because they are said to reject the acquisition of synonyms because they are initially biased towards acquiring a single name for each item in the world (see also Markman's mutual exclusivity principle, e.g., Markman, 1992). It also offers an explanation as to why young bilinguals can possess synonyms across their two languages: presumably this is because they *know* that they are acquiring *two* languages. This is revealed by the fact that they can possess translation equivalents *across* their two languages, but not within a single language.

OBJECTIVES

Why has the bilingual paradox continued? Is early bilingual acquisition fundamentally similar to monolingual acquisition or is it delayed and confused? When do young bilinguals first possess the capacity to differentiate their two native languages and what brain-based mechanisms contribute to this capacity?

To address these questions, first, we empirically studied young bilingual babies' lexical growth in each language first-hand, rather than relying exclusively on parental checklist data such the MacArthur CDI (as the few previous studies had done), and we applied standardized criteria in making lexical attributions (discussed below). Second, we studied a fascinating population of young babies—those acquiring a signed and a spoken language from birth (signing-speaking)—and we compared them to young babies acquiring two spoken languages from birth (speaking-speaking).

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Although decades of linguistic analyses of signed languages have taught us that signed languages are indeed real languages used by rich and diverse cultures of deaf people around the world (e.g., Petitto, 1994), there are, however, important ways that this particular population is special and will provide us with a unique way to address controversies in the study of childhood bilingualism and language acquisition at large:

(1) **Delay**: If very early bilingual language exposure, *per se*, causes babies to be delayed relative to monolinguals, then the prediction is that these babies should demonstrate especially dramatic timing delays or asynchronies in the maturational course of language development in one language mo-

dality over the other modality. This is especially true given that different neural substrates underlie the production and perception of signing with the hands and speaking with the tongue, each with differing rates of brain maturation in early development.

(2) **Confusion**: If very early bilingual language exposure, *per se*, causes babies to be language-confused relative to monolinguals, then they should be unable to differentiate which language a particular word belongs to, resulting in a marked absence of translations equivalents. TEs in Langue des Signes Québécoise (LSQ)-French as well as French-English children therefore should be exceedingly rare, despite modality differences between the LSQ-French that could make differentiation of the two languages clearer. In addition, because the phonological distinction between words in young bilingual (and monolingual) babies can be very unclear, we also hoped that the dramatic differences between the two modalities in signing-speaking babies would provide a truer window into the age when young bilinguals differentiate between their two languages.

METHOD

Subjects

Five bilingual children were the focus of the present study (see Table 1). The first two bilingual children (both female) were hearing children acquiring spoken French and spoken English (Children 1 and 2). The other three bilingual children (one male and two females) were hearing and acquiring LSQ and spoken French (Children 3-5). The children studied were between the ages of 7 months and 2 years (0;7-2;0). Children 1-4 had bilingual exposure from birth, and Child 5 received her first intensive bilingual exposure from age 11 months. All of the children had regular and consistent exposure to both of their two input languages. Children 1-3 were being raised in families where each parent identified himself or herself as using primarily one language with their child; no adult reported routinely mixing languages with their child. Child 4 had parents who were both hard of hearing and were using equal amounts of LSQ and French to communicate with each other and with their daughter. Child 5 had profoundly deaf parents who spoke only LSQ to the child; at the age 0;11 months the child began attending a French day care on a daily basis where all of her peers and teachers were speakers of spoken French only. Child 1 and Child 3 were drawn from a larger study of six children (see Petitto, Katerelos, et al., 2001), studied over a one-year period, and followed beyond their first-word and first two-word combinations in each of their two languages. Children 2, 4, and 5 were entirely new bilingual children studied here for the first time, and were studied over 6 months until they achieved their one or two word milestones.

Table 1

AGES OF BILINGUAL CHILDREN AT VIDEOTAPED SESSIONS

ENGLISH-FRENCH CHILDREN		
Child	Session no.	Age
1	1	1;00.20
	2	1;01.17
	3	1;02.16
	4	1;05.05
	5	1;08.16
2	1	0;07.23
	2	0;11.07
	3	1;01.07
LANGUE DES SIGNES QUÉBÉCOISE-FRENCH CHILDREN		
Child	Session no.	Age
3	1	0;10.24
	2	1;00.09
	3	1;04.29
	4	1;07.26
4	1	0;07.09
	2	0;09.00
	3	0;11.10
5	1	1;03.26
	2	1;06.05
	3	1;08.10

** Differences in number of participant observation sessions are due to attrition.*

Procedure

Data Collection. Experimental sessions with children and family were videotaped. Each session contained 5 conditions that were designed to elicit language from the children across a rich range of social contexts and, crucially, across familiar and novel speakers of each of their two native languages (see Petitto, Katerelos, et al., 2001, for a detailed account of these methods).

After each experimental session, experimenters wrote a summary of the session, indicating their observations of the child's comprehension and production in each language. They also recorded parents' comments that were made off camera about their child's linguistic abilities. Furthermore, MacArthur CDI data were collected from bilingual parents (Children 1-4) and for LSQ only regarding the hearing bilingual Child 5 (as her deaf parents could not assess their child's spoken French). Despite the fact that the primary data in this study consisted of the analysis of the videotapes, these additional data were used to ensure that our data were representative of the child's linguistic achievements. They were also commensurate with published standardized norms, and they were also used in our analysis of children's translation equivalents in each of their respective languages.

Transcription and Coding. Videotaped sessions of the babies' speech were fully transcribed according to the CHILDES (Child Language Data Exchange System, Mac Whinney, 1998) standardized format, and included phonetic transcriptions. LSQ utterances were transcribed using the identical format, transcriptions, and methods. Indeed, we used the signed language transcription software called SignStream (developed by Carol Neidle/USA) and then combined these data into CHILDES for all LSQ transcriptions. The children's data were entered into a computer database that permitted distributional, frequency, and relational analyses.

The same coding procedures were used here that were used previously (Petitto, Katerelos, et al., 2001). The attribution of lexical status: standard procedures were applied when attributing lexical status to all children's verbal or manual productions (see especially Petitto, 1988; Petitto & Marentette, 1991; Vihman & McCune, 1994), and were based on three criteria:

(i) A child's verbal or manual production (or "form") was coded as a word or sign if it was used in relation to a referent (extensionally or intensionally) across contexts. Note that only an apparently intentional pairing of a form and a referent was required. This criterion ensured that meanings expressed by the children that did not contain the identical referential properties of adult words were nonetheless counted as words or signs in the child's individual language representational system.

(ii) The child's form minimally had to contain one phonetic unit in common with the adult form of the word or sign, and

(iii) The child's form had to exhibit a similar pattern of syllabification and stress (relevant to both spoken and signed linguistic structure). These latter two criteria prevented the overly strict requirement that the child's form had to contain the identical pronunciation of the adult form, and it permitted us to capture the younger baby's first stab into the lexical process. Thus, baby words and forms with immature phonology did not go unnoticed or uncounted. Taken together, these three criteria prevented the over-attribution of lexical status to other expressive activity, which is particularly relevant during the first year of life. It reliably differentiated among babies' gestures (which signaled meanings, for example, but lacked consistency in phonetic form), babbling (which did not signal meaning, but had consistency in phonetic form), and genuine attempts to produce words or signs (be they phonetically well- or ill-formed). At the same time, these three criteria prevented under-attribution of lexical status to children's productions, because it recognized their forms that had neither the full meaning nor the full pronunciation of the adult target language[1].

Translation Equivalents (TEs): TEs were words in each respective language that connoted the identical referent or concept, for example, simultaneously possessing the word "*lit*" (bed) in French and the word "*bed*" in English. We derived a cumulative vocabulary total for the children by combining the total number of words (signs) produced in each language (across all experimental sessions with any additional lexicon reported by their parents in their CDIs). Following Pearson et al. (1995; Petitto, Katerelos, et al., 2001), we then counted the total number of TEs. As did Pearson and her colleagues, we corrected for the number of lexical types for which there were no equivalents between the two languages by subtracting them from a baby's cumulative vocabulary total, as analyses were conducted only over potential TEs. Also following Pearson and her collaborators, neutrals in the French-English children were given a single count in the calculation of TE percentages. Finally, each baby's number of TEs was divided by its cumulative vocabulary total to derive the TE percentage.

Reliability measures. As in our previous studies (Petitto, Katerelos, et al., 2001), videotapes for the two groups were fully transcribed twice, each time by a native user of each respective language on the videotape. An LSQ deaf signer, for example, transcribed each tape for the child's signed utterances, and then a French speaker transcribed the tapes for the French utterances. Two additional transcribers (one for each language) checked lexical attributions, with respect to both the lexical gloss (type) and its tokens in addition to other coding judgments.

[1] See Petitto, Katerelos et al., 2001, for information about additional coding that was done for each lexical form, including, for example, the baby's direction of eye gaze when producing the form, the apparent referent that the form was used in relation to, apparent communicative function, manner of use, immediate actions both preceding and after the production of a form, the interlocutor's apparent interpretation of the baby's lexical form, as all of this further helped clarify any ambiguous attributions of lexical status to baby productions.

Disagreement regarding both lexical attributions and coding was resolved through discussion.

RESULTS

Analysis I: Language delay in young bilinguals?

We conducted comparative analyses of the onset timing of our young bilinguals' early language milestones in each of their two languages. These timing milestone results are summarized in Table 2, which shows that the bilingual children were not delayed in the achievement of the classic early language milestones in *each* of their respective native languages (first-word, first 2-word combinations, first 50 words). Remarkably, all of the bilingual children's milestones were precisely within the established norms for monolingual children's achievement of the classic early language milestones. Also of note, there were no dramatic delays or asynchronies in the timing of the LSQ-French child's achievement of linguistic milestones across signed and spoken modalities.

Table 2

Milestone Achievement by the Children in Both of their Languages

Child	Milestone	Language (Age) English	French	Monolingual Range
1	1st word combination	1;02	1;00	0;09 - 1;02
	2-word combination	1;08	1;05	1;05 - 2;02
	50 words	1;09	1;05	1;07*
2	1st word	0;11	0;11	
		LSQ	French	
3	1st word	0;10	0;10	
	2-word combination	1;05	1;08	
	50 words	1;05	1;08	
4	1st word combination	0;11	1;00	
5	2-word combination	1;08	1;08	

**Approximate age; range has not been established*

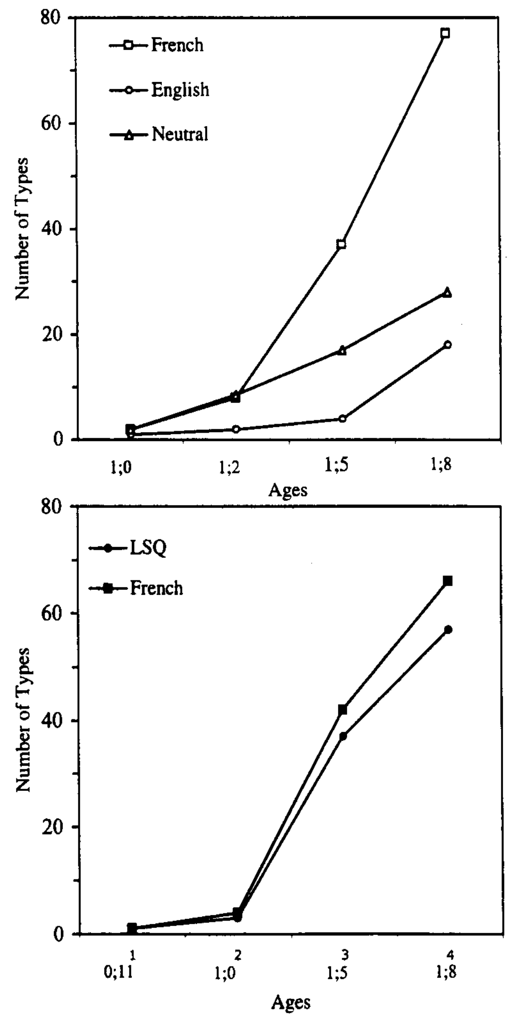
Analysis II: Are other indices of normal language growth delayed in young bilinguals?

Does early bilingual language exposure cause insult to other indices of normal language acquisition in each of a young bilingual's two languages, especially regarding the normal rate and growth of vocabulary over time? In light of the differences between language on the hands and language on the tongue, the signing-speaking bilingual children (in particular) may reveal a very different rate and growth of vocabulary in each of their respective languages.

To study these questions, we analyzed the rate and growth of vocabulary in each of the bilingual children's two languages over time. For all five of the bilingual children, the findings revealed that there was a steady rise in the number of new word types in *each* of their two lexicons over the duration of the study. It is further noteworthy that the rate and growth of vocabulary were highly similar across the signed and the spoken modalities in the LSQ-French children. Thus, this vocabulary analysis demonstrates that early bilingual language exposure *per se* does not cause significant delay to other maturational indices of normal language acquisition.

Figure 1 provides a clear representative ex-

Figure 1. Types of words or signs produced in sessions over time: (a) French-English (Child 1) and (b) LSQ-French (Child 3). Taken from Petitto, L. A., Katerelos, M., Levy, B. G., Gauna, K., Tétrault, K., & Ferraro, V. (2001). Bilingual signed and spoken language acquisition from birth: Implications for the mechanisms underlying early bilingual acquisition. *Journal of Child Language,* 28 (2), 453-496.



ample of the findings. It shows the cumulative number of the new types of words or signs that two of our bilingual children (Child 1 and Child 3, chosen for illustration because they were studied the longest) produced at each testing session in each of their native languages over time (see also Petitto, Katerelos, et al., 2001). Not only was the rate and growth of these two children's new vocabulary in each of their native languages generally equivalent, it was also generally commensurate with what has been reported in the literature for monolinguals over the same period of time (e.g., Capute et al., 1986; Petitto, 1987). In the large MacArthur CDI investigation (Fenson et al., 1991), by age 1;0, 49 % of the monolingual babies studied produced 1-10 words (range: 17 % of the children had 0 words and only 2 % had 41-100 words). Here we see in Figure 1 that by age 1;0, each of our bilingual babies' two languages fell well within this 49 % CDI group of monolinguals, because they produced up to 10 new word types in each of their native languages.

There was one exception to the parallels noted: although the production of English vocabulary types in the French-English baby (Child 1, top of Figure 1, (a) most certainly increased over time, it increased at a reduced number relative to French. Indeed, this young bilingual produced more French word types than English word types. This is in contrast to the LSQ-French baby's progression (Child 3, bottom of Figure 1, (b), whose number of LSQ sign types relative to French word types was highly equivalent.

There are two possible reasons why the French-English child (Child 1) showed a relatively decreased production of English word-types (relative to French word types) at a specific *point* in time, while nonetheless showing a steady increase *over time*. First, the baby stayed home with her French-speaking mother and playmates, and her English exposure came from her English-speaking father who was away during the day at work. Thus, we witnessed here the classic impact of "frequency of exposure" discussed in the literature (e.g., Goldin-Meadow, 1981), whereby environmental factors—such as frequency of exposure to a large *number* vocabulary words—can cause an increase in the *number* of vocabulary words produced by a young child, but it cannot impact the more biologically-governed aspects of language development. For example, it cannot actually cause the age at which a young child achieves a particular grammatical milestone to be significantly changed (such as the first-word and/or the first two-word milestone).

Second, we would argue that the difference between the French and English vocabularies in Child 1 is only apparent, due to ambiguities caused by immature phonology, specifically involving a class of words we termed the "neutral" word class. It is indeed such words with immature phonology that we suggest constitutes one major source of the misperception that young bilingual children are language "delayed" (see the Discussion). "Neutrals" were forms that were lexical items for the child (see criteria above) but that, because of their immature phonology, could not be judged as being either French or English and this class also included proper names used in both languages (e.g., "Big Bird"). For example, it could not be determined whether the child's persistent production of [na] to express negation was the French word "non" versus the English word "no." Although the child seemed clear about what she meant when she used this and other "neutrals," we adults did not know which language they came from.

Remarkably, all of the bilingual children's milestones were precisely within the established norms for monolingual children's achievement of the classic early language milestones.

As would be expected, neutrals did not occur in the LSQ-French child, where clear modality differences between the hands versus the mouth signaled which language was being used from the child's very earliest onset of language production; in fact, this is one of the places where the LSQ-French children provided a clearer view of early bilingual development in a manner not possible with children acquiring two spoken languages. Had this class of "neutrals" been identifiable as either French or English, the proportion of this child's French and English new word types over time may have been even more similar to one another—and even more similar to what was observed in the LSQ-French child. However, the phonological ambiguity of "neutrals" made this hypothesis impossible to test. Table 3 provides the new types of "neutrals" developed by the French-English Child 1 over time and, as corroborating evidence, Table 4 provides a summary of the types of "neutrals" produced by the French-English Child 2 by time of the last session at age 1;01:07. Most of the "neutrals" denoted common and proper nouns with forms that generally preserved the initial phonetic content and typically the syllabification of the word for the concept in English. But the problem was that the word for the same concept in French had a highly similar phonetic contour as the English word, and vice versa. The total absence of "neutrals" in the LSQ-French children, and the robust existence of semantic translation equivalents across all children's two languages (see Tables 3-4), gave us confidence that "neutrals" stemmed from phonetic interference when producing different words with shared sounds across languages in the identical speech modality, using a single mouth. "Neutrals" did not reflect underlying semantic and conceptual representational confusion due to shared meanings.

Table 3

Development of "Neutral" Word Types Over Time of French-English (Child 1)[a]

Age	Child's "Neutral" Word	English Word	French Word
1;00.20	[BA]	Ball	Balle
	[BA]	Bottle	Bouteille
1;01.17	[BA]	Baby	Bebe
	[BA]	Banana	Banane
1;02.16	[SHA]	Shoe	Chaussure
	[NUM]	Yum Yum	Miam Miam
1;05.05	[BEHBEH]	Big Bird	Big Bird
	[EMO]	Elmo	Elmo
	[ENE]	Ernie	Ernie
	[MMME]	Moo	Meu
	[NA]	No	Non
	[KAKA]	Quack Quack	Coin Coin
1;08.16	[BABA]	Balloon	Balloune
	[BABA]	Belly	Bedaine
	[BO]	Bert	Bert
	[BOBO]	Booboo	Bobo
	[KAKA]	Caca	Caca
	[KA]	Carrot	Carrotte
	[KIKIKI]	Cookie Monster	Cookie Monster
	[MIMI]	Emily	Emily
	[FE]	Fork	Fourchette
	[MAH]	Meow	Miaou
	[ALA]	Olivia	Olivia
	[PA]	Pea	Pois
	[SA]	Snake	Serpent
	[TATA]	Tractor	Tracteur

[a] *Taken from Petitto, L.A., Katerelos, M., Levy, B. G., Gauna, K., Tétrault, K., & Ferraro, V. Bilingual signed and spoken language acquisition from birth: Implications for the mechanisms underlying early bilingual acquisition (2001). Journal of Child Language, 28 (2), 453-496.*

Table 4

"Neutral" Word Types for of French-English (Child 2)

Age	Child's Neutral Word	English Word	French Word
1;01.07	[BY]	Bye	Bye (colloquial Quebecois)
	[TIT]	Tomato	Tomate

Analysis III: Are young bilinguals confused about shared word meanings across their two languages?

The results of our TE analysis demonstrated that TEs were observed across all children in relatively comparable and high percentages. Notably, TEs were not rare in the LSQ-French children. These results fail to confirm accounts of an initial lack of lexical differentiation in very young bilingual babies as well as their associated biologically-based implications involving representational (semantic and conceptual) confusion (see also Petitto et al.). They instead provide robust cross-modal support for the hypothesis that young bilinguals can differentiate their dual lexicons from their very first words. The results of this TE analysis appear in Table 5 where we compare Child 1, Child 2, and Child 3 from our study to Pearson's participants (Pearson et al., 1995), and find striking similarities.

Table 5

Total Vocabulary and Translation Equivalent (TE) Percentages for Children 1, 2 and 3, and Pearson Subjects[a] Matched for Age and Vocabulary

Child	Age	Total Vocabulary	TE
French-English			
1	1;02	22	50%
	1;05	106	36%
2	1;01	13	23%
LSQ-French			
3	1;02	41	40%
	1;05	198	51%
English-Spanish			
Pearson subject 6A	1;00	15	17%
	1;02	41	40%
	1;06	82	36%
Pearson subject 6D	1;04	60	28%
Pearson subject V7	1;03	27	41%
	1;06	127	36%

[a] *Taken from Pearson, B. Z., Fernandez, S. C., & Oller, D. K. (1995). Cross-language synonyms in the lexicons of bilingual infants: One language or two? Journal of Child Language, 22, 345-367.*

DISCUSSION

Here we considered young bilinguals' linguistic activity from a broad perspective, one that included both biological and contextual factors, and a clear picture emerged—one that did not concur with the biological assumption implicitly underlying the unitary language system hypothesis (whereby human language acquisition is ostensibly neurologically "set" at birth for monolingual language exposure). The data that helped us arrive at this conclusion included facts from an extraordinary group of children. These were young hearing children being exposed to a signed and a spoken language from birth, whom we compared to our other more typical experimental-control group, young hearing children being exposed to two spoken languages from birth. Modality differences between the hands and the tongue offered us a unique test of existing hypotheses because, once the constraints of the mouth are removed, highly asynchronous language development and fundamental early lexical (representational, semantic) confusion could have occurred if early bilingual language exposure first begins with single and fused linguistic representation that only gradually differentiate over the first three years of life.

Why weren't there more differences between our two bilingual groups? More differences are not observed because bilingual babies appear to enter into the language acquisition process with the representational scaffolding of their two languages already well in place by infancy and it is certainly well in place by their first words. (For example, recall that the early lexicons of all of the bilingual children contained a word from each of their languages that connoted the same concept, or TEs, which could only have occurred if these children were differentiating between their two languages.)

The hypothesis that we are advancing here is that young bilingual babies have distinct representations of their two input languages from their first steps into language acquisition through a process that Petitto has identified as Adaptive Phonological Differentiation (APD; see especially Petitto, in press, as well as Petitto, 2000, for a discussion of the theory summarized here). Building upon Positron Emission Tomography (PET) brain-scanning discoveries demonstrating identical functional dedication of specific cortical tissue to specific linguistic processing in the brains of hearing and deaf adults (i.e., Superior Temporal Gyrus tissue dedicated to the processing of maximally-contrasting, phonetic-syllabic units in both speech and sign; Petitto, Zatorre, Gauna, Nikelski, & Evans, 2000), Petitto has suggested that this tissue is the brain site that contributes to the initiation of human language acquisition, and is especially vital in the establishment of nascent phonological representations in all humans (monolinguals and bilinguals).

Recent research on young monolingual babies' powerful predisposition to detect specific maximally-contrasting, rhythmical patterning and distributional regularities in the input is especially promising as these may be the mechanism upon which the capacity to detect and establish dual phonological representations arises in the very young bilingual brain (Petitto, Holowka, Sergio, & Ostry, 2001; also Marcus, Vijayan, Bandi Rao, & Vishton, 1999; Petitto, 1997; Petitto & Marentette, 1991; Saffran, Aslin, & Newport, 1996). A recent study by Petitto et al. (2001b) demonstrated that young monolingual babies have peaked sensitivity to, and consequently produce, specific maximally-contrasting rhythmical patterning in the input that corresponds to specific aspects of the patterning of language: rhythmical patterns underlying the phonetic-syllabic unit at the heart of babbling (see especially Petitto, Holowka, et al., 2001; Petitto & Marentette, 1991). This capacity, in turn, yields the relevant syllabic segments over which babies can then discover the phonological inventory and combinational regularities of their native language (e.g., Jusczyk, 1999; Petitto & Marentette, 1991). Such a mechanism may function tacitly to segment and categorize the constantly varying stream of environmental input for the baby. Again, most probably the Superior Temporal Gyrus brain tissue is the site of this capacity (Petitto, Holowka, et al., 2001).

This nascent mechanism may provide the monolingual baby with the basic capacity to group linguistic information as it is heard. For example, with these mechanisms, the baby can tacitly "know" that this is information to attend to as potentially linguistic (versus information that is potentially non-linguistic) because it has the right tightly-constrained rhythmical patterning unique only to aspects of language patterning, be it signed or spoken. Crucially, this identical mechanism may also operate when a bilingual baby is confronted with two languages at birth. Here the mechanism can initially provide the bilingual baby with the means to detect that two related but different rhythmical linguistic patterns are coming in. This, in turn, may serve as the basis upon which bilingual babies can tacitly build up representations of their *two distinct phonological systems* (hence, the adaptive phonological differentiation/APD). We hypothesize that these processes are developing in the very early months of language exposure (be it monolingual or bilingual), beginning probably by birth. It is most certainly well underway by age 0;6, and exhibits regular growth and expansion in the capacity to detect systematic rhythmical-temporal and distributional patterns over time.

Thus, to review, based on the research establishing that young monolingual babies have rudimentary knowledge of the (a) phonetic inventory and its combinatorial regularities—plus knowledge of other systematic regularities involving (b) probabilistic word order and word groupings—it is a reasonable conclusion that *each* of a bilingual baby's input languages are also well in place

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by first-word onset at around age twelve months. This capacity, in turn, is made possible through brain-based mechanisms that establish early on dual phonological representations. To be sure, this feat is accomplished by utilizing the identical mechanisms at work in the monolingual baby. The major idea being advanced here is that the same brain mechanisms are at work in monolingual and bilingual babies. The reasoning is three-fold: First, in child language acquisition we already understand that babies are not genetically programmed to know which country they will be born in (e.g., Japan versus England) and, related to this, none are genetically programmed to know which language they will be exposed to. Nor are they genetically programmed to know which modality they will be exposed (signed or spoken). Second, and following from the first, it is equally improbable that babies are genetically programmed in the womb to know whether they will be exposed to one language or two. Third, fascinating evidence from recent brain-scanning studies of adult bilingual brains have demonstrated that the neural pathways for a bilingual's two languages are the same (and similar to monolinguals), but only if they had very early bilingual language exposure (Klein, Milner, Zatorre, Evans, & Meyer, 1995). Taken together, we must conclude that the young baby exposed to two languages builds upon what the human species already has in place to acquire language.

Yet we do not mean to suggest that our brains are set for monolingual acquisition that is then drawn upon in bilingual acquisition. Instead, we suggest that the human species may not be neurologically set for acquiring one language at all. Looking over the course of time, it is indeed more common for our species to have had need for, and to have been in social contexts where knowledge of multiple languages might have afforded special advantages. Thus, an ironic and daring idea is that, perhaps, the human species is biologically set to acquire multiple languages, and the contemporary pockets of civilization where one language is spoken are the aberrant deviation; in other words, perhaps our brains were neurologically set to be multilingual!

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Why might views of delay and confusion have prevailed? First, one answer concerning why paradoxical views exist about early childhood bilingualism involves the reasons why variability exists between a young bilingual's two languages – because we do see variability. For example, it is not uncommon for a mother in my laboratory to exclaim in despair that her bilingual child "does not speak the father's language!" even though both parents have been faithful to the "one parent, one language" method. When we analyze the videotapes, however, we find that of course the child comprehends and produces words in the father's native language but, crucially, what we do find is a difference in the vocabulary size of the bilingual child's two lexicons. Thus, we never see a total absence of one language versus the other in young bilinguals, as instead we see differences in the raw number of vocabulary words produced across their two lexicons (with comprehension of the two languages being roughly equivalent). Nonetheless, a child's asymmetric use of its two languages provides insight into how the perception of language delay and confusion can arise. To be sure, our findings have taught us that this very circumstance is due to strong environmental and sociolinguistic factors that literally predict this outcome.

Environmental factors as one source of variability involving greater exposure of one language over the other: We see differences in the size of a young bilingual's two lexicons, and such differences in vocabulary size stem from powerful environmental influences that we already know impact vocabulary size from the study of monolinguals. Specifically, we know that vocabulary is especially susceptible to environmental factors such as direct instruction, drilling, and frequency of exposure (e.g., Goldin-Meadow, 1981). In the monolingual child, to be sure, direct vocabulary instruction, drilling and frequency of exposure can indeed yield increases in the amount (number) of vocabulary items that an individual child produces. However, such environmental input factors cannot significantly change the biologically-controlled maturational age range within which a normally developing child will achieve a particular language milestone. Nor can a child be pushed to a more advanced stage of grammatical development (involving morphological and syntactic knowledge) through environmental drilling and frequency of exposure (e.g., Goldin-Meadow, 1981).

In a bilingual home, therefore, the baby who is at home all day with her French mother will have a greater number of French vocabulary words as compared to her vocabulary words in English, the language spoken by her father whom she sees only at night and on weekends. In other words, this child may indeed end up in early life producing more French than English due to established environment frequency effects on vocabulary size, but not due to any inherent "damage" caused (involving language delay and confusion) by having been exposed to two languages simultaneously from birth. Instead, the most critical observation here is that the child hit all of her linguistic milestones in English and in French within the identical maturational age range (for example, the "first-word" milestone both in French and in English within 9-14 months)—as this is the true key index of "normal" language development. Yet, without this knowledge, it is entirely understandable why her parents may instead worry that their bilingual baby is language "delayed" when, for example, she says many different words in French, only a few words in English—plus a fairly high number "neutrals!" (see Figure 1).

Sociolinguistic factors as one source of variability involving greater preference for one language over the other: We see such variability in the young bilingual's two lexicons also in part because of sociolinguistic factors, for example, the fact that (as was implied above) no child receives absolute, pure 50/50 bilingual input (Sebastián-Gallés & Soto-Faraco, 1999). Crucially, however, we see variability because of the young bilingual's own emerging "language preference." Where do children's language preferences come from? Across my studies of early bilingualism (e.g., study reported here; Holowka et al., 2002; Petitto, Katerelos, et al., 2001; Petitto & Holowka, in preparation), we found that each child's most frequently used language (the preferred language) corresponded to the language of his or her primary "sociolinguistic group." Although this can change from child to child, in practice, a child's sociolinguistic group is the language of the person or group that the child has both the strongest bond and the most constant contact (e.g., Meisel, 1989). For some children, this was the language of their mother with whom they stayed at home all day, for others this was the language of their siblings and friends with whom they spent the day. For others still, this was the primary language of the children and teachers at their daycare. A child's "preferred language" appeared to be their default setting—or, the language that they "fell back on"—and, for most, the language that they might persist in using with an adult even if that adult does not know it!

Second, another reason why paradoxical views exist about early childhood bilingualism involves the existence of what we refer to above as the "neutral" word class. This class of words provides yet another clue as to why a perception has remained that young bilinguals do poorly relative to monolinguals in their language development. Here we witnessed that the French-English children produced a class of "neutral" words – words that were difficult to determine for sure which of their two languages were being produced – often to the despair of their parents who told us that such words demonstrated that their children were linguistically confused. By contrast, it is significant that "neutrals" (which would have involved phonological blending of phonetic units on the hands with phonetic units on the mouth) simply did not occur in the LSQ-French children. This is so because the dramatic modality differences between signing and speaking rendered impossible such phonological blending, and thereby made identification of the source language straightforward. And, interestingly, the LSQ-French parents never told us that they thought their children were confused. Surprisingly, through the unique lens afforded to us by our examination of the LSQ-French bilinguals, we learned that young babies are fully capable of different but parallel acquisition of two languages from the very first onset of language production—here, as early as age eleven months when one baby turned to her deaf mother and signed "CHAPEAU" ("hat") and then in a heartbeat turned to the unfamiliar French experimenter and said "chapeau" (albeit, phonetically immature). We further learned that the "neutrals" observed in the more typical case of babies acquiring two spoken languages, like French and English, were largely a peripheral artifact of the phonetic production demands of forming words across two languages with shared sounds in the identical speech modality. This was instead of being a product of central, representational confusion, as "neutrals" were primarily due to immature phonetic and pronunciation factors. Interestingly, this observation was recently corroborated in a separate study of the semantic and conceptual underpinnings of three bilingual children's early words (from ages 0;7 through 2;2), revealing that 23.57% of the children's combined new word types were comprised of the class of "neutrals" (N = 132 "neutrals" out of 560 word types; Petitto & Holowka, in preparation). Because most bilingual parents and educators do not have access to this information, understandably, they find it disconcerting to hear their children produce partial words of an ambiguous language origin.

These observations help us understand from whence the "bilingual paradox" might arise, especially with regard to the more negative side of the coin involving fears of language delay and confusion. What they also teach us is that the negative conclusions are unwarranted.

On a practical level, we hope to have provided fundamental information regarding how young bilingual children develop their two languages that will be relevant to all Pre-K-8 teachers with bilingual children in their classroom, as

Another reason why paradoxical views exist about early childhood bilingualism involves the existence of what we refer to as the "neutral" word class.

well as foreign language teachers in general. We found no evidence that the human being is biologically programmed to be monolingual. Instead, as we discovered within, babies exposed to two languages in early life develop each language entirely *normally*—that is, each language is acquired on the same regular time course as the other, and on the same regular time course as the young monolingual child. Such early-exposed bilingual children exhibit neither "language confusion" nor "language delay." Instead, they develop into fully healthy language users, and as if they had two monolingual brains in one. The regularly-timed achievement of early linguistic milestones in all children (be they monolingual or bilingual) teaches us that early language milestones are under biological control and are not amendable to environmental differences that result from having different home environments. Interestingly, what was amendable to environmental differences was the young child's sheer number of vocabulary words. Here, children with more exposure to one language versus the other did make a difference, as these children did produce more words in the language to which they had more exposure. Practically, then, teachers' efforts to have language learners spend more "time on task" is important and does make for a positive outcome. Another implication here is that even children in a bilingual environment are not necessarily "balanced bilinguals." Nonetheless, these children can and do become fully and equally bilingual if dual language exposure occurs (a) early in life, (b) consistently and in a sustained manner, and (c) across a wide and rich range of contexts. To be sure, our research has taught us that these three factors are the key components that make up the "formula" for successful childhood bilingual acquisition, whereby the child grows into an adult who possesses full and equal mastery of two native languages. Yet another implication here is that monolingual children who are exposed to a foreign language in the later school years cannot be expected to be truly bilingual after three years of a foreign language class ranging from 20-60 minutes a week. The problem here is not their advanced age relative to young children, but instead is due to the lack of consistent and sustained input and the lack of foreign language exposure across a wide and rich range of contexts. Fortunately, if our educational systems moved towards building up these two components, we can significantly improve our children's knowledge of foreign languages and the wonderful diversity of foreign cultures. Without a doubt, the complex factors that contribute to early bilingual language acquisition (especially early bilingual acquisition of a signed and a spoken language) warrant further research. In particular, a very intriguing area of research will be to explore the brain's mechanisms that permit the young monolingual and bilingual child's capacity to phonologically segment the linguistic stream (both in sign and in speech). Because, as was suggested here, this is clearly where the action is in terms of the early mechanisms that contribute to launching human language acquisition, and those that work in conjunction with other crucially important social and environmental input factors. But one fact has emerged from the research loud and clear: Being exposed to two languages from birth—and, in particular, being exposed to a signed and a spoken language from birth—does not cause a child to be language delayed and confused.

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Dr. Laura Ann Petitto with one of the children participating in this study.

Photographs by Joseph Mehling, Dartmouth College mehling@dartmouth

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