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Bilingual signed and spoken language acquisition from birth: implications for the mechanisms underlying early bilingual language acquisition*

LAURA ANN PETITTO

Department of Psychology, McGill University and, The McDonnell-Pew Centre for Cognitive Neuroscience, McConnell Brain Imaging Centre, Montreal Neurological Institute

MARINA KATERELOS, BRONNA G. LEVY, KRISTINE GAUNA, KARINE TÉTREAULT AND VITTORIA FERRARO

Department of Psychology, McGill University

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ABSTRACT

Divergent hypotheses exist concerning the types of knowledge underlying early bilingualism, with some portraying a troubled course marred by language delays and confusion, and others portraying one that is largely unremarkable. We studied the extraordinary case of bilingual acquisition across two modalities to examine these hypotheses. Three children acquiring Langues des Signes Québécoise and French, and three children acquiring French and English (ages at onset approximately 1;0, 2;6 and 3;6 per group) were videotaped regularly over one year while we empirically manipulated novel and familiar speakers of each child's two languages. The results revealed that both groups achieved their early linguistic milestones in each of their languages at the same time (and similarly to monolinguals), produced a substantial

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number of semantically corresponding words in each of their two languages from their very first words or signs (translation equivalents), and demonstrated sensitivity to the interlocutor's language by altering their language choices. Children did mix their languages to varying degrees, and some persisted in using a language that was not the primary language of the addressee, but the propensity to do both was directly related to their parents' mixing rates, in combination with their own developing language preference. The signing-speaking bilinguals did exploit the modality possibilities, and they did simultaneously mix their signs and speech, but in semantically principled and highly constrained ways. It is concluded that the capacity to differentiate between two languages is well in place PRIOR to first words, and it is hypothesized that this capacity may result from biological mechanisms that permit the discovery of early phonological representations. Reasons why paradoxical views of bilingual acquisition have persisted are also offered.

INTRODUCTION

Bilingual language acquisition is the norm in many parts of the world and has fuelled a prevailing belief that young children can effortlessly acquire two or more languages. At the same time, there is also the widespread belief that early bilingual language exposure is somehow 'bad' for very young children, causing a troubled course of early language acquisition that is fundamentally different from young monolinguals. This 'bilingual paradox', as we have come to call it, has intrigued us: on the one hand, many parents, educators, and scientists, alike, will freely marvel at the seemingly effortless ways that children can acquire two or more languages if exposed to them in early life. On the other, many of these same individuals have concluded that exposing a baby 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 babies to the family's other language so as to avoid confusing them. They also worry that very early bilingual language exposure may cause their child to be language delayed, or only partially competent in either of its two languages as monolingual children are in one. As a result, many parents decide not to take this risk, opting instead to 'withhold' the family's other language until it is 'safe', with the puzzle being at what age is it 'safe'.

The fear that exposing a child to another language too early may interrupt 'normal' language development is also reflected in contemporary educational policy, where children in many countries around the world receive their first formal schooling in the other majority language well after the toddler years, with some supporting this practice as a way to avoid the language contamination that may result from early exposure to another language (e.g.

Crawford, 1999). Such formal segregation of language instruction both in the homes and in the schools may impact the developing brain's neural and representational architecture when it is most neurologically plastic in ways that are only beginning to be understood in the bilingual brain (Klein, Milner, Zatorre, Evans & Meyer, 1995). This practice may also be premature given the paucity of empirical research that exists to date on very young bilingual children. In the present study we empirically examine bilingual language acquisition in young children acquiring two spoken languages and, crucially, in young children acquiring a spoken and a signed language. Our goal in studying these two key populations is to shed new light on the knowledge underlying very early childhood bilingualism, and the paradoxical views surrounding it, by clarifying the maturational time course and nature of early bilingual language acquisition during the first few years of life.

Echoes of the divergent views expressed in the 'bilingual paradox' can also be heard either implicitly or explicitly in contemporary scientific research on childhood bilingualism. Although here scientific focus has been largely on understanding the social context and nature of young children's underlying knowledge of their two input languages (i.e. whether young bilinguals tacitly know that they are acquiring two languages versus one), two general classes of hypotheses have prevailed: first termed the UNITARY and DIFFERENTIATED language system hypotheses by Genesee (1989; see this paper also for an excellent analysis of these two classes of hypotheses).

Researchers holding views subsumed under the 'unitary language system' hypothesis assert 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. Although these researchers have never claimed that young bilinguals are language delayed relative to monolinguals, the assertion that such children's initial linguistic knowledge is fused does imply that they undergo protracted language development as they sort out their two input languages in early life, which is an idea commensurate with the public perception of language delay in young bilinguals (Watson, 1996; Chiocca, 1998); indeed, both Oller, Eilers, Urbano & Cobo-Lewis (1997) and Pearson, Fernandez & Oller (1993) provide insightful discussions of this widespread perception of delay among young bilinguals, despite a surprising lack of research on the topic. For example, the classic study by Volterra & Taeschner (1978), showed that very young bilinguals in the one-word stage have few semantically corresponding words across their two languages (if a child has the word 'ball' in one language, she will not have it in her other language), suggesting that young bilinguals do not initially differentiate between their two native vocabularies. More recently, however, researchers adhering to this general view have focused on the fact that bilingual toddlers around age 2;0 and beyond frequently mix words from both languages in their 2- or 3-word combinations (rudimentary sentences).

Here, such apparent external confusion in these children's language production is said to be due to their internal fusion of two linguistic systems into one (e.g. Redlinger & Park, 1980; Vihman, 1985).

Researchers holding views subsumed under the 'differentiated language system' hypothesis, however, question the above attributions (e.g. Genesee, 1989; Meisel, 1989; Lanza, 1992; Genesee, Nicoladis & Paradis, 1995; Deuchar & Quay, 1999). These researchers do not deny that bilingual children mix elements of their two languages in conversation. Instead, they suggest that the language mixing seen in bilingual children exhibits regular grammatical patterns and is directly influenced by sociolinguistic factors. For example, these children's language mixing is sensitive to the specific language used by the adults around them, as well as to their parents' pattern and degree of language mixing. Therefore, these researchers argue that language mixing does not reflect confusion but instead demonstrates the bilingual child's distinct representations of their two input languages from an early age. But the key question concerning exactly when such language differentiation occurs has not yet been answered because most all such studies have focused on bilingual children's multi-word combinations. These empirical studies are first begun around eighteen months of age and up, which is well after important early language milestones have already passed or are in progress (e.g. first-word, first 50 words, and first two-word combinations).

Each of the two classes of hypotheses above reflects a different side of the 'bilingual paradox' coin, and, recently, two types of studies have provided crucial developmental facts regarding the impact of very early bilingual language exposure on infants and young children – facts that can begin to inch us closer to a resolution of the bilingual paradox. These include studies of the young bilingual's (i) timing of the achievement of early linguistic milestones in each language that provides insight into the issue of possible developmental language delay, and (ii) early lexical knowledge in each of the languages being acquired that provides insight into the issue of possible representational confusion; crucially, both sets of studies provide insights into the key question of when language differentiation begins.

First, studies of the maturational timing that a bilingual infant's two languages follow have provided critical data to evaluate the above two classes of hypotheses in terms of their implicit assumptions about biology versus sociolinguistic (environmental) factors underlying childhood bilingualism. Timing – regularity in the rate and nature by which specific behaviours or processes are expressed in the development of an organism – is a central construct in developmental biology and its importance as an index of biologically-controlled processes has been understood for decades (e.g. Lenneberg, 1967; Wolpert, Beddington, Brockes, Jessell, Lawrence & Meyerowitz, 1998). In early monolingual language development, for example, social-environmental input factors are understood to have a robust impact on the frequency (amount) of young children's vocabulary items but not on the age at which they hit universal linguistic milestones; indeed, 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. Brown, 1973; Bloom, 1975; Petitto, 1987), first 50-words (types) on average around age 1;7 (e.g. Nelson, 1973; Petitto, 1987; Charron & Petitto, 1991) – ages which are not modifiable to any great extent despite intensive instruction and drilling. Said another way, young children's vocabulary is thought to be highly amenable to environmental variation in learning conditions and consequently is impacted greatly by a lot or a little input. By contrast, the achievement of the overall language production milestones, certain grammatical word types, and other grammatical and syntactic knowledge is less amenable to environmental variation, less modifiable, and judged to be more determined by biological regulation (see Goldin-Meadow, 1981, for a discussion of resilient and fragile properties of language in development).

The view that young bilinguals initially begin with a unitary linguistic system that is later differentiated is built on the logical, but testable, premise that human language acquisition is neurologically 'set' at birth for monolingual language acquisition that suffers 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. 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; additionally, the overall time course of bilingual versus monolingual acquisition should be different if the neonate brain is set for one language only. Note that the converse of this hypothesis is most certainly not that the human brain is neurologically set at birth for two languages. Instead, the alternative hypothesis – one that is most commensurate with contemporary understanding of neural reorganization and plasticity and the facts of early human development – is that infant brains may have dedicated neural mechanisms to detect highly particular patterns in the input relevant to natural language structure and these same mechanisms may be recruited – if bilingual language exposure is early – thereby permitting the establishment of dual or multiple language representations right from the start; exactly how these mechanisms may function in the developing brain is elaborated upon further in the Discussion.

In our previous studies on the timing of early signed language milestones in profoundly deaf children receiving either one or two signed languages from birth (Petitto, 1985, 1988; Petitto & Marentette, 1990), we noticed that a subset of our hearing control groups did something remarkable (ages 0;8 through 2;0). The specific control groups included (a) hearing bilingual infants acquiring spoken French and spoken English, (b) hearing bilingual infants acquiring a spoken and a signed language, either English and American Sign Language, or French and Langue des Signes Québécoise, and (c) hearing monolingual infants acquiring either French or English. Contrary to the general perception of linguistic delay in very young bilinguals, these earlier studies showed that babies in our two hearing bilingual control groups (a) and (b) consistently achieved the classic early linguistic milestones on a similar time table in each of their two languages (first-word, first 50 words, and first two-word milestones), and on a time table that was fundamentally similar to our monolinguals in (c).

Since making these observations, one research group has recently corroborated the finding that bilingual children may not be delayed in their achievement of linguistic milestones. Pearson *et al.* (1993), and Pearson & Fernandez (1994) asked parents to fill out a vocabulary checklist (MacArthur Communicative Development Inventory, CDI; Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick & Reilly, 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. The researchers suggest that any differences between their two languages can be directly attributed to differences in the child's sociolinguistic environment. Although 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. Crucially, the combined amount of words produced taken from both of their languages equaled that of the monolingual child's.

A second type of study that has cast new light on the linguistic knowledge of young bilinguals involves close examination of their first words in each of their languages, and provides unique insight into young bilinguals' early semantic and conceptual knowledge. The protracted process of neurological differentiation implied by the unitary language hypothesis also 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. According to Eve Clark's 'principle of contrast' (Clark, 1987), monolingual children reject the acquisition of synonyms because they are biased towards acquiring a single name for each item in the world. 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' (Pearson, Fernandez & Oller, 1995), because they would view, for example, the English word 'cup' and the French word 'tasse' (cup) as being synonyms in the same language. Pearson *et al*. (1995), investigated the accuracy of this prediction as well as the earlier claim that young bilinguals do not produce translation equivalents (i.e. Volterra & Taeschner, 1978). They examined the early vocabularies of 27 English and Spanish bilinguals by asking parents to fill out the CDI vocabulary checklist at various intervals between the ages of 0;8 and 2;6. They found that on average 30% of children's early vocabularies consisted of translation equivalents. The researchers concluded that the findings provide evidence against there being a single fused lexicon in the young bilingual; here, Clark's principle of contrast offers one possible explanation as to why young bilinguals can possess synonyms across their two languages, but not within any one of their languages (see Quay, 1995, who also reports the existence of translation equivalents).

Objectives

One objective of the present study is to understand better the basis for the 'bilingual paradox'. Why have such seemingly contradictory views about bilingual acquisition prevailed? Is infant bilingual acquisition fundamentally similar to monolingual acquisition or is it delayed and confused? When (what age) do young bilinguals first possess the capacity to differentiate their two native languages and what brain-based mechanisms contribute to this capacity? Is language mixing in the young bilingual child an index of language confusion? To answer these questions, we (1) examine empirically the maturational timing and growth of young bilingual's early lexicon in each of their respective languages, (2) study the existence of translation equivalents, and (3) investigate the intriguing phenomenon of linguistic mixing as a means to address our primary question: what is the knowledge that underlies very early bilingual language acquisition?

We studied the above questions using a unique methodology and in ways that represent a fundamental departure from former studies, including our own. In our previous studies, the patterns of language acquisition that we observed in young bilinguals came from a small number of children who were our control subjects in larger studies. Here we focus specifically on this population and examine a sample of children of diverse ages, with more detailed analyses of the linguistic and, crucially, social contexts of bilingual language use. Our study also departs from previous studies in the literature in two important ways: (a) our methodology, and (b) the use of a unique population of children.

Regarding (a), we empirically studied young bilingual infants' lexical growth in each language first-hand, rather than relying exclusively on parental checklist data such the MacArthur CDI, and we applied standardized criteria in making lexical attributions. Second, we directly observed bilingual infants' and children's patterns of language use and misuse across multiple contexts by empirically manipulating novel and familiar speakers over time.

Regarding (b), we study a unique population of children to gain insight into the knowledge underlying all bilingual language acquisition. These bilingual children are acquiring a language in the spoken modality, French, and a language in the signed modality, Langue des Signes Québécoise (LSQ). Analysis of signed languages have revealed that they exhibit the same levels of language organization as spoken languages (phonemic, morphological, syntactic, discourse) and are lateralized in the same areas of the left hemisphere (e.g. Bellugi, Poizner & Klima, 1989), utilize identical brain tissue as hearing speakers when processing identical linguistic functions (e.g. phonetic-syllabic units in sign are processed in the identical secondary auditory tissue as hearing people even though this tissue has never processed sound in the deaf signers; Petitto, Zatorre, Gauna, Nikelski, Dostie & Evans, 2000), and are acquired in similar ways as spoken language (e.g. Newport & Meier, 1985; Petitto, 1987, 1992, 2000; Petitto & Marentette, 1991). Given this, we may conclude that a child exposed to a spoken and signed language from birth is indeed in a bilingual situation comparable to a child exposed to two spoken languages from birth. 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.

In the typical case of bilingual infants exposed to two spoken languages from birth, only SERIAL production of the two input languages is possible. Here, the young bilingual can only produce, in sequence, one element from one language and then one element from the other language, with such language mixing rendering *a priori* the appearance of being confused. What if this constraint were removed and the two input languages could, in principle, be produced at the same time? In the atypical case of hearing infants exposed to a signed and a spoken language from birth, these children can potentially produce their two input languages at the same time. This is a new kind of language mixing, 'simultaneous language mixing'. Would these children use this option and, if so, how?

The unique possibilities available to the signing and speaking bilingual can provide new insights into the underlying mechanisms at work in early childhood bilingualism: (1) Delay: If very early bilingual language exposure, *per se*, causes infants to be delayed relative to monolinguals, then the prediction is that these infants should demonstrate especially dramatic timing delays or asynchronies in the maturational course of language development in one language modality over the other modality, especially given that different neural substrates underlie the production and perception of signing and speaking, each with differing rates of brain maturation in early development (e.g. Lecours, 1975). (2) Confusion: If very early bilingual exposure, *per se*, causes fundamental disruption to young bilinguals' ability to establish stable and independent language representations – presumably because they first possess one fused linguistic system that later becomes differentiated – then the following predictions apply to both populations. First, very young bilingual babies and children should produce language mixing that is largely independent of any sensitivity to the specific language of the addressee ('interlocutor sensitivity'); they should initially flip from one language to the other, exhibiting no systematic relationship between their language and the specific language of the adult, with a more fine-tuned relationship developing only over time. Second, and most theoretically revealing, the young LSQ-French bilinguals' language mixing should be internally unsystematic. Once the physical constraint of the mouth is removed and these babies and children are provided with the opportunity for rampant simultaneous language mixing of their two languages, they should take it – boldly joining linguistic units from one modality with linguistic units from the other in highly irregular ways.

If, however, the bilingual child's mixing is not due to an underlying representational confusion – because they possess two representational systems of their input languages right from the start – and is instead the result of other factors (such as children's interlocutor sensitivity, parental language input patterns, developing language preference), then once the physical constraint of the mouth is removed, the prediction is that the signing-speaking infants will nonetheless maintain a systematic distinction between their two languages. Rather than being highly irregular, the signing-speaking child should exhibit language mixing patterns that are strongly sensitive to the language of the interlocutor. Further, we should see simultaneous signing-speaking language mixing, but such mixing should exhibit a strongly principled and internally systematic relationship. Because the phonological distinction between words in young bilingual (and mono-lingual) babies can be very unclear, we also hoped that signing-speaking babies would provide an unique view into early bilingualism in a manner not possible through the exclusive study of young speaking bilinguals: signing-speaking children's two native languages reside in such physically different modalities – involving the tongue versus the hands – that we hoped our scrutiny of the interplay between these two modalities over time would provide us with an especially clear window in the age at which language differentiation occurs in production.

METHOD

Subjects

Six hearing children participated in this study. Three of the children were acquiring Langue des Signes Québécoise (LSQ) and French, and three of the children were acquiring French and English; the inclusion of this latter group of children constituted a crucial design feature of the present study. Here, the French-English children served both as an experimental group, which we could study relative to the literature at large, and as an important control group with whom we could compare with our key experimental group, the signing-speaking children. All six children had regular and consistent exposure to both of their two input languages from birth, and each parent of each child identified himself or herself as using primarily one language with their child; indeed, no adult described themselves as being someone who routinely mixed languages with their child, with parental patterns of language use and mixing being a variable that we assessed independently here (more below).[1] The six children were divided into three groups by age and languages: Cell 1 (ages approx 0;10–2;0; 1 female French-English, 1 male LSQ-French), Cell 2 (ages approx 2;6–3;6; 1 female French-English, 1 female LSQ-French), and Cell 3 (ages approx 3;6–4;6; 1 male French-English, 1 female LSQ-French). All children were studied over a one year period, with a component of their data presented here. Cell 1 children were studied every month until the occurrence of their first word (first sign) in each of their input languages, and afterwards they were studied on a tri-monthly basis, yielding five experimental sessions in the present analysis. Note that here the infants were studied before the production of their first words (first signs) and were followed beyond their first-word and first two-word combinations in each of their two languages. Children in Cells 2 and 3 were studied every 3 months, for a total of three sessions, so as to

[1] The French-English parents did know and speak these two languages, even though each parent claimed to use only one language with their child, save the father of the Cell 3 boy who did not know French (only the mother spoke French). Interestingly, parents who were deaf and using LSQ were bilingual in LSQ and French in that they did know (have competence in as distinct from performance) both languages (e.g. the deaf parent did read and write in French). Here, however, they only 'spoke' one of them with native fluency, LSQ (and some could produce some common lexical items in spoken French, although the pronunciations significantly differed from standard French); and, of course, they could not hear French as the deaf adults in this study were profoundly deaf from birth and acquired LSQ as their first language from their deaf parents or deaf family members. The children's behaviours indicated that they were generally aware of adults' language abilities and/or hearing status from the earliest ages of language production; for example, though anecdotal, we were quite struck by one eleven month old LSQ-French infant who turned to the right and signed 'hat' to mother (who was about to put on the infant's winter hat) and then turned to the left and said 'chapeau' (*hat*) to the nearby French-speaking experimenter.

observe the patterns of language use in children already well into the acquisition process. The majority of the sessions were conducted in a comfortable play room for children at McGill University. One of each of the child's sessions was conducted in the child's home to capture their daily interactions. Table 1 provides information about the subjects.

TABLE 1. *Ages of subjects at videotaped sessions*

Cell	Session no.	French-English	LSQ-French
1	1	1;00.20	0;10.24
	2	1;01.17	1;00.09
	3	1;02.16	1;04.29
	4	1;05.05	1;07.26
	5	1;08.16	
2	1	2;09.05	2;10.11
	2	3;00.04	3;00.27
	3	3;03.08	3;04.04
3	1	3;08.01	3;09.00
	2	3;11.19	4;00.07
	3	4;02.05	4;03.24

Procedure

Data collection. All experimental sessions with children and family were videotaped and each session contained the following 5 conditions: in condition 1, experimenter, parent, and child interacted together freely; when both parents and other relatives or siblings were present, all parties participated in this condition. The goal of this condition was to observe the child's language choice within a natural and uncontrolled discourse context, as well as to examine the child's spontaneous sensitivity to the language of others. At an appropriate moment during this condition, parents were also asked to comment on their child's linguistic achievements in each language (on-line videotaped interview). In condition 2a, one parent was left alone to play and converse with the child using a standard set of creative toys and books. Then, in 2b, the other parent was left alone to play and converse with the child. The goal of this condition was to capture the child's patterns of language use during consistent exposure to one of their input languages from a primary caregiver. In Novel Experimenter conditions 3 and 4, the child first interacted alone with an experimenter who was a native speaker of one of the child's native languages, and then the child interacted alone with another experimenter who was a native speaker of the child's other native language; all novel experimenters in one language, say French, were instructed to respond to a child's use of the other language, say English, by gently saying that they did not understand in the language of their condition, as it was our desire that the children might assume that they were addressing a monolingual. The goal of these two Novel conditions was to observe how children use each of their native languages with novel individuals, to observe their linguistic sensitivity to the interlocutor when it was not their primary caregiver, and to gain insight into a child's language preference by their patterns of language mixing with adults when they spoke only one of their native languages to them. Use of this type of condition is also important to avoid the possibility that children's linguistic differentiation is simply due to a learned association of the language with a parent (though developed here independently, see Genesee & Boivin, 1996, for use of a similar task). In Competition condition 5, a competition task was employed, involving the use of a large blackboard and chalk followed by a drawing activity with crayons while seated at a table. Here we observed the child interacting simultaneously with two adults, each using one of the child's native languages. The goal of this competition condition was to observe how young bilinguals select a language in order to interact with each individual when they are simultaneously confronted with different language users in a controlled discourse context. Conditions 1 and 5 were conducted for approximately 10 minutes, with the intervening conditions having a duration of approximately 5 minutes each; while the experimental component of each videotaping session with the children and family lasted for approximately 35 minutes, videotaping of the children both before and after typically yielded one hour or more of spontaneous videotaped data per child, per session.

Immediately following each experimental session, experimenters wrote a summary of the session, reporting their observations of the child's comprehension and production in each language. They recorded any of the parents' comments about their child's linguistic abilities that were made off camera. In addition, MacArthur CDI data were collected from the parents.[2] Although the primary data in this study consisted of analysis of the videotaped experimental tasks, these additional data were used to ensure that our data were representative of the child's linguistic achievements and were commensurate with published standardized norms. The CDI data were also used in combination with our videotaped data in the analysis of children's translation equivalents in each of their respective languages.

[2] After every session, the parents of Cell 1 children were required to fill out a MacArthur CDI (Fenson *et al*., 1991) for infants (designed for ages 0;8 to 1;4) for each of the child's two languages, noting both the words (or signs) that they produced and comprehended; the toddler version of the CDI (designed for ages 1;4 to 2;6 months) was used once Cell 1 children were beyond the age of 1;4. Parents of Cell 2 children filled out the inventory only once at the beginning of the study, using the CDI for toddlers; Cell 3 children were too old for the CDI, being outside of its age range. The LSQ-French parents were given a CDI that was both translated into and adapted for French by Diane Poulin-Dubois and her collaborators; we are sincerely grateful to her for sharing this with us (Frank, Poulin-Dubois & Trudeau, 1997; Trudeau, Frank & Poulin-Dubois, 1997).

Transcription and coding. The videotaped sessions of the Cell 1 infants' speech were fully transcribed according to standard CHILDES child language format and included phonetic transcriptions. LSQ utterances were transcribed using the identical format; as in the spoken language transcripts, LSQ transcripts included notation for (manual) babbling, gestures and various forms of signing (e.g. baby signs, protosigns, phonetically well- or ill-formed signs; all types defined below) using sign-phonetic diacritics as appropriate (i.e. for hand shape, spatial location, palm orientation, and movement parameters of a 'sign' – equivalent to the 'word' – plus eye gaze, head and facial markings). The sign-phonetic diacritics are analogous to the IPA and are standard in the linguistic notation of signed languages (e.g. see further discussion in Petitto & Marentette, 1991). Standard sampling methods were being used with the older children in Cells 2 and 3 (see below). All the children's data was entered into a computer database that permitted distributional and relational analyses.

Two kinds of coding procedures were used. (a) The attribution of lexical status: standard procedures were applied when attributing lexical status to all children's (all Cells) 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 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,[3] and (iii) the 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 infant'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; for example, it reliably differentiated among infants' gestures (which signaled meanings, but lacked consistency in phonetic form), babbling (which did not signal meaning, but which had consistency in phonetic form), and genuine attempts

[3] One exception was the exceedingly small number of 'protowords' observed across the corpora, whereby a child might produce a highly consistent sound-referent pairing that contained no phonetic match with the adult word.

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.

The verbal or manual forms of Cell 1 infants judged to be lexical according to the above criteria were further transcribed as to the infant's direction of eye gaze when producing the lexical form and the infant's immediate actions (both preceding and after) the production of the form. The interlocutor's apparent interpretation of the infant's form was also transcribed; systematic patterns of eye gaze, actions, and adult interpretations, together, provided us with additional information that helped clarify any ambiguous attributions of lexical status to infant productions. The infants' lexical forms were then coded for their apparent communicative function, including whether a form was used to name, comment, answer a question, request, pose a question, command, or whether the form was produced as a social greeting or as an attempt to get attention. An infant's lexical form was also coded for its manner of use, including whether it was produced spontaneously, elicited (e.g. produced in response to a question) or imitated (e.g. produced with no apparent evidence of comprehension). Crucially, for every word (sign) that they produced, we further identified the apparent item (referent) that it was used in relation to (extensional or intensional); such coding of function, manner of use, and referent further helped clarify any ambiguous attributions of lexical status by providing rich information on the semantic underpinnings of the young children's lexical forms.

(b) Coding and analysing children's and adults' patterns of language use and mixing: we examined the bilingual children in Cell 1 at the one-word stage (e.g. interutterance mixing; see below) and, crucially, the children in Cells 2 and 3 who had first-words (signs) well under their belt; because these slightly older children produced a rich array of words (signs) and in rich combinations, we used a standard language sampling method. Here we analysed the children's language from approximately three minutes of each of their five experimental conditions. Each child's language data were then coded by 'utterance', a standard unit of analysis in our study, child language, and in studies of childhood bilingualism (e.g. Lanza, 1992; Genesee *et al.*, 1995). The 'utterance' was defined as the expression of a thought (or thoughts), marked off by pauses (including intonation, stress) or conversational turns, which the child produced with some apparent intent to communicate (even if only to one's self). An utterance could be comprised of a single unit ('*No*!') or multiple units ('*I said no*!'), and it proved to be a readily identifiable entity.

To determine children's and adults' patterns of language use and mixing, all utterances sampled from each of the five experimental conditions were coded along the following dimensions: (a) 'interutterance' (across utterances) language use, or the languages used by the child across utterances (from one utterance to the next), (b) 'intrautterance' (within utterance) language use, or the number of words (signs) produced by the child in each of its respective native languages per utterance; words that could not be distinguished as being either French or English, either because of the pronunciation or because they were proper names, were coded as 'neutral' (neutrals were not relevant to the LSQ-French group because modality differences made clear which language was being used), (c) the addressee of the child's utterance, including the native language of the addressee, and (d) the languages that the adult had just used with the child; this provided a relative measure of the nature of the child's linguistic input across contexts.

With the French-English parents, we coded both their inter- and intra-utterance language use (language mixing or codeswitching); indeed, we were especially interested to see the extent to which these parents used French and English words within the same utterance.[4] We coded the same information for the LSQ-French parents. Notably, like the French-English parents, a deaf-signing parent would at times produce language mixing; in this latter case, they might produce a sign and a partial phonetic approximation to the semantically corresponding French word within the same utterance. To be clear, the signing parents in this study were profoundly deaf who used LSQ as their primary means of communication and were NOT speakers of a spoken language. Nonetheless, some deaf parents while conversing with their (hearing) children only – and possibly as a result of their own childhood speech-training – would produce phonation that contained at least one phonetic unit and partial syllabification of a target French word. For example, one deaf parent would produce a sound similar to [tow] for the French word 'bateau' (boat) while holding up a toy boat, then (placing the boat down) would switch to signing BATEAU, and on other occasions would produce these two forms at the same time (termed 'simultaneous mixing' described below). We coded the nature, frequency and distribution of deaf parents' vocal productions.

The LSQ-French children produced language mixing in the above manner (producing a sign from LSQ followed by a word from French, or *vice versa*), and they produced an additional phenomenon, which we termed 'simultaneous mixing'. Here a child might produce an LSQ sign and a full French word at the same time, and our coding system was designed to capture the

[4] In studies of bilingualism, children's language mixing is often referred to as 'mixing', implying a lack of linguistic order and sophistication. Yet adult language mixing is referred to as 'codeswitching', implying linguistic order and sophistication; for a discussion of this controversy see Lanza, 1992. While there are ways in which these two linguistic activities differ, we have found important ways in which these two activities are similar and principled. Thus, to avoid confusion, we chose to use the same term across children and adults.

various permutations of simultaneous mixing that these children produced. For every utterance, we coded how many words it contained and, of this, how many of its lexical items were produced simultaneously (involving both modalities). When lexical items were produced simultaneously, we further coded whether the sign and the word had the same meaning, termed 'congruent mix', or different meanings, termed 'incongruent mix'. In calculating utterance length in these instances, a simultaneous 'congruent mix' received one lexical count, whereas a simultaneous 'incongruent mix' received two lexical counts.

Reliability measures. The videotapes for the French-English and the LSQ-French Cell 1 infants were fully transcribed twice, each time by a native user of each respective language on the videotape; for example, an LSQ Deaf signer 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. Similarly, the Cell 2 and 3 children's two languages were each coded by a signer or speaker of the relevant child's languages (LSQ, French, or English), with checks of coding decisions assessed on a subset of the sampled utterances. Disagreement regarding both lexical attributions and coding were resolved through discussion.

RESULTS

Analysis I: are young bilinguals 'delayed' in their achievement of the early language milestones in each of their two languages?

If bilingual language exposure, *per se*, causes infants to be 'delayed', then bilingual infants in their first attempts to produce language may demonstrate delays or asynchronies in the maturational time course of language development in one language over the other.

The timing milestone results are summarized in Fig. 1, below, where we conducted comparative analyses of the onset timing of the two youngest (Cell 1) bilinguals' early language milestones in each of their two languages.

We will discuss each child in turn. The child acquiring two spoken languages from birth, French and English, acquired her first French word at age 1;0 and her first English word at 1;2. She first combined two French words at age 1;5 and two English words at 1;8. She reached the first 50-word milestone at age 1;5 in French and at 1;9 in English.

The results for the child acquiring a spoken and a signed language from birth, LSQ and French, were similar to the above French-English subject. He acquired his first LSQ sign and first French word milestone at the age of 0;10. He first combined two LSQ signs at age1;5 and he first combined two

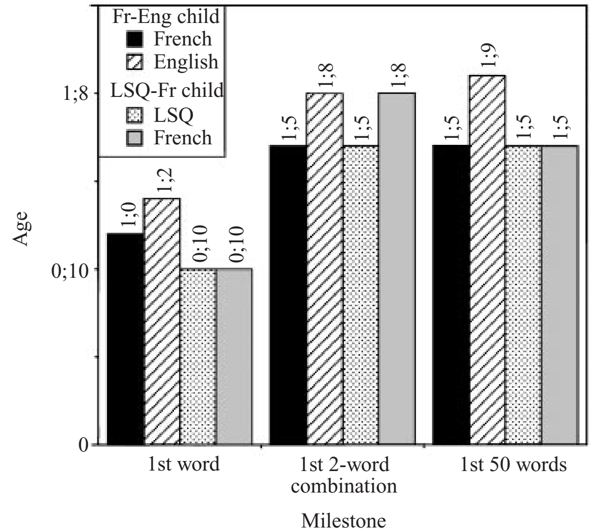

Fig. 1. Linguistic milestones: French-English and LSQ-French Cell 1 children.

French words at 1;8. By age 1;5, this child had acquired 50 words in both LSQ and French.

The main finding from this analysis, then, is that the young bilinguals were not delayed in the achievement of the classic early language milestones in each of their respective native languages. Their milestones were also similar to the established norms for monolingual children's first-word, first two-word combinations, and first 50 words. Further, dramatic delays or asynchronies in the timing of the LSQ-French child's achievement of linguistic milestones across the spoken and signed modalities were not observed. Given such 'normal' milestones, it is not clear why a general perception of language delay in young bilinguals has prevailed (recall the 'bilingual paradox'). What is clear, however, is that whatever ostensible asynchronies may exist between a young bilingual's two languages, its source is outside of the brain's biological mechanisms that determine the timing of early human language milestones.

Analysis II: are young bilinguals delayed or deviant involving other indices of normal vocabulary rate and growth?

If early bilingual language exposure, *per se*, causes disruption to the time course of language acquisition, then one might expect young bilinguals to exhibit deviance in other indices of normal vocabulary growth in either one or both of their native languages. Given potential differences between vocabulary on the hands in LSQ versus vocabulary on the tongue in French,

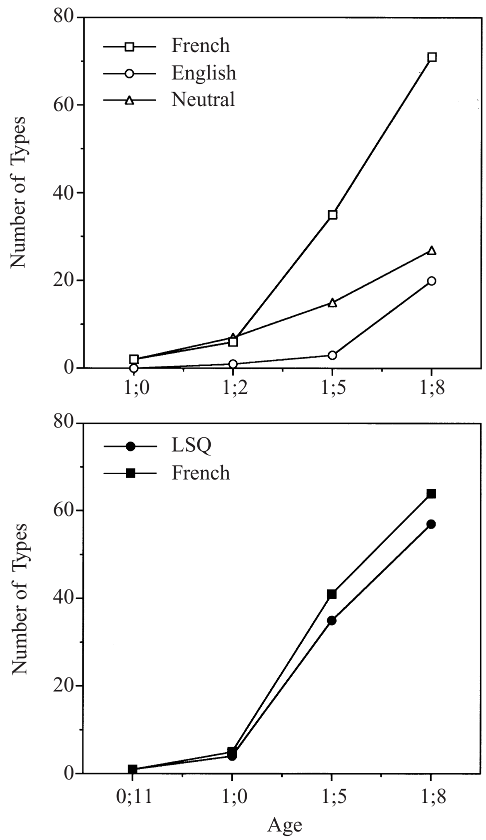

Fig. 2. Types of words or signs produced in sessions over time: (a) French-English and (b) LSQ-French Cell 1 children.

this type of bilingual language exposure might result in even stronger disruptions in lexical acquisition across the two modalities.

The vocabulary results appear in Fig. 2, which presents the cumulative number of the types of words or signs that each Cell 1 infant produced at each session in each of their native languages over time. Here we see that each infant demonstrated a general trend of increasing vocabulary types in both of their respective languages over time, with the rate and growth of vocabulary types in one of their languages being generally commensurate with the other, with the following exception: the French-English child produced more French word types than English word types. Here, production of English vocabulary types began at 1;2 and increased over time but at a reduced number relative to French. By contrast, the LSQ-French child's number of LSQ sign types relative to French word types was highly equivalent throughout acquisition, with each language demonstrating distinct but parallel development right from the start of language production. Further, the age at which these two infants produced their first lexical items in each language, as well as the number of new words produced in each language, were not only well within the norms reported for monolinguals in the MacArthur CDI (Fenson *et al.*, 1991) but their norms in EACH language fell well within the norms for the majority of the infants in this study; this was also true of our infants' norms if we combined their new word types across languages over time and compared them with those reported in the CDI. For example, by age 1;0, 49% of the monolingual CDI infants studied produced 1–10 words (range: 17% of the children had 0 words and only 2% had 41–100 words). As can be seen in Fig. 2, by age 1;0, each of our bilingual infants' two languages fell well within this 49% CDI group of monolinguals, as they produced up to 10 new word types in each of their individual languages.

Fig. 2 also shows that the French-English child alone produced a class of neutral lexical forms. 'Neutrals' were forms that based on our criteria were indeed lexical items for the child but that, because of their immature phonology, could not be judged as being either French or English; 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'; to be sure, the child seemed quite clear (even emphatic) about what she meant when she used this and other 'neutrals', it was just that we adults did not know which language they came from. Obviously, neutrals did not occur in the LSQ-French child, where clear modality differences between the hands versus the mouth signalled which language was being used from the child's very earliest onset of language production; here is one of the places where the signing-speaking child provides a clear view of early bilingual development in a manner not possible with children acquiring two spoken languages. Crucially, 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 – but the phonological ambiguity of neutrals made this hypothesis impossible to assess. Table 2 provides the French-English Cell 1 child's new types of neutrals over time, as some neutral types were repeated both within and across sessions. As can be seen here, most of the neutrals signified common and proper nouns with forms that generally preserved the initial phonetic content (and, in most instances, the syllabification) of the word for the concept in English, with the problem being that the word for the same concept in French had a highly similar phonetic contour as the English word, and *vice versa*. Both the total absence of neutrals in the LSQ-French

TABLE 2. *Cell 1 French-English child's new 'neutral' word types over time*

Age	Child's neutral word	English word	French word
1:00.20	[BA]	ball	balle
	[BA]	bottle	bouteille
1;01.17	[BA]	baby	bébé
	[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

TABLE 3. *Total vocabulary and translation equivalent (TE) percentages for Cell 1 children, and Pearson subjects matched for age and vocabulary**

Subject	Age	Total vocabulary	TE (%)
Cell 1	1;02	22	50
French-English	1;05	106	36
Cell 1	1;02	41	40
LSQ-French	1;05	198	51
Pearson subject 6A	1;02	27	50
English-Spanish	1;06	82	36
Pearson subject V7	1;03	27	41
English-Spanish	1;06	127	36

* Pearson subject data from Pearson, Fernandez, & Oller (1995).

bilingual group and the robust existence of semantic translation equivalents across all children's two languages (Analyses III below), caused us to analyse neutrals as stemming from phonetic interference when producing different words with shared sounds across languages in the identical speech modality, as opposed to reflecting underlying semantic and conceptual representational confusion due to shared meanings.

The main finding from this second vocabulary analysis shows that early bilingual language exposure did not cause significant delay or deviance to other maturational indices of normal language acquisition. Lexical rate and growth in each of the infants' native languages was generally equivalent, and generally commensurate with what has been reported in the literature for monolinguals over the identical time period (e.g. Capute *et al*., 1986; Petitto, 1987). Neither of the two analyses of maturational timing (milestones, lexical rate and growth) support the biological implications that follow from assumptions of initial delay: any protracted neurological reorganization that might be needed to establish additional neural pathways to process two languages from an ostensible base of one, would not have yielded such a similar maturational time course across young bilinguals' two native languages, nor one that is so time-locked to monolinguals. In particular, parallel lexical growth was observed across the signed and the spoken modalities in the LSQ-French child. While the findings do not offer compelling insight into why the French-English child showed a relatively decreased production of English word-types, the LSQ-French data teach us that some differences here may be only apparent and due to ambiguities caused by immature phonology – specifically, the French-English children's 'neutral' word class. Because English vocabulary development does not cease, but only increases with less frequency than French, and because vocabulary frequency is highly vulnerable to environmental input factors (e.g. Goldin-Meadow, 1981), we are compelled to consider sources outside of the child's biological capacities as the cause of such variation.

Analysis III: are young bilinguals 'confused' regarding the semantic differentiation of their two lexicons? Do they produce 'translation equivalents'?

If early bilingual language exposure causes confusion in children's underlying linguistic representations, one prediction is that they should be unable to differentiate which language a particular word belongs to, resulting in a marked absence of translation equivalents (TEs, or different words in each language that refer to the same concept). TEs in LSQ-French and French-English children therefore should be exceedingly rare, despite modality differences between LSQ-French that could make differentiation of the two languages clearer.

The results of this TE analysis appear in Table 3, where we first derived a cumulative vocabulary total for each infant 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), we then counted the total number of TEs.

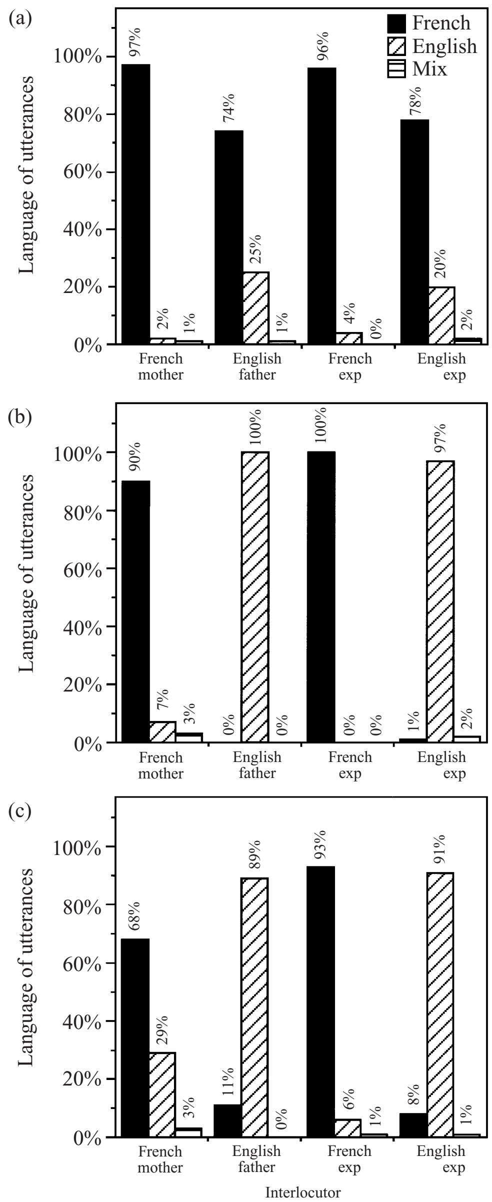

Fig. 3. Language of utterances addressed to each interlocutor: French-English children (a) Cell 1, (b) Cell 2, and (c) Cell 3.

Like Pearson *et al.*, we corrected for the number of lexical types for which there were no equivalents between the two languages by subtracting them from an infant's cumulative vocabulary total, as analyses were conducted only over potential TEs. Also following Pearson *et al.*, neutrals in the French-English child were given a single count in the calculation of TE percentages. Finally, each infant's number of TEs was divided by its cumulative vocabulary total to derive the TE percentage.

Table 3 presents the findings for our Cell 1 infants as compared with two of Pearson *et al.*'s subjects matched for age and vocabulary achievement at two ages. Both of our experimental Cell 1 children produced TEs and their TE percentages were comparable as well as quite sizeable. At 1;2 and 1;5 the French-English child's TE percentages were 50% and 36%, respectively. The LSQ-French child's TE percentages were 40% and 51%, respectively. Remarkably similar results were observed in Pearson *et al.*'s subjects.

The main finding from this TE analysis, then, is that TEs were observed across both Cell 1 language groups in relatively comparable and high percentages. TEs were not rare in the LSQ-French child and were instead comparable to other children. Such 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. Instead they provide powerful cross-modal support for the hypothesis that young bilinguals can differentiate their dual lexicons from their very first words.

Analyses IV: are bilingual children 'confused?' Evidence from children's interlocutor sensitivity, child and parent mixing patterns, and language preference

To test further the hypothesis that early bilingual language exposure is marred by language confusion, we examined how children used their two languages with different speakers. If young bilinguals are confused, the prediction is that their language choice should be unrelated to the external speaker context. Once freed of the constraints of a single mouth, young signing-speaking bilinguals may show this phenomenon most robustly, producing language across the modalities in a way that bears little systematic relationship with the language of the addressee.

The results showing the French-English children's language choices by interlocutor are reported in Fig. 3, with those for the LSQ-French children appearing in Fig. 4, and they represent analyses of utterances sampled from all 5 conditions (note that in Fig. 4, the Cell 2 child's interlocutor called 'mixing friend' is the primary adult male caregiver in this family). As a further measure of interlocutor sensitivity, we examined the extent to which children altered their language choice with the Novel experimenters in the Competition condition (condition 5; Fig 5). Finally, to understand better

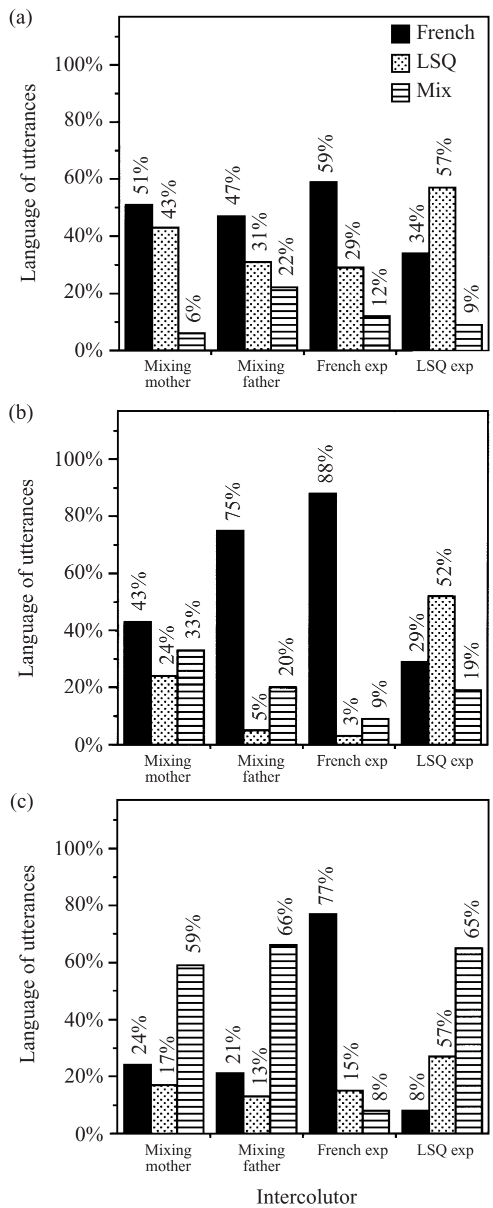

Fig. 4. Language of utterances addressed to each interlocutor. LSQ-French Children (a) Cell 1, (b) Cell 2, and (c) Cell 3.

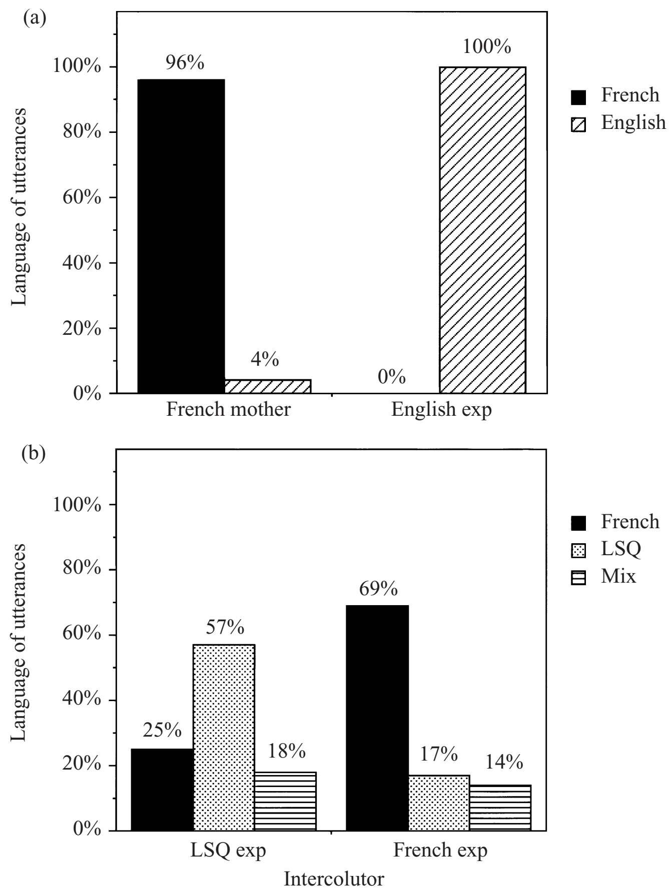

Fig. 5. Language of utterances addressed by Cell 1 children to each interlocutor in Competition condition: (a) French-English child, and (b) LSQ-French child.

whether there was a specific relationship between the children's language choice and the adult language, we also calculated the distribution of the language(s) that parents used when addressing their child, reported in Fig. 6 for two sets of caregivers ($n = 4$ adults); these two sets of caregivers (one set drawn from our signing-speaking bilingual population and one drawn from our speaking-speaking bilinguals) were chosen because of our interest in understanding the youngest ages at which children demonstrate interlocutor sensitivity and because the two set of adults were at different ends of the language mixing continuum: one set of adults never mixed (those of the Cell 1 child), the other set of adults frequently mixed (those of the Cell 2 child). In all cases, we calculated the patterns of INTERUTTERANCE (across utterances) language use, or the percentage of utterances used to a given addressee that

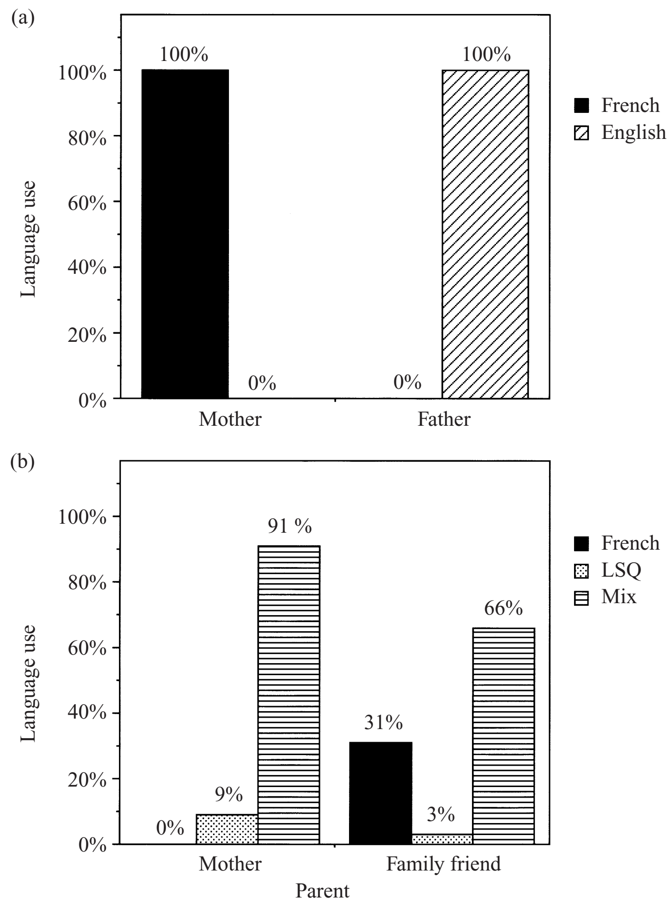

Fig. 6. Distribution of parental language use: (a) French-English child Cell 1, and (b) LSQ-French child Cell 2.

were in one or the other language, as well as the patterns of INTRAUTTERANCE (within utterance) language use, or the percentage of utterances used to a given addressee that contained both languages within a single utterance ('language mixing' or 'mixed utterances'). Analysis of these two types of language use and, in particular, analysis of the way a child mixed their two languages within a single utterance (intrautterance) was an especially strong test of young bilinguals' hypothesized 'confusion'.

Interlocutor sensitivity and patterns of interutterance language use. All children's language choice was systematically related to the language of the interlocutor. All children produced a different pattern of language use with each of their parents, one that generally reflected that individual parent's unique language patterns. Then, all children's language choice changed yet again depending upon the specific language of each of the two novel experimenters. At the same time, children did not always address an adult exclusively in the adult's language. Some children would alter the amount that they used one of their native languages to match the specific language of an addressee, but would still use their other language. Crucially, however, we found that the degree to which children did this was directly related to their parents' mixing rates and/or to the children's emerging preference for one of their two native languages, each of which will be explained below. The key result is that all children demonstrated a clear capacity to alter their language choices depending upon the specific language of the addressees, despite differences in degree.

An example of children's interlocutor sensitivity can be observed by comparing the French-English Cell 1 child (Fig. 3a) with the LSQ-French Cell 1 child (Fig. 4a). The two youngest infants are discussed here to illustrate that the capacity to differentiate between languages was evident even in the youngest bilinguals' earliest instances of language production. The French-English infant addressed her French mother in French 96·8% of the time and she used English in only 2% of her utterances. She then increased her use of English utterances to her English father to 25% and decreased her French to him to 74% of her utterances. A similar pattern was observed in the two experimental conditions that followed. With the Novel French experimenter, she used French in 96% of her utterances and she used English in only 4%. With the Novel English experimenter, she then increased her English to 20% and decreased her French to 78%. Turning to the LSQ-French Cell 1 child shown in Fig. 4a, we immediately see that this infant produced a high degree of language mixing to all parties, which we observed to be directly related to his parents' high degree of mixing discussed below. Note, therefore, this boy's language patterns with the Novel French experimenter. Here he used spoken French with the French experimenter 59% of the time and signed LSQ 29% of the time. With the LSQ experimenter, he increased his LSQ signing to 57% and he decreased his spoken French to 34%. The clear pattern of increasing and decreasing the use of one or the other of their two native languages depending upon whom they were addressing was a phenomenon common to all of the children, even the infants, and it bespeaks a capacity to differentiate their two languages from an early age.

Fig. 5 shows the results from two children's representative data from condition 5 (Competition condition), which further illustrate children's capacity to increase and decrease the use of one or the other language depending upon the addressee's language, and the corollary capacity: the ability to differentiate between languages. Recall that here children were confronted with multiple interlocutors simultaneously, and they had to both differentiate and switch between their two languages 'on-line.' In this Competition condition, the French-English Cell 1 child spoke French to her French mother 96% of the time and English 4% of the time (Fig. 5a), which was commensurate with this child's patterns of language use with her mother across other conditions (above). She used English with the Novel English experimenter 100% of the time, which indicates strong language differentiation; recall that this child does speak French with her English father, but here she exclusively avoids doing so with an English stranger. Notably, the LSQ-French boy in Fig 5b demonstrated a similar pattern of differentiation. Fifty-seven percent of his utterances to the Novel LSQ experimenter were in LSQ and only 25% in French. He increased his French to 69% to the Novel French experimenter, with his use of LSQ dropping down to only 17% of his utterances.

Intrautterance language mixing. All children produced language mixing, but each child's rate of language mixing was directly related to their parents' rate of language mixing. Fig. 6 provides representative data from two parents that demonstrates this specific relationship. Compare the rate of language mixing in the French-English parents in Fig. 6a with their daughter's data in Fig. 3a. Fig. 6a shows that this French mother spoke French to her child 100% of the time and her English father spoke English 100% of the time. Similarly, Fig. 3a shows that their girl's rate of mixing was exceedingly small, never rising above 2% of her utterances to any speaker over time. By contrast, compare the rate of language mixing in the LSQ-French parents in Fig. 6b with their Cell 2 daughter's rate of mixing in Fig. 4b (note that in Fig. 6b, Cell 2's 'Family friend' is the primary adult male caregiver in this family). Fig. 6b shows that this mother produced intrautterance language mixing (LSQ and French) to her child 91% of the time, and the adult male family friend produced such mixed utterances to this child 66% of the time. Related to this, Fig. 4b shows that this child also produced a high rate of intrautterance language mixing, ranging from 33% to 9% of her utterances depending upon who she was addressing. When the child addressed her mixing mother (91%), the child herself mixed 33% of the time. When she addressed the mixing male family friend (66%), she in turn mixed 20% of the time. When she addressed the Novel LSQ experimenter, she mixed 19% of the time, and when she addressed the Novel French experimenter, her mixing plummeted to 9%. This child's variation in rate of mixing is informative, and representative. While the signing-speaking bilingual children did produce a higher rate of language mixing as compared with the French-English children, their rates were directly related to the higher mixing rates of their parents. What was most striking, however, is that these children increased and decreased their mixing rates depending upon the specific language of their interlocutor.

Language preference. Although even our youngest babies were strongly influenced by their parents' patterns of language mixing, parents' influence on their children's language was not total. First, children were able to pull away from the mixing pattern of their parents and modify it according to whom they were addressing, thereby demonstrating clear interlocutor sensitivity. Second, children used their languages in ways that their parents never would. Recall, for example, the French-English Cell 1 girl (Fig. 3a), who spoke French to her anglophone father 74% of the time even though he spoke to her exclusively in English (Fig. 6a); she also spoke French to the Novel English experimenter in 78% of her utterances. A similar phenomenon occurred across all of the children, differing only in degree. Taken together, a different picture from a biologically-based, representational confusion can be evoked to explain bilingual children's language mixing and differential use of their two native languages. Bilingual children did use their two native languages differently, but this appeared to be guided by their sensitivity to the interlocutor, their parents' mixing patterns, and a third factor: the child's emerging language preference. In an attempt to harness the challenging concept of language preference, we examined the data for the child's propensity to use one language over the other.

The results of our language preference analyses are summarized in Table 4, where we calculated the frequency and distribution of each of a child's two languages across all experimental conditions and contexts (including when children talked or signed to themselves, initiated conversations to a previously silent addressee, and the like) and across all sessions over time. For this analysis, the most frequently used language across all sessions was regarded as the child's preferred language.

Table 4 shows that of the French-English children, the Cell 1 child used French most (54%; 4% English, 42% Neutrals), the Cell 2 child used her two languages in approximately balanced proportions (47% English; French 43%), and the Cell 3 child used English most (55%; 41% French, 2% Neutrals); the percentage of mixed utterances was very small across the three Cells (0·2%, 2%, 2%, respectively). Of the three LSQ-French children, the Cell 1 child used French most (62%; 34% LSQ, 4% Mixed), the Cell 2 child used French most (64% French; 17% LSQ, 19% Mixed) and the Cell 3 would be closest to the child with balanced proportions above – except that here her two most frequent forms of communication involved spoken French (39%) and mixed utterances containing both LSQ and French (44%), with only 17% of her utterances in LSQ alone. We therefore see that within the French-English cells, the first child preferred language was (a) French, the second child's preferred language was (b) balanced French and English, and the third child's was (c) English (respectively). Furthermore, we see that within the LSQ-French cells, the first child preferred language was (i) French, the second child's preferred language was (ii) French, followed by

TABLE 4. *General pattern of language use over all sessions for each child*

Cell	French-English children				LSQ-French children		
	% French only utterances	% English only utterances	% Neutral only utterances	% Mixed utterances	% French only utterances	% LSQ only utterances	% Mixed utterances
1	54	4	42	0.2	62	34	4
2	43	47	8	2	64	17	19
3	41	55	2	2	39	17	44

equal use of LSQ-mixed utterances, and the third child's was (iii) balanced French and mixed utterances (respectively). Such findings reveal an intriguing portrait regarding what constituted each population's pair of greater- and lesser-used languages. As expected, the French-English children's language pair was made up of French and English. Surprisingly, however, the LSQ-French children's language pair was not made up of LSQ and French but, instead, French and mixed utterances; here mixed signing and speaking appeared to take on the role of the stable other native language; we explore the nature of this population's fascinating linguistic activity in V below.

Where do children's language preferences come from? In all cases we found that each child's most frequently used language (the preferred language) corresponded to the language of its primary sociolinguistic group – a fluid construct that could change over time, and whose constitution could change from child to child. In practice, however, a child's sociolinguistic group was the language of the person or group with which the child had 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 home all day, for others this was the language of their siblings and friends with whom they were in contact all day. For others still, this was the primary language of the children and teachers at their daycare. So, for example, we found that the French-English Cell 3 boy was English dominant, even though his francophone mother was exceedingly careful about speaking to him exclusively in French, because she also spoke English to his older brother who was home with them all day, the father spoke English (and virtually no French), and they lived in a predominantly English community. Likewise, the LSQ-French Cell 1 was French dominant because he was in a French day care all day from a very early age. Children's preferred language appeared to be their default setting (the language that they fell back on) and, for some, the language that they persisted in using with an addressee even if that adult did not know it! Thus, it is not that children persist in using an adult's non-primary language because they are confused. Rather, in most cases, we can predict the bilingual child's differential use of their two languages, based on our knowledge of their sociolinguistic environment.

The main results from the above analyses showed that all children were sensitive to the language of their interlocutor, there was a systematic relationship between child and parent's mixing patterns and, this fact, in combination with children's emerging language preference, was predictive of both their propensity to mix with addressees and their propensity to use one of their languages more than the other (i.e. differential bilingual language use). In the signing-speaking children, mixed utterances appeared to constitute the stable other language in their bilingual language pair, which is explored below. These results fail to confirm the implication that follows from confusion accounts which suggest that young bilinguals' mixing involves disruption to underlying representational knowledge; instead the source of the bilingual children's language mixing and differential language use appeared to rest squarely in sociolinguistic-environmental input factors.

Analyses V: analyses of simultaneous language mixing in signing-speaking children: a unique test of confusion hypotheses

To further evaluate the hypothesis that bilingual children's language mixing reflects their fundamental confusion (presumably due to a single fused linguistic system), we used the unusual circumstance of bilingual language acquisition across two modalities as a unique test case. If early bilingual exposure, *per se*, causes language confusion, the prediction is that all young bilinguals' language mixing should be internally unsystematic, but the signing-speaking bilinguals should exhibit this in most remarkable ways. Here, once the physical constraint of the mouth is removed and children are provided with the opportunity for rampant simultaneous language mixing of their two languages, they should take it – boldly joining linguistic units from one modality with linguistic units from the other in unsystematic ways.

The results regarding Cell 2 and 3 children's overall propensity to produce language mixing appear in Table 4 (% mixed utterances). Recall that our analyses focused on Cell 2 and 3 children's total set of utterances containing language mixing because potential language confusion reveals itself most robustly in the multi-word combinations typical of these two ages. As is shown in Table 4, the French-English children in Cells 2 and 3 produced little language mixing (only 2% of each child's total utterances were mixed); these were of course all sequential mixes – or word(s) from one language followed by word(s) from the other within a given utterance. Conversely, the LSQ-French children produced much language mixing (19%, Cell 2; 44%, Cell 3); of the combined total number of mixed utterances that these two children produced ($n = 341$), 21 or 6% were sequential mixes and 320 or 94% were simultaneous mixes, indicating clearly that the LSQ-French children did take advantage of the possibilities afforded to them by bilingual language acquisition across two modalities. Each population will now be considered in turn.

Sequential language mixing in French-English bilinguals. Table 5 provides the total 18 sequential language mixes produced by the French-English children (divided according to whether the child was addressing a French or English adult) and reveals the following clear pattern regarding children's interlocutor sensitivity and the directionality of language mixing: children do not produce half a sentence in French and half in English (unless, of course, it is a two-word utterance). Instead, given a specific host or matrix language (typically the same language of their addressee), they will introduce 1 or 2

TABLE 5. *Cell 2 and 3 French-English children's utterances containing language mixing**

Child to French addressee	Child to English addressee
1. Regarde ça c'est un **cookie** 'Look that is a **cookie**'	13. **Bien**, I go get another toy '**Good**, I go get another toy'
2. Maman toi fais un **curtain** 'Mommy you make a **curtain**'	14. Daddy he's **quarante-et-un** 'Daddy he's **forty-one**'
3. Avec le prince va faire des **glass slippers** hein? 'With the prince will make some **glass slippers** eh?'	15. A **soleil** 'A **sun**' 16. A **bébite** 'A **bug**'
4. Il a des beau **slippers** 'He has nice **slippers**'	17. …go the **bébite** '…go the **bug**'
5. Moi je veux colorer une **star** 'I want to color a **star**'	18. A **marteau**-er 'A **hammer**-er'
6. Déposer la bol **here** 'Put the bowl down **here**'	
7. Un **tail** 'A **tail**'	
8. C'est **cup** 'It's **cup**'	
9. La **moon** 'The **moon**'	
10. Le **rabbit** 'The **rabbit**'	
11. Dans le **van** 'In the **van**'	
12. **What is** le courant? '**What is** the current?'	

* lexical items from guest language in **boldface type**.

words from the 'guest' language (the other native language relative to a specific speaker).

A second clear pattern emerged concerning systematic regularities in the semantic and grammatical properties of language mixing: guest words that are introduced into the host language are not mixed in randomly, as the resulting mixed utterances were always semantically appropriate with each part adding relevant information to form a cohesive whole. Further, the greatest occurrence of guest words comprised nouns (77% of the time) or other content words (e.g. verb, adverb, adjective). By contrast, far fewer of the guest words were comprised of other grammatical classes such as pronouns, prepositions, and the like; indeed, only 2 uses of pronouns were observed and they were highly routinized forms (locative/'here', interrogative/'what'). Our analyses further revealed that only mixing of full words occurred between the children's two languages (those involving free-standing morphemes, such as 'star'). We saw no morphological mixing (mixing of bound morphemes involving one from each language, such as 'saut+ing', to mean 'jumping') and we observed only 1 possible phonological blend, 'marteau+er' (marteau and hammer). As for why full word mixing occurs in the first place, the patterned nature of these results suggests causes other than confusion, including the fact that guest words may be better known in the guest language (examples 1, 2, 10, 11) or children may be more accustomed to using particular words in only one of their languages (examples 3–9, 12, 13, 15, 16, 17), or simply that they may have no equivalents in the other language (examples 14, 18; following 14, the child explicitly stated that he did not know the word in English).

Sequential language mixing in LSQ-French bilinguals. The signing-speaking children did produce strictly sequential languages mixing, involving LSQ sign(s) and French word(s), or *vice versa*, with no additional simultaneous units in the utterance. Interestingly, the total number of such sequential language mixes for these children ($n = 21$) was roughly comparable to the sequential mixing rate observed in the French-English children ($n = 18$). The sequential language mixes were also similar in kind to those observed in the French-English children and, overall, they exhibited similar patterns to those discussed above (see Example 1 below).[5] Although the sequential mixing rates across the two subject populations were relatively comparable, the LSQ-French children's sequential mixing rate was relatively low (21 of 341 total mixed utterances, or 6%) as compared to their second type of language mixing, simultaneous language mixing (94%); given this, we now turn to examine the fascinating phenomenon of simultaneous language mixing.

Example 1

French Words: Ça ressemble

$\longrightarrow$

LSQ Signs: MOUCHOIR

'This resembles a [facial] tissue.'

Simultaneous language mixing in LSQ-French bilinguals. The lion's share of language mixing in these children involved utterances in which signs and words were produced simultaneously (again, 320 of the 341 total mixed utterances or 94%). Interestingly, their average utterance length was 3·15, which was similar to the average length of utterances without language mixing. For any given utterance of this type, it was common for some of it to contain simultaneously produced words and signs, and some of it to

[5] The spacing of the vocal French text (in italics) and the signing LSQ text (in Caps) in Examples 1 and 2, indicate the time when each language (spoken or signed) was produced. In Example 1, the onset of the sign MOUCHOIR (facial tissue) occurred immediately after the child finished saying the spoken French part of this single utterance. In Example 2, the placement of 'canards' (ducks) on top of one another indicates that the two lexical items were produced at precisely the same time. This spacing convention was also used in Table 6.

contain free-standing signs and/or free-standing words. In this regard, we found that on average 63% of this utterance type was signed and spoken simultaneously, 28·5% of the utterance on average was speech alone, and 8·5% of the utterance on average was sign alone.[6]

Most of the utterances involving simultaneously produced signs and words contained semantically congruent mixes (285 of the 320 simultaneous language mixes or 89%; the signs and words had the same meaning). Like the French-English children, all mixed utterances were semantically appropriate (including those discussed here and below); none were unsystematic nor meaningless. Also like the French-English children, a grammatical analysis of these congruent mixes revealed that they contained predominantly content words (e.g. nouns, verbs, adverbs, adjectives), and not grammatical word classes such as pronouns, prepositions, and the like (see Example 2 below). Further like the French-English children, nearly all mixing involved full words and full signs.[7]

Example 2
French Words: des canards
⟶
LSQ Signs: CANARDS
'some ducks'

Fewer of the utterances involving simultaneously produced signs and words contained semantically incongruent mixes (35 of the 320 simultaneous

[6] This was determined by first creating a separate database (drawn from the total corpora of utterances) that contained only utterances that had at least one instance where a sign and a word were produced simultaneously. (This database included utterances like the simultaneously produced signed and spoken example provided in the text that also had a free-standing spoken phrase, and included those that contained free standing signs as well; note that this database did not include any utterance containing only words or only signs.) For each individual utterance of this kind, we then calculated the number of lexical items that were signed and spoken simultaneously, spoken only, or signed only. To determine just how much of an utterance each of these items occupied (i.e. the relative weight of simultaneous mixes, spoken only, and signed only lexical forms within a given utterance), we further calculated their percentage of occurrence within each utterance; for example, we divided the number of simultaneously signed and spoken lexical items by the total number of lexical items produced in a given utterance string. We further averaged the percentages across utterances to achieve the numbers reported here.

[7] Differences in language typology between LSQ and French render the separate production of some grammatical-syntactic items in LSQ, *a priori*, impossible; thus some LSQ-French simultaneous productions could not occur in principle. For example, the preposition 'to' in LSQ is conveyed through a grammatical inflection on the verb stem rather than by a full (free-standing) lexical item as occurs in French. This is true, however, of only a small subset of function words, with many other function words being possible to co-produce in LSQ and French (e.g. pronouns, other prepositions such as 'in', 'on', 'under', and the like). The key observation here is that the LSQ-French children do not take this path; that is, they could, but never co-produce this highly select class of words. As with other negative evidence in child language, there is much information in the things that children could have done, but do not.

language mixes or 11%; the signs and words had a different meaning), but they were highly revealing. First, the sign and word were nearly always from two different grammatical categories. Even so – and like the French-English children – each part added relevant information to form a cohesive whole, as the mixed elements added to the meaning of the utterances in semantically appropriate ways. See Table 6, set A.

A subset of this small class of simultaneous incongruent mixes (6 of the 35 total incongruent mixes or 17%) fell into a very special category that suggested that the LSQ-French children had two distinct grammars, rather than one fused grammar. Here, the child produced two different utterances in LSQ and French at the same time, and, crucially, preserved the correct syntactic order that the signs and words should have in the grammar of each respective language.[8] See Table 6, set B.

The main findings from this analysis of sequential and simultaneous language mixing included the fact that surprising similarities existed between the two subject populations. Both groups (a) produced mixed utterances that were semantically meaningful, (b) drew their mixed units nearly always from content words (nouns, adjectives) rather than other grammatical units such as pronouns, functor words, and the like, and (c) produced full lexical mixes (rather than joining parts of words or parts of grammatical markings), a pattern that has also been observed in other studies of bilingual children (e.g. Schylter, 1993). Once the constraints of the mouth were removed, the LSQ-French children did exploit this capacity by producing a rare type of mixing, 'simultaneous language mixing'. But the result was not random. Instead, simultaneous sign and speech language mixing was produced in highly constrained ways and followed the overall pattern of the bilingual French-English controls. Taken together, analyses IV & V teach us that language mixing in both LSQ-French and French-English populations was systematic and principled from the time that all children first entered the language acquisition process in production (around age 0;10). Such results further fail to provide support for the hypothesis that young bilingual children's language mixing is initially characterized by confusion that only gradually sorts itself out by age 3;0.

GENERAL DISCUSSION

The key objective of this research was to gain insight into the knowledge underlying very early bilingual language acquisition. We were also fascinated

[8] Because a different lexical item from each language was produced at the same time, these productions were included in this category, despite the fact that the meanings of the mixed items in the full utterance were semantically identical in both languages. We adopted this procedure with these few instances to preserve overall consistency in our coding.

TABLE 6. *Sample of Cell 2 and 3 LSQ-French children's utterances containing language mixing*

Utterance	Translation
A. *Mixed utterances involving simultaneous mixing of sematically incongruent lixical items**	
tiens **puis** du jus	'here **and** some juice'
⟶	⟶
BOIS JUS	'**DRINK** JUICE'
ça **brule**	'it **burns**'
⟶	⟶
MAIN	'**HAND**'
la **vaisselle**	'the **dishes**'
⟶	⟶
LAVER	'**WASH**'
B. *Mixed utterances containing dual language-specific syntax*†	
mon chien	'**my dog**'
⟶	⟶
CHIEN MON	'**DOG MY**'
vache petite vache	**'cow small** cow'
⟶	⟶
PETITE VACHE VACHE	'**SMALL COW** COW'
hé regarde, **toi papa**	'hey look, **you daddy**'
⟶	⟶
HÉ, **PAPA TOI**	'HEY, **DADDY YOU**'
mon ami Marcel	'**my friend** Marcel'
⟶	⟶
AMI MON LÁ	'**FRIEND MY** there'

French in lower case, LSQ in UPPERCASE,
* Semantically incongruent items in **boldface** type.
† Language-specific syntax in **boldface** type.

by the 'bilingual paradox' – simply put, the perception that very early bilingual language exposure is both good and bad for a child.

Gaining a handle on children's underlying knowledge is not straightforward, but classic studies on the timing mechanisms that determine early language acquisition by Lenneberg (1967) and others, have shown us that children's very early language milestones are under biological control. This, then, seemed like a good place to begin our investigations. First, all current theorizing about the knowledge underlying childhood bilingualism carries implicit assumptions about the brain and its biological capacity to acquire two languages or not. In turn, these assumptions yield powerful predictions about the course of early bilingual acquisition that are testable. Yet we found no empirical studies that directly tested these biological hypotheses. Second, we found no direct empirical investigations of the very young bilingual baby's earliest language productions. In the present study, we attempted to do both.

The basic premise of the unitary language system hypothesis attracted our attention. In this view, young bilinguals ostensibly begin the bilingual acquisition process with a single, fused linguistic representation of their two input languages that becomes differentiated only over time (e.g. Volterra & Taeschner, 1978; Redlinger & Park, 1980; Vihman, 1985). Examples are provided of developmental differences in young bilinguals' first lexicons in each of their native languages, contributing to a general perception of initial delay, and examples of their language mixing around ages 2;0 and beyond have contributed to attributions of representational confusion that is gradually sorted out by around age 3;0. What especially attracted our attention was the implicit biological assumption that followed from this view: the human brain is neurologically set at birth to acquire one, and only one, language, and then must undergo fundamental neural reorganization in the face of two. A scenario of this sort, would both predict and explain delay and confusion in early bilingual language exposure.

However, when we considered young bilinguals' linguistic activity from a broad perspective, one that included both biological and contextual factors, a different picture emerged – one that did not concur with the biological assumption implicitly underlying the unitary language system hypothesis. The data that helped us arrive at this conclusion included 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 unsystematic language mixing could have occurred if early bilingual language exposure first begins with single and fused linguistic representation that only gradually differentiates over the first three years of life; the excitement here, of course, comes from the understanding of what these bilingual children could have done given the possibilities afforded to them by acquiring languages in two dramatically different modalities (hands, mouth), but what they did not do.

Our analyses of these two groups showed that neither were delayed in their achievement of early linguistic milestones; both achieved the classic milestones at the same time in each language, and on the same developmental time table as monolinguals (Analysis I). Both groups demonstrated normal vocabulary growth in each of their languages (Analysis II). Both groups produced 'translation equivalents', which were present even from their first attempts at language production, suggesting that even young bilinguals can differentiate their dual lexicons from their very first words (Analysis III).

Moreover, all children demonstrated a robust capacity to differentiate their two languages when they conversed with adults; the children's patterns of language choice indicated that they were keenly aware of and sensitive to the language of their interlocutors (Analysis IV; 'Interlocutor sensitivity … '). Our slightly older bilingual children (from around age 2;6 and beyond) did mix their languages (to varying degrees), and they did exhibit differential use of their two languages; specifically, some persisted in using a language that was not the primary language of the addressee – but they were decidedly NOT confused. On the contrary, the propensity to demonstrate both types of linguistic activity was directly related to their parents' mixing rates, in combination with their own developing language preference (Analysis IV; 'Intrautterance language mixing', and 'Language preference'). Remarkably, the signing-speaking bilinguals did exploit the possibilities afforded to them by having access to two different modalities, and they did simultaneously mix their signs and speech. But they did so in semantically principled and highly constrained ways (Analysis V).

Despite such similarities, a key question arises concerning differences. Why weren't there fundamental differences between our two bilingual groups?; why aren't there fundamental differences between early bilingual and monolingual language acquisition? The answer to these questions implies a different view of the bilingual acquisition process than that offered in the unitary language system hypothesis. Greater differences are not observed because bilingual infants appear to enter into the language acquisition process with the representational scaffolding of their two languages already well in place by their first words – an idea that is clearly commensurate with that expressed by the 'differentiated language system hypothesis' – but here we sought to understand better both when, from what age and with what brain-based mechanisms such differentiation might be possible.

The fundamental hypothesis being advanced here is that very young bilingual infants have distinct representations of their two input languages from their first steps into the language acquisition process (Petitto, 2000). Exactly how such dual representations might arise is not known, but recent research on young infants' powerful predisposition to detect specific maximally-contrasting, temporal patterning as well as distributional regularities in the input are especially promising as being possible mechanisms upon which this capacity could be built (Petitto & Marentette, 1991; Saffran, Aslin & Newport, 1996; Petitto, 1997; Marcus, Vijayan, Bandi Rao & Vishton, 1999). For example, in the monolingual infant, the propensity to detect specific maximally-contrasting, temporal patterning in the input may, in turn, yield the relevant data over which infants can discover the phonological inventory and combinatorial regularities of their native language (e.g. Petitto & Marentette, 1991; Jusczyk, 1999). In the same way that this mechanism can give the monolingual infant the basic 'cut' regarding environmental input – information to attend to as potentially linguistic versus information to set aside as potentially non-linguistic – this identical mechanism, may also operate when a bilingual infant is confronted with two languages at birth, initially providing it with the means to detect tacitly that two related but different temporal linguistic patterns are coming in; this could then serve as the basis upon which they can tacitly build up representations of their two distinct phonological systems. It is further hypothesized that these processes are developing 'on-line' in the early months of language exposure (be it mono or bilingual), beginning most probably by birth, but it is most certainly well underway by age 0;6, exhibiting regular growth and expansion in the capacity to detect systematic temporal and distributional patterns. Given this, rudimentary knowledge of the (i) phonetic inventory and its combinatorial regularities, plus knowledge of other systematic regularities involving (ii) probabilistic word order and word groupings, regarding EACH of a bilingual infant's input languages, should be well in place by first-word onset at around age twelve months.

The above hypothesis about the knowledge underlying early bilingual (and monolingual) language acquisition, as well its biological underpinnings, raises intriguing questions about how bilingual infants will perform on classic perception tasks such as categorical perception of phonetic units when there are two phonological systems coming in rather than one. The hypothesis also raises questions about what is the upper limit of language learning that this neural architecture can accept; how many languages can a young infant be exposed to simultaneously from birth without ultimately and genuinely resulting in confusion (i.e. disruptions to the normal maturational time course of language acquisition and language representation)? Further, the above hypothesis has clear implications for the neural organization underlying adult bilingual brains regarding possible differences in neural circuitry following early bilingual language exposure versus later bilingual language exposure, especially in light of our knowledge of sensitive maturational periods of human brain development. Indeed, further research in this area may provide insight into when (what age) is exposure to the 'other' family or community language ideal for optimal bilingual language development; preliminarily, both the present study as well as recent brain imaging studies of adult bilingual cerebral organization (e.g. Klein *et al.*, 1995) suggest that the earlier the exposure the better. All of which are exciting topics for future exploration.

After having observed that there were no gross linguistic differences between our two groups of bilingual children and those reported in the literature for monolinguals (e.g. Brown, 1973; Nelson, 1973; Bloom, 1975; Capute *et al.*, 1986; Petitto, 1987, 1988; Petitto & Marentette, 1990; Charron & Petitto,1991), we are still left with the puzzle we began with: the 'bilingual paradox'. While the present research cannot resolve it, we hope to have suggested some clues as to why perceptions of delay and confusion have prevailed. These include the fact that differences between vocabularies are especially susceptible to environmental factors (e.g. Goldin-Meadow, 1981). For example, the infant who is at home all day with her French mother, may indeed end up in early life with more French vocabulary words than English. Even though the critical observation here is that this child hit all of her linguistic milestones in English and in French at approximately the same time (this being the key index of 'normal' language development), it is entirely understandable why her parents may instead worry that their child has, for example, 71 different words in French and only 20 in English – plus 27 'neutrals'.

This latter word class provides yet another clue as to why a perception has remained that very 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, neutrals were not observed in the LSQ-French children because the dramatic modality differences between signing and speaking made identification of the source language straightforward and, interestingly, these parents never told us that they thought their children were confused. Indeed, through the unique lens afforded to us by our examination of the LSQ-French bilinguals, we learned that young infants 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). We further learned that the neutrals observed in the more typical case of infants acquiring two spoken languages, like French and English, were largely a peripheral artifact of the production demands of forming words across two languages with shared sounds in the identical speech modality, rather than being a product of central, representational confusion, as 'neutrals' were primarily due to immature phonetic and pronunciation factors. Because most bilingual parents do not have access to this information, understandably, they find it disconcerting to hear their children produce partial words of an ambiguous language origin. Taken together, the above two observations provide insight into how the seeds of apprehension may be sowed in bilingual parents with babies and young children: frequency differences between young children's two languages could lead to the conclusion of 'delay', and the presence of 'neutrals' could lead to the conclusion of 'confusion'. What the findings from the present study teach us, however, is that both conclusions are unwarranted.

It is also the case that slightly older children's language mixing does seem confused if looked at in isolation, but it emerges as a strongly patterned activity when considered in the context of their parents' language mixing rates. Another regularity emerges when we see that children's mixing also changes to accommodate the specific language of their interlocutors. And some children's persistent use of one language in the face of someone who doesn't know it makes a lot more sense when, after studying their consistent language choices, we see that this may be due to their desire to use a language that they have come to prefer. This last observation may also help explain why some parents say to us, 'My child refuses to speak to her grandmother in English'; or, ' ... his father in French', and the like. To be sure, the balance of factors that contribute to the early bilingual language acquisition process are complex and warrant further scrutiny. But one observation seems equally sure: being exposed to two languages from birth, by itself, does not cause delay and confusion to the normal processes of human language acquisition.

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