

Second Language Learning in Early Childhood: Creating a Language Intervention for Infant Education Centers in Madrid

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1. Introduction

In today's global world, bilingualism is an international fact of life (McCabe et al., 2013). According to estimates, most of the world's children grow up learning more than one language (Grosjean, 2010), and although bilingual infants have twice as much language to learn as monolingual infants, they are able to accomplish this task without delay or confusion (Byers-Heinlein, Morin-Lessard, & Lew-Williams, 2017; Werker & Byers-Heinlein, 2008). Studies consistently show that infants raised in bilingual homes achieve language milestones on a similar schedule as monolinguals, provided that they receive an adequate amount of high-quality language input in both languages (Byers-Heinlein & Werker, 2009; Hoff et al., 2012; Petitto et al., 2001).

In addition to the obvious communicative (Fan, Liberman, Keysar & Kinzler, 2015), social (Liberman, Woodward, Keysar & Kinzler, 2016; Yow & Markman, 2011), and economic advantages (Callahan & Gandara, 2014), research consistently shows advantages in bilingual children's meta-linguistic awareness (Galambos & Goldin-Meadow, 1990; Barac & Bialystok, 2012; Byers-Heinlein & Werker, 2009), "openness" to learn another language (Cenoz, 2003; Bartolotti & Marian, 2017; Petitto et al., 2012), as well as documented advantages in executive functioning (Carlson & Meltzoff, 2008; Bialystok, Craik & Luk, 2008). Recent studies with bilingual adults demonstrate that active use of two languages provides protection against cognitive decline with aging (Gold, Johnson &

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Powell, 2013), and is associated with delaying the onset of Alzheimer's disease (Schweizer, Ware, Fischer, Craik & Bialystok, 2012).

Brain research using advanced, non-invasive neuroimaging and brain recording techniques is consistent with the above-discussed behavioral studies and demonstrates that, while non-trivial differences exist between bilingual and monolingual children's neural processing of language (Ferjan Ramírez, Ramírez, Clarke, Taulu, Kuhl, 2016), the infant brain is capable of simultaneously encoding two languages (Garcia-Sierra, Ramírez-Esparza & Kuhl, 2016; Petitto et al., 2012). Recent neuroimaging studies also shed light on earlier, seminal behavioral studies, which demonstrated clear and strong benefits of *early*, as opposed to later L2 exposure for full L2 acquisition (Flege, MacKay, & Meador, 1999; Johnson & Newport, 1989; Mackay & Flege, 2004). Specifically, recent MRI studies demonstrate that acquiring two languages in infancy, compared to acquiring a second language (L2) in later childhood or adolescence, results in more efficient neural language processing (Berken, Gracco, & Klein, 2017; Klein, Mok, Chen, Watkins, 2014) and higher brain-tissue density in regions supporting language, memory, and attention (Mechelli et al., 2004).

1.1. Early Bilingual Education: School Settings and Laboratory Research

Considering the above described research findings, it is not surprising that many communities around the world aspire to create school-based programs for early L2 acquisition. A growing body of research is beginning to document the effectiveness of such programs, and factors such as children's age at the start of instruction, length and intensity of exposure, didactic approach, teacher training, and teacher proficiency, have been associated with children's L2 outcomes (Rohde 2010; Steinlein et al., 2010; Unsworth et al., 2015; Edelenbros, Johnstone & Kubanek, 2006).

When interpreting the findings of school-based L2 studies, it is important to understand that the vast majority focus on children older than 3 years (and in many cases, over 5 years of age) who already have a well-established first language (L1), and receive L2 instruction through a single non-native speaker (see Muñoz, 2006), in a fairly limited context. Therefore, the majority of these studies do not capitalize on the well documented ability of infants and toddlers to rapidly, naturally, and efficiently acquire one or multiple languages through social interactions (see Kuhl, 2007 for review).

Laboratory studies indicate that infants have the ability to learn aspects of foreign language with remarkable speed: 9-month-old infants exposed to a foreign language through play sessions led by a live tutor learn to discriminate foreign language sounds at levels equivalent to infants exposed to that language from birth (Kuhl, Tsao, & Liu, 2003). Importantly, however, no learning occurs if the same material on the same schedule is presented via audio or video, demonstrating the critical role that social interaction plays in language learning (Kuhl, 2007). Furthermore, such short-term foreign language exposure in infancy modulates neural responses to foreign language sounds (Conboy & Kuhl, 2011), which are predictive of language skills up to three years of age (Kuhl et al., 2008).

1.2. Foreign Language Learning in Infant Education Centers?

Although the above-described laboratory findings are encouraging, attempts to introduce L2 learning in infant education settings have been limited, with the exception of small private programs, which are often very expensive and only available to a small subset of families. For most infants growing up in monolingual families, access to an L2 during the first three years of life is still limited. This is true in the United States, and Latin America, but also in Europe, where many countries have already adopted bilingual education curricula, but often at the grade school level, and only occasionally in preschools (Goorhuis-Brouwer & de Bot, 2010; Nikolov, & Djigunović, 2011).

Over the past two decades, Spain has made a commitment to bilingual (Spanish-English) education through immersion in public schools, with an agreement between the Spanish Ministry of Education and the British Council in 1996 (Dobson, Pérez Murillo, Johnstone, 2010). In the Madrid metro area (Comunidad de Madrid), the excitement for bilingual education was particularly strong, and the stated goal was to eventually adopt bilingual education in 100% of preschools (serving children 3-6 years of age), 50% of elementary schools, and 30% of high-schools (Gerena & Ramírez-Verdugo, 2014).

In 2014, a pilot program for bilingual immersion education was also introduced in a small number of Madrid's public infant education centers (escuelas infantiles), serving children 0-3 years of age. However, while the grade-school bilingual program in Spain was based on guidelines and evaluation practices from the Council of Europe Framework (2005), few, if any, guidelines were available for establishing an infant bilingual program, and its evaluation was limited to observation. Similar to their grade schools, where part of the curriculum is taught in English, the focus of the infant Spanish-English program in Madrid is on activities that are already part of each school's existing everyday curriculum. The program consists of approximately 2 hours of weekly instruction led by a Spanish-English trained bilingual teacher, who introduces simple English vocabulary and phrases through typical nursery school activities such as book reading, nursery rhymes, and singing. All English teachers hold the Cambridge B1 or B2 Certificate; however, their English is accented. The infant schools have English books, and other English materials, such as posters and wall decor with English words, which are utilized by the teachers during the English instruction period.

In the academic year 2015/2016, we launched a collaboration with the Madrid's Ministry of Education, Youth, and Sports, with the goal of evaluating this program and testing an alternative approach through a research-based intervention, described in detail in Ferjan Ramírez & Kuhl, 2017, henceforth referred to as the "2017 Study."

1.3. Foreign Language Intervention in Madrid's Infant Education Centers

The goal of our initial 2017 Study in Madrid was to assess how much, and what kind of foreign language exposure is necessary to ignite L2 learning in the

context of infant education centers. Specifically, we tested a six-point language learning intervention, which was based on a theoretical model and research in infant language development (Kuhl et al., 2008), against Madrid's current Infant Bilingual Program described above (henceforth referred to as Current Practice Comparison, CPC), over a period of 18 weeks, in four public infant education centers, located in different parts of the Madrid metro area.

In each of the four participating schools, we randomly assigned children ($N = 250$; age range: 7–33.5 months) to the “intervention” and CPC group, matched on age, gender, and baseline Spanish and English levels. The schools were located in different neighborhoods of the Madrid metro area (two in predominantly low-income neighborhoods, and two in mid-income neighborhoods), and served local families.

In each school, half of the children received the intervention, while the other half continued receiving the usual bilingual program (CPC). Each day during the 18-week period, intervention children left their regular classroom, and went to a different room to participate in 1-hour English sessions (intervention), led by teams of four language “tutors,” who were native English speakers and undergraduate students or recent graduates of the University of Washington. Prior to the start of the intervention, all tutors participated in an in-person, 2-week training at the Institute for Learning & Brain Sciences at the University of Washington (UW I-LABS), during which they received instructions about how to execute the language intervention through daily, 1-hour group play sessions.

The 6 principles of the 2017 Study intervention, and the research behind the intervention, are described in detail in Ferjan Ramírez & Kuhl, 2017. In brief: **(1)** Tutors provided a high quantity of English input. **(2)** During the intervention sessions, tutors used “parentese,” which is characterized as having higher pitch, slower tempo, and exaggerated intonation contours. **(3)** The learning context was highly social with weekly themes, games and activities that prompt face-to-face interaction. **(4)** Tutors were trained to provide prompt, contingent responses and engage the children in frequent back and forth exchanges. Children were encouraged to “talk” and interact. **(5)** Children heard English from multiple native speakers (four tutors worked with 12 children at a time). **(6)** The daily sessions were presented through adult-scaffolded play and language content was delivered in a way that ensured distributed exposure.

In both groups, the initial Spanish levels were assessed by the European Spanish MacArthur-Bates Communicative Developmental Inventory (CDI; López Ornat et al. 2005). Spanish and English comprehension was assessed with the Computerized Comprehension Task (CCT; Friend & Keplinger, 2003); English production outcomes were assessed using the LENA (Language ENvironment Analysis) technology, in combination with manual transcription of children's English utterances.

Results demonstrated that the 2017 Study children who experienced the intervention showed rapid gains on measures of English comprehension and production, significantly outperforming the CPC group on all L2 measures. Specifically, while both groups showed some growth in English word comprehension over 18 weeks, the intervention group outperformed the CPC

group by a large margin ($p < .001$; Cohen's $d = 1.34$). For language production, the difference between the two groups was even more pronounced: At the end of the 18-week period, the intervention group produced an average of 74 English vocalizations per child per hour, while CPC children averaged at 13 English vocalizations per child per hour, a significant difference with a large effect size ($p < .001$, Cohen's $d = 1.79$). Importantly, children's L1 (Spanish) comprehension grew equally in both groups, showing that it was not affected by the participation in the intervention.

In follow-up testing, we investigated the degree to which the 2017 Study children retained their L2 knowledge after the conclusion of the intervention, through an additional English comprehension assessment, conducted 18 weeks after having returned to their usual (CPC) classrooms. Children's English comprehension scores did not decline (or grow) during this period, demonstrating that the effects of English learning were retained at least 18 weeks after the completion of the intervention. Another interesting finding was that neighborhood wealth did not play a role in children's L2 learning. In other words, children's English comprehension and production advanced rapidly, regardless of whether they came from a mid- or a low-SES neighborhood.

Together, these results demonstrate that infants, across a range of socioeconomic (SES) backgrounds, are capable of making rapid gains in L2 learning, in a context of an early education setting. However, the above described results also underscore the fact that the nature and quality of foreign language programs for infants and toddlers play a critical role in learning. Infants can begin acquiring a second language rapidly, but the environment must engage them through high quality and quantity language input.

1.4. Scaling up the Intervention

With the above-described findings in mind, one important question to consider is whether the language intervention presented in the 2017 Study is scalable. That is, could it be applied more broadly, and offered to a larger number of children across a range of early education settings? We began to explore this question with a follow-up study, conducted three years later (academic year 2018/2019). The first step in the process of creating a scalable program was to design an online version of the 6-point 2017 Study training for the language tutors (recall that the tutor training in the 2017 Study was administered in person, at UW I-LABS). The online program was accessed and completed on a laptop or tablet, and language tutors could log in and complete it on their own time (see Methods below). The second step in creating a scalable program was to return to Madrid, and test the intervention with a new set of on-line trained language tutors, a new and larger number of schools, and a new cohort of children. Our initial findings of this follow-up scale-up study are described in detail in Ferjan Ramírez & Kuhl (*in press*), and summarized below.

2. Methods

2.1. SparkLing™

In preparation for the second study (henceforth called the SparkLing™ Intervention Study), the original, in-person training was transformed into an interactive training and certification tool, called SparkLing™. SparkLing™ consists of a training, a certification, a set of lesson plans, and a collection of books and classroom materials. The training consists of five units describing the six-point method through interactive analogies, activities and video examples of desired tutor behaviors and children's responses. Frequent knowledge checks in the form of quiz questions appear throughout the training, and must be answered correctly in order to proceed. Each unit ends with a graded certification, which must be passed in order to progress to the next unit. Upon passing all five certification tests, tutors receive access to 36-weeks (full school year) of classroom curriculum (lesson plans), which describe how to implement the research principles through 45-minute daily play sessions. Upon passing all five certifications, tutors are granted access to the SparkLing™ curriculum materials, which include a collection of classroom manipulatives and children's books to support the classroom activities.

Prior to launching the SparkLing™ Intervention Study, a new cohort of language tutors was trained and certified with SparkLing™. As in the 2017 Study, all tutors were native English speakers (self-identified and confirmed with an interview), and were undergraduate students or recent graduates of the University of Washington, in a variety of different majors. They were recruited within the University of Washington by announcements on bulletin boards, sharing through social media, departmental email lists, announcements in classes, and word of mouth. Prior research experience, knowledge of Spanish, or of language acquisition, and prior experience working with children were *not* required for participation in the program as a tutor.

2.2. Schools, Children, and Intervention Implementation

The SparkLing™ Intervention Study was implemented in 13 public infant education centers, serving local families with children between 0 and 3 years of age, in various neighborhoods of the Madrid metro area. Over 800 children between 9 and 33 months of age at the start of the study participated in the program. Language data was collected in 7 schools, varying in size, number of classrooms receiving the program, length of program (18 or 36 weeks), and ages of participating children (children between 9 and 21 months only, or children between 21 and 33 months only, or both age groups participated across different schools). Twenty-eight SparkLing™ language tutors and four full time Research Assistants lived in Madrid for the duration of the 2018/2019 academic year to execute the program and collect language data.

To test the scalability and robustness of our intervention method and curriculum, the SparkLing™ Intervention Study introduced several implementation changes:

1) The vast majority of children came from low SES backgrounds. In the 2017 Study, children's SES backgrounds varied from mid to low. Thus, the overall SES was lower in the SparkLing™ Intervention Study, and ranged from mid-low in some schools to extremely low in others. This change was implemented in order to allow us to generalize the findings across a broader range of SES backgrounds, and focus on children from low-SES families.

2) Language sessions were shorter in the SparkLing™ Intervention Study (45 minutes) compared to the 2017 Study (60 minutes). This change was implemented in order to reduce interference with the schools' usual curriculum, children's meals, diapering needs, and naps.

3) Tutor/child ratio was lowered: in the 2017 Study, 4 tutors worked with groups of 12 children. In the SparkLing™ Intervention Study, 3 tutors worked with up to 14 children in classrooms for ages 9-21 months and with up to 20 children in classrooms for ages 21-33 months. This change was implemented to reduce the cost of the program.

4) Children stayed in their usual classroom for the SparkLing™ Intervention Study language sessions. In the 2017 Study, children were asked to move to another room. This implementation change was made in order to eliminate the need for additional space, and in order to make the transition easier for the children.

5) Finally, the success of a half year (18 week) vs. a full year (36 week) intervention was tested in the SparkLing™ Intervention Study. In the 2017 Study, only the 18-week version was tested. The main objective of this implementation change was to assess the effect of program duration.

We hypothesized that the general pattern of results from the SparkLing™ Intervention Study would replicate those of the 2017 Study with a new cohort of SparkLing™-trained tutors, and new schools and children, but also expected to observe some attenuation in L2 growth as a result of shortening the sessions, lowering the tutor/child ratio, and the overall lower initial language skills (in children's native language, Spanish) stemming from the lower SES neighborhoods represented in the SparkLing™ Intervention Study.

3. Results

Detailed results of the initial analyses, based on data from four schools, are presented in Ferjan Ramírez & Kuhl (*in press*). Four schools were selected for initial analyses in order to obtain an age match with the participants in the 2017 Study, an age-match between the Intervention and CPC children within the SparkLing™ Intervention Study, and an age match between the 18- and 36-week version of the SparkLing™ Intervention Study. For comparison purposes, the language measures and statistical analyses in the SparkLing™ Intervention Study closely match the approach adopted in the 2017 Study.

The general pattern of results of the SparkLing™ Intervention Study replicates those of the 2017 Study. That is, over the course of 18 weeks, the SparkLing™ Intervention Study children outperformed the CPC group by a large margin, and on all measures of English comprehension and production. As in the 2017 Study, Spanish comprehension grew equally in both groups and was not affected by participation in the intervention. Compared to the 2017 Study, children in the SparkLing™ Intervention Study showed a comparable increase in English comprehension (although the initial, as well as final English levels were lower). In terms of English production, we observed a 4.7-fold increase from Week 1 to Week 18, as compared to a 6-fold increase in the 2017 Study, confirming our hypothesis that L2 growth would be somewhat attenuated. However, as confirmed by a large effect size (Cohen's $d = 1.19$), the increase in English production over 18-weeks in the SparkLing™ Intervention Study was still substantial, and children produced an average of 49.5 English vocalizations per child per hour. The SparkLing™ Intervention Study results also replicate the 2017 Study findings with regard to retention: Children who participated in the intervention over 18-weeks and then returned to their usual classrooms retained what they had learned for 18-weeks post intervention. As in the 2017 Study, SES was not a factor in L2 learning. Extending the findings of our 2017 Study, the SparkLing™ Intervention Study shows that those children who received the intervention over the entire school year (36 weeks), continued to advance their English comprehension and production in the second half of the school year, demonstrating that the program continues to enhance L2 skills.

Together, these results confirm that infants, across a range of SES backgrounds, can begin acquiring a second language rapidly in a school context through a program that engages them through high quality and quantity language input and social interaction. The results of the scale-up intervention also demonstrate that the research-based program was sufficiently robust to replicate the original (2017 Study) pattern of results under more realistic educational settings. In the next section, we consider some potential future applications of the SparkLing™ Intervention program.

4. Potential applications

In developing SparkLing™, our goal was to create a research-based approach for play-based language instruction in group settings for communities worldwide aspiring to provide early exposure to more than one language. The currently available program is thus intended for use in early education settings serving infants 0-3 years of age, and requires the participation of 2-4 language tutors with a group of children (groups ranging between 12 and 20 children have been tested). The lesson plans are structured as daily, 45-minute play-sessions, though modifications of this format are possible. While the existing version of the program uses English as the L2, the content of the program can be translated and adapted to accommodate other languages.

In addition to the 0-3 program described here, we have simultaneously created a program for preschool-aged children (3-5 years of age), which is yet to

be tested. This second “track” of SparkLing™ materials and curriculum closely matches the structure of the 0-3 track, but the content is adapted to serve older children. The third “track” of SparkLing™, currently in development, combines both, the 0-3 and the 3-5 track in a single training and certification, but provides separate lesson plans and classroom materials for each group.

A particularly exciting potential application of SparkLing™ are communities of Dual Language Learners (DLLs) in the United States. According to current estimates, 27% of U.S. children 0-6 are raised in homes where languages other than English are spoken (Capps et al., 2004). DLL children have the full potential and ability to learn both their parents’ language and English, but often do not receive adequate exposure to either of their languages. Our vision is that adaptations of SparkLing™ will provide methods and curricula grounded in basic science on early learning and language acquisition that support the needs of this growing population in *both languages*, and insure that all children in the United States and internationally enter Kindergarten prepared to learn in not just one, but two languages.

Importantly, and as with any other educational program implemented across cultures, it is critical that future applications of SparkLing™ work to implement culturally sensitive, responsive, and informed educational and research practices (Fouad & Arredondo, 2007). These will have to be considered on a case-by-case basis, by working with the communities wishing to implement the program.

5. Remaining questions

As we explain above, the language program is based on six research-based principles. As such, we cannot yet specify the minimal conditions that are necessary and sufficient for producing the observed effects. This means that the results presented thus far (Ferjan Ramírez & Kuhl, 2017; Ferjan Ramírez & Kuhl, *in press*) do not allow us to determine whether and how the observed learning patterns may change upon making changes to any one of the six parameters (for example, some communities may wish to replace the native-speaking L2 tutors with non-native speaking language teachers, or provide L2 instruction over 2-3 1.5 hour sessions instead of daily 45-minute blocks). While the SparkLing™ Intervention Study demonstrated that the program is sufficiently robust to replicate the original (2017 Study) pattern of results under less ideal educational settings, future studies investigating modifications of a single variable at a time will be needed to further address questions about the minimum conditions that are necessary and sufficient to induce the level of rapid learning observed in our two studies.

Another question for future studies is parental involvement: In the above-described studies, we asked parents *not* to expose children to English outside of the school during the study. However, we believe that parental support could be helpful for enhancing learning and/or retention, and we plan to explore the role of family involvement in the future.

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