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Thomas E. Allen, Donna A. Morere, M. Diane Clark, and Leah Murphy

Gallaudet University

Author Note

Thomas E. Allen, Department of Education, Gallaudet University; Donna A. Morere, Department of Psychology, Gallaudet University; M. Diane Clark, Department of Education, Gallaudet University; Leah Murphy, Counseling and Wellness Center, Ithaca College.

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Correspondence concerning this article should be addressed to Thomas E. Allen, Co-Principal Investigator, Science of Learning Center on Visual Language and Visual Learning, SLCC 1223, Gallaudet University, 800 Florida Avenue, NE, Washington, DC 20002. E-mail: thomas.allen@gallaudet.edu

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The first five years of a child's life are critically important for subsequent success in school and in life. The mastery of language, the development of cognitive skills, the acquisition of knowledge about the world, and an awareness of the fundamental pre-lexical and lexical elements of reading such as alphabetic and word knowledge are all prerequisites for the acquisition of literacy, and they are all acquired (or should be) in early childhood before the beginning of formal schooling. Sadly, for children who are deaf and have little or no access to auditory information, our understanding of how these skills develop is limited; consequently, many deaf children start school unprepared for academic training.

Indeed, there exists considerable controversy over how language abilities and literacy develop in children who are deaf. While all would agree that early identification and early intervention are important (Vohr et al., 2008; Yoshinaga-Itano, Sedey, Coulter & Mehl, 1998), there is considerable disagreement over the nature of the underlying mechanisms of early cognitive and literacy development, and these disagreements have led to divergent prescriptions for interventions (Chamberlain & Mayberry, 2008; Moeller, 2000; Mayer, 2007; Wilbur, 2000). These differing approaches are confusing for parents who must make high-stakes choices about how best to communicate with and educate their children.

To date, there have been no systematic studies of deaf children in their preschool years that have tracked the acquisition of early language and literacy skills throughout this early period of development. In 2008, researchers from the National Science Foundation-supported Science of Learning Center on Visual Language and Visual Learning (VL2), began the design of a longitudinal study that would track children, ages 3-5, over a three year period. Titled the VL2 Early Education Longitudinal Study (EELS), the purpose of this effort was to create a longitudinal data set from which hypotheses could be tested that were targeted at deaf children with specific characteristics, for example those with cochlear implants, those who had exposure to ASL in the home, or those who attended a specific type of educational program. The design of the EELS project was purposefully non-theoretical, and our goal was to be as inclusive as possible in the selection of participants and measures. For example, we included measures of sound-based phonological knowledge, as well as measures of ASL and fingerspelling. We included a large number of questions about cochlear implant use, as well as questions about the extent of exposure to sign language in the home. It is our hope that the data will be used to further theories of learning and literacy development, by allowing researchers to test specific hypotheses regarding language and literacy outcomes and their antecedents.

At the time that the EELS project was being designed, the US Department of Education, Institute for Educational Science, National Center for Special Education Research (NCSER), had recently completed a six- year national longitudinal study of preschool and

early elementary school-aged children with disabilities called the *Pre-Elementary Education Longitudinal Study* (PEELS; Markowitz, et al, 2006). PEELS examined children between the ages of 3-5 and followed them for a period of six years, with the goal of describing the preschool and early elementary school experiences of children with disabilities and determining the factors associated with students' academic achievement.

At the outset, we had hoped to acquire some basic data on preschool aged deaf children from the publically available PEELS dataset. Unfortunately, given the low prevalence rate of deafness, there were too few deaf children in the entire PEELS database to conduct any meaningful statistical analyses. Additionally, the PEELS study did not include data that are critical for fully exploring the contributions of important variables to the early literacy development of deaf children. For example, there are no questions about early home communication and language experience, and no assessments of ASL skill. The PEELS database is therefore not useful as a data source for exploring language and literacy acquisition among deaf children in the United States. Thus, we used the PEELS design as a model for EELS, including many of the same assessments, but made many adaptations to the procedures to increase their relevance for this population.

Method

Participants

Three eligibility criteria were established for the recruitment of participants: First, we limited the sample to those children who were between the ages of three and five on September 1, 2010. Next, we restricted our sampling to those children whose average unaided hearing thresholds were 60 dB or greater in the better ear. Finally, we excluded children who had been diagnosed with a severe learning or cognitive impairment. Beyond these restrictions, we sought a diverse sample. Children with cochlear implants and other assistive devices were actively recruited, as were children from a range of family backgrounds. Printed materials were prepared in Spanish and English, and all parents were given the option of an interview conducted in English, Spanish, Chinese, or ASL. The assessment teams always included assessors fluent in both English and ASL.

Two strategies were used to recruit participants. The first was to contact schools that had participated in either the Gallaudet Research Institute Annual Survey of Deaf and Hard of Hearing Children and Youth or the American Annals of the Deaf program directory. The second strategy was to recruit parents directly through list serves and parent-to-parent contact.

Thirty-two schools from 20 states responded to this participation request. Participating schools were located in a fairly uniform distribution across different community types: 21.3% of the sample were reported from rural communities; 25.5% from small or medium-sized cities; 36.2% from large or very large cities, 14.9% from the Suburbs, and 2.1% (only one school) from an Indian Reservation.

Each school designated a contact person who sent a participation package for each eligible child home to the parents. The package included enrollment forms, consent letters, and postage-paid return envelopes. Parents were instructed to return consent and enrollment forms directly to VL2. The recruiting procedure secured the participation of 262 children. Recruitment ended in August 2011.

Direct recruitment of parents included announcements in newsletters of parent organizations, social media, list serves, and word-of-mouth. Parents were encouraged to

contact the EELS recruitment representative directly. Each parent received the participation package and completed and returned of the consent and enrollment forms. An additional 25 children were enrolled through this pathway.

Assessments and Instrumentation

The EELS battery of tools included individually administered direct child assessments of the basic cognitive functioning, language development (English and ASL), and emergent reading; indirect assessments of the children's language, communication, and social abilities provided by both parents and teachers; family and child background characteristics provided by parents; classroom characteristics provided by teachers; and school level characteristics provided by program administrators. The direct assessments and the parent and teacher questionnaire were administered in each of three successive years. The administrator surveys were administered only in the first year.

The Assessment Teams. The assessors were advanced doctoral students in the Gallaudet University Clinical Psychology program who had completed training and supervised experience in psychological assessment and were skilled in both English and ASL. They were provided a procedures manual that contained information concerning administration and scoring of the measures, including variations to be used with the oral and signing children. All assessors underwent training in the assessment of young deaf children using the instruments described below and were supervised by a licensed clinical psychologist with over 20 years of experience evaluating deaf children.

The individual direct assessments were scheduled with early childhood education programs, elementary schools, teachers, special educators, and parents. When assessment sessions were scheduled, assessors received a list of the participant(s) being tested (typically, multiple students were tested at the same school), along with a packet of test protocols and a VL2 EELS cover sheet for each participant. This packet included the child's name, VL2 identification number, date of birth, and age. The cover sheet included space for the assessor to record information about the session including, VL2 identification number, school, gender, date of birth, age, the child's handedness, the use of glasses or assistive listening devices (e.g., hearing aids, cochlear implants), known disabilities or diagnoses, the communication method(s) used, and the examiner's name. The cover sheet also included space for the assessor to make notes about the child's performance on any or all of the assessments.

All children were given the standard age-based assessment protocol. The assessors were responsible for determining the language of assessment (ASL or English); the assessor asked the school administrator or teacher which language was used in instruction and the child's preferred language. In all cases, the assessors used their clinical judgment in determining whether the child fully understood instructions during the assessment and made accommodations if necessary. This accommodation typically involved altering the language of administration or instructions (American Sign Language or English). Sign-Supported English, a communication style involving signs being produced in conjunction with spoken English, was also utilized depending on the child's preference and level of residual hearing. The assessor also interpreted the signed instructions for the American Sign Language Receptive Skills Test (ASL-SRT; the only test in the battery that is presented fully in ASL) when necessary. Accommodations also included gesturing or using exaggerated facial expressions to ensure the child understood the task demands. When possible, children were forewarned of the upcoming assessment, but this accommodation was used particularly for children with a history of struggling with transitions or who were shy around strangers. If

necessary a parent, teacher, or aide was invited into the room during the assessment to encourage the child's participation.

While the duration of the assessment varied depending on the age of the child and other individual factors, on average approximately 60 to 90 minutes was required to complete the testing of each child. The set of measures varied depending on the age of the child. Due to factors such as inability to respond to some tasks, frustration or loss of attention or motivation, parent or teacher intervention (e.g., picking child up early or not wanting the child to miss a specific activity), or time constraints, not all children completed the set of measures established for their age group. When children had difficulty maintaining effort or attention, the assessor used clinical judgment to determine which, if any, additional measures would be administered.

The Direct Assessment Battery. The following tools made up the set of assessments administered to EELS participants:

Leiter- R Attention Sustained (Roid & Miller, 1997). Attention Sustained is a subtest of the Leiter-R, an intelligence measure designed to be administered nonverbally to children as young as 2 years of age which has a long history of use with deaf and hard of hearing children (Vernon, 2005). The Attention Sustained subtest is a paper-and-pencil task requiring approximately 5-minutes to complete, that can be administered using signed, spoken, or gesture-based instructions. There are three different forms of the task, designed for students at different ages. The child is instructed to cross out all objects matching a model in an array of figures under time constraints. Each of four trials is preceded by a practice trial using the relevant designs and array layout.

Primary Test of Nonverbal Intelligence (PTONI; Ehrler & McGhee, 2008). The PTONI is a measure of intelligence designed to limit the impact of language on cognitive estimation. The manual indicates that the test is appropriate for use with deaf and hard of hearing children using either English or ASL. It is designed for children ages 3-0 through 9-11. The child is presented with a set of designs and points to the one that does not belong with the others in the set. The PTONI raw scores are converted to a Nonverbal Index, a standard score with a mean of 100 and standard deviation of 15.

Woodcock Johnson, Third Edition Normative Update (NU) Tests of Achievement (WJ-III; Woodcock, McGrew, Schrank & Mather, 2001, 2007). The WJ-III is a battery of subtests which allows for a comprehensive evaluation of academic skills. The subtests can be administered together or singly and are intended to be administered individually. Age- and grade-based normative data are available for ages 2 to over 90 years and grades K.0 through 18.0. Raw scores are converted to standard scores with a mean of 100 and standard deviation of 15. Four tests from the WJ-III achievement battery were used in the current study:

1. Letter-Word Identification. This is a measure of basic word recognition and decoding. At the early stages, the child is asked to match and then name a series of upper and lower case printed letters. As the test progresses, simple word identification is required. *2. Passage Comprehension*. This subtest measures reading comprehension beginning at the preschool level with matching of icons to pictures of items, then simple two to three word phrases to pictures. It then transitions to a task that requires the child to produce a single word to complete a passage of increasing complexity. While early items can be answered based on basic word recognition and sentence comprehension skills, success on later items relies on the integration of the words and syntax of the text combined with prior knowledge of the topic in order to derive the meaning of the paragraph and retrieve the appropriate response.

3. Picture Vocabulary. This is an expressive vocabulary task on which the child is shown a picture and asked to produce a word/sign label. Standard administration requires the response to be spoken; however, either a spoken or fingerspelled word or the sign equivalent was accepted. As with other tasks, some of the more advanced vocabulary items have no sign equivalents, but for most children within the preschool and early elementary years, this was not a significant concern. *4. Understanding Directions*. This task evaluates the child's ability to understand increasingly complex English sentences and produce a response based on the instructions provided. The child is given a sentence (either orally or signed with or without voice, in English word order and with English markers) and is required to point to items within a picture in the proper sequence based on these instructions. Standard administration is via audiotape or cd; however, all children were presented the tasks by the examiner in order to provide visual access to the item content (via signs and/or speechreading in addition to any available auditory access). This task requires the child to rapidly analyze the English sentences and hold the information in working memory until it is time to respond. Simple comprehension of the words/signs alone is not sufficient to produce a correct response beyond early items. As the complexity of the sentences increases, the child must demonstrate fluency in analysis of English grammar in order to allow for rapid processing of the content so that an accurate selection and sequencing of the items to be identified is possible.

Woodcock Johnson-III Tests of Cognitive Abilities (WJ-III Cog; Woodcock, et al, 2007) -*Visual-Auditory Learning Subtest.* This is a subtest in a battery of cognitive measures co-normed with the WJ-III Ach. Despite its name, this task is readily signed and is used clinically with deaf children using oral or signed administration. It is a measure of associative learning on which the child is asked to learn relationships between icons and words (signs) and then read ("aloud" using speech or signs) sentences presented via the icons. This represents the child's ability to associate symbols (such as printed words) with their pre-existing linguistic structures (spoken words or signs).

Test of Preschool Early Literacy (TOPEL; Lonigan, Wagner, Torgesen, Rashotte, 2007). The TOPEL is a set of measures of pre-reading skills designed for children three to five years old. It is designed to identify skills associated with early reading development. Two subtests from this measure were administered: *1. Print Knowledge*. This subtest of the TOPEL measures alphabet knowledge and early knowledge about written language conventions and form; the child is asked to identify letters and written words, point to specific letters on command, name specific letters, identify letters associated with specific sounds, and say the sounds associated with specific letters. *2. Phonological Awareness*. This TOPEL subtest measures word elision and blending abilities; the child is asked to say a compound word, and then point to the picture which represents the word without one of the component words. Additional pictorial supports were added to clarify the instructions and questions. The second set of elision items requires the child to perform this task without pictorial supports first with compound words and then with individual words for which they must say what is left after dropping out specific phonemes. The second type of task requires the child to listen to (watch) separate phonemes and then select the picture which represents the word produced by the set of sounds (blending), again starting with two words which produce a compound word and then individual phonemes to produce one syllable words. This task is then repeated without pictorial supports.

Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, Rashotte, 1999. The CTOPP is a battery of tasks, which measure a range of phonological

processing skills. It is normed for individuals ranging from ages five through 24. Subtest raw scores are converted to standard scores with a mean of 10 and standard deviation of three, using age-based norms. Five subtests from this battery were selected, a subset of which were administered depending on the age of the participant. Four of these are rapid naming tasks, on which the items are readily signed. (The authors are currently evaluating the impact of signing on the timing of responses, given the importance of time to the scoring of these subtests.) *1. Rapid Color Naming,* involves saying/signing the names of a series of colors presented on two separate pages as quickly as possible *2. Rapid Object Naming* involves saying/signing the names of a series of simple objects (e.g., stars, fish) presented as line drawings on two separate pages as quickly as possible. *3. Rapid Letter Naming and 4. Rapid Digit Naming* (normed for children beginning at age 7) involve saying/signing two sets of letters or numbers presented in a manner similar to the previous tasks. The fifth test employed was *5. Sound Matching* that measures awareness of English phonology based on selection of pictures of objects whose labels have matching initial or final sounds. It is normed for children, ages five through seven.

Peabody Picture Vocabulary Test, Fourth Edition (PPVT-4; Dunn & Dunn, 2007). The PPVT is a broadly used measure of English vocabulary. It is normed for individuals ages two years, six months to over 90, and produces a standard score with a mean of 100 and standard deviation of 15. It is a receptive vocabulary task on which the child selects a picture from among a set of four, which best represents the word presented. This task was used for children identified as oral or who demonstrated significant spoken English skills.

Carolina Picture Vocabulary Test (CPVT; Layton &Holmes, 1985). This is a sign-based receptive vocabulary test similar to the PPVT-4 developed to measure the vocabulary of deaf and hard of hearing children whose primary mode of communication is sign-based. It should be noted that this test was not developed to measure ASL vocabulary, but rather more generic signed communication including a variety of sign systems. Layton and Holmes (1985) reported that items selected for the CPVT had to both have a sign equivalent and be able to be depicted pictorially. Each item involves a signed stimulus, following which the child must select the picture best representing the sign's meaning from an array of a target and three foils. The test was normed on a sample of 767 congenitally deaf (80 dB or greater in the better ear) children with IQs between 80 and 100. All had hearing parents and used signs (with or without speech) as their primary mode of communication. Children with multiple disabilities were excluded. Normative data are available for ages 4-0 to 11-11 generating standard scores with a mean of 50 and standard deviation of 10. Split-half reliability averaged .917 across the age ranges, while test-retest reliability was .86 across an average interval of 30 days in one study and .99 with at least a two-week interval between administrations in another study. Although the norms are somewhat dated, and the normative sample somewhat restricted, this test provides a rough estimate of sign vocabulary.

Letter Say/Sign and Letter Writing. The child is first asked to say (or fingerspell) the letters of the alphabet in order, and then is asked to write the letters in order. The responses are scored for production time, the total number of letters produced correctly, and the number of letters produced in the correct sequence.

Peabody Individual Achievement Test- R Reading Comprehension (PIAT:Reading Comprehension; Markwardt, 1998) . This measure is a multiple-choice task, evaluating reading comprehension at the sentence level. This task measures understanding of printed sentences based on responses that only require the child to select the picture among a set of

four which best reflects the meaning of the sentence. The child cannot re-read the sentence, so the selection must be based on their initial understanding of what was read.

American Sign Language Receptive Skills Test (ASL-RST; Enns & Herman, 2011). This test was designed to measure the receptive skills related to linguistically accurate ASL sentences. The child is presented with a video clip of a signed sentence and must select the picture among a set of four that best represents the meaning. Sentence length and complexity increases as the task proceeds. As with the WJ-III Understanding Directions, skill with the vocabulary alone is not sufficient; fluency with the grammar of the language is necessary for accurate linguistic analysis and selection of the correct response.

Family Background, Teacher, and Administrator Surveys. In conjunction with the individual child assessments, parents, teachers, and school administrators were asked to complete questionnaires for each child in the study. These individuals received a small compensation for their participation.

The Family Background Questionnaire included demographic data related to both the child and their family and took about 90 minutes to complete. During Wave One of the study, two versions of the teacher questionnaire were used: The Early Childhood Teacher Questionnaire (for children not yet in kindergarten) and the Kindergarten Teacher Questionnaire. An Elementary Teacher Questionnaire for children in grades 1 and higher was added beginning in Wave 2. This questionnaire required about 30 minutes to complete. Hereafter, these surveys are referred to as the Teacher Survey. The Elementary School Principal Questionnaire or Early Childhood Program Director Questionnaire (referred to as the Administrator Survey) was sent to principals or program directors, as appropriate, of the children's schools/programs and required about 20 minutes to complete.

Surveys were made available in written English or Spanish. Participants also had the option to request that the survey be read to them over the phone or signed to them over videophone in American Sign Language. Their completed surveys were either returned to the EELS team if they had selected a paper copy, or they were given a password to complete the survey on line. Below is a general description of the sections of each questionnaire. Surveys can be found on the VL2 website (ABAS items have been redacted.)

***Indirect Assessments*.** Three sets of raters, parents, teachers, and school administrators, completed indirect assessments on the children as well provided information regarding the school and home contexts.

Adaptive Behavior Assessment Scale (ABAS). Items from the Adaptive Behavior Assessment System, Second Edition (ABAS-II; Harrison & Oakland, 2003) were used to reflect adaptive behaviors. ABAS scores help describe a person's general adaptive behavior as well as his or her functioning in adaptive skill areas including: communication, community use, functional academics, school/home living, self-care, self-direction, and social/ leisure behaviors. These skill areas encompass the practical, everyday skills required to function and meet environmental demands, including those needed to effectively and independently care for one's self and to interact with others. Royalties were paid to embed the items into the parent and teacher questionnaires.

In addition, permission was obtained from Pearson Education Inc. to adapt some items to reflect the communication skills used by deaf children. Therefore, two sections on communication were developed, one on spoken language and the other on sign language. Parents were directed to complete the section(s) that matched their child's use of language. For example, if a child did not sign but only used spoken language, only the spoken language

component would be completed. But if the child used both languages, parents were asked to complete both sections.

Fingerspelling Scale. A 13 item fingerspelling scale was developed to evaluate children's use and understanding of fingerspelling. The items are on a four-point scale with the following values; *Is not able*, *Never when needed, Sometimes when needed*, and *Always when needed*. Both parents and teachers completed the Fingerspelling Scale embedded within their surveys.

Demographics. Parents provided information about their child and the characteristics of their family in the first two sections of the Parent Survey. The Gallaudet Hearing Scale was included. The statement, "Select the statement that best describes your child's ability to hear and understand speech without using hearing aids", is then followed by seven statements to determine the hearing loss of the child. The response options range from being able to understand whispered comments to an inability to hear anything. The Parent Questionnaire also collected information related to the family's adaptation to the child's hearing loss. Questions about the child's and the family's communication modalities were included.

Cochlear Implant Survey. An AuD, Ph.D. audiologist who had been the director of a Cochlear Implant Center worked with the EELS team to develop this survey. Questions include information about implantation, the kind of device selected, services obtained, and satisfaction with the implant.

Classroom and Home Experiences. Parents and teachers independently reported on a wide variety of classroom and home experiences that potentially affect literacy development. These ranged from children's use of video and text materials in the school and home to their interactions with deaf and hearing peers and siblings.

Parent-Teacher Relationships. Items relating to the effectiveness of parent and teacher interactions were included on the Parent and Teacher Surveys. These items included such topics as frequency and methods of communication between school and home, parental involvement in school activities, and expressions of satisfaction with teacher and parent relationships.

IEP Goals and Strategies. A set of questions queried teachers about each child's IEP and asked them to report on strategies for meeting stated IEP goals for individual children.

School Curriculum. The Administrator Survey focused on school characteristics including the types of personnel working in the program, services provided in the program, and which curricula were used in the school.

Beliefs and Attitudes about Deaf Education Scale (BADE). Parents and teachers were asked to complete the BADE to better understand their own perceptions and beliefs about educating a deaf child. The original scale included 47 items using a five point Likert scale. Items were roughly divided into three groups; those focusing on spoken language, those focusing on sign language, and those that focused on simultaneous communication. Half of the items were worded positively and the other half was presented negatively. These items have been subjected to psychometric analysis, and the current BADE includes 26 items on four subscales (Clark, Baker, Choi, & Allen, 2013)

Results: Characteristics of the EELS Wave 1 Participants

Completeness of data from different data sources

As noted above, the EELS project employs a complex design that involves collecting survey data from parents, teachers, and administrators, as well as administering a battery of

cognitive, language and emergent literacy tests to deaf children who were between the ages of 3-5 in the first wave of data collection. Ideally, we would have obtained a complete set of data from all these information sources. Of course, given the volunteer nature of surveys, and the logistics and expense involved with traveling to over 30 locations in 25 states to schedule and administer the direct assessments to project participants, it was not realistic to imagine that we would be able to assemble an EELS database with complete data from all respondents from all sources.

Table 1 shows the numbers of participants within each of the information source datasets during Wave 1 of the study. In this table it is important to note that we do not have complete data on each participant. Table 1 also shows the number of participants in various combined datasets across the three information sources containing information on individual children.

The varying "completeness" of the combined datasets will impact the types of statistical analyses that can be performed on the data and limit the complexity of statistical models that can be evaluated, particularly those that include data from all three information sources. Nonetheless, there are over 100 participants with both direct assessment and family background data (A+FB); and over 100 participants, as well, with combined assessment and teacher data (A+T). These sample sizes should allow for adequate statistical power for testing models that evaluate the interrelationships among early literacy development and both school and family characteristics.

Table 1: EELS Wave 1 Data Sets by Information Source, Singly And in Combination

Information Source	N	%
Single Data Sets		
Assessment Data	190	76%
Family Background Data	160	64%
Teacher Data	136	54%
Data Sets in Combination		
Assessment Data Only	36	14%
Family Background Data Only	31	12%
Teacher Data Only	15	6%
Assessment + Family Background Only	48	19%
Assessment + Teacher Only	40	16%
Family Background + Teacher Only	15	6%
Complete Data (A+FB+T)	66	26%
(Assessment + Family Background Total)	114	45%
(Assessment + Teacher Total)	106	42%
Total	**251**	**100%**

Note: Administrator data were not collected at the individual student level.

Age. When we initially contacted programs for participation in the EELS project, we asked program administrators to identify all children in their programs who would be between 3 and 5 at the beginning of the 2010-2011 school year. As the project progressed through this first wave, it was clear that, due to timing and logistics, we would need to spread out participant recruitment, assessment trips, and collection of both parent and teacher survey data throughout the school year. As a result, the numbers of students at different ages shifted, as children had birthdays during the year, and as additional children were recruited throughout the year. When analyzing direct assessment data from the individual

assessments or indirect assessment data from the parent surveys, it is critical, given the importance of developmental factors, to know the age of each participant at the time the assessments occurred. For other analyses of characteristics that are not expected to change over time, for example looking at the crosstabulations of participant age and income, it makes better sense to define a specific date cutoff and determine the age of each participant at that particular date.

Table 2 presents three different age distributions: the first column shows the ages for all participants as of December 31, 2010, providing a common date for determining participant ages at the midpoint of the school year. The second column reports the distribution of participant ages, as of the day they were tested. The third column reports the distribution of participant ages as of the day their parent or guardian completed the family background survey. A wider distribution of ages can be observed using the standard December 31 reference date due to the wide interval of time employed for conducting data collection. It can also be noted that we included some six year olds in the Wave 1 assessments. This inclusion is likely the result of the time interval between when the participants were recruited and the time the assessments occurred.

Table 2: Age Distributions of EELS participants, using three different reference points for determining participant age.

Age	Age as of December 31, 2010	Age at time of testing	Age at time of parent's survey
2	6 (2.5%)		1 (.6%)
3	63 (26.7%)	45 (23.7%)	54 (34.0%)
4	75 (31.8%)	65 (34.2%)	43 (27.0%)
5	72 (30.5%)	67 (35.3%)	49 (30.8%)
6	17 (7.2%)	13 (6.8%)	12 (7.5%)
7	3 (1.3%)		
Total	**236**	**190**	**155**

Note: The total N of 236 does not equal the total 251 because it does not include the participants for whom only teacher surveys were submitted. Teachers were not asked to report the birthdates of participating students.

Sex. Information regarding the biological sex of each child was collected on both the Family Background Survey and on the assessment protocols during the direct assessments. Given the incomplete data, sex was aggregated from both sources to calculate the overall distribution of males and females in the sample. Across both data sources, 137 (58.3% of the 236 participants with direct assessments and/or family background data were Boys, and 98 (41.7%) were Girls.

Race and Languages Used in the Home. The distribution of participant responses to the survey question about racial background and languages used in the home are presented

in Table 3. Both questions allowed for multiple responses. Among the 140 respondents answering the question about race, 123 (87.9%) reported "White". This indicates that white participants are overrepresented, compared to the most recent US Census Bureau figures (2012) that indicate that Whites comprise 77.9% of the US population. (This figure includes Whites who are of Hispanic or Latino background. The percentage of the US population who are White and not Hispanic or Latino is 63.4%.) In the EELS sample, 9.3% of the cases report being from African American background. This compares to the US Census figure of 13.1%. It is important to note that, in addition to the EELS sample over-representing Whites, the raw numbers of participants from non-White families is quite small; this issue will limit the utility of the EELS sample for fully exploring the growth patterns of deaf children from non-white families.

Regarding languages used in the home, the data presented in Table 3 reveal that a high percentage of families reported the regular use of both English and ASL in the households of EELS participants. It also shows that 8.2% of the respondents regularly used Spanish in the homes. These figures indicate a fairly high degree of language diversity among the homes of EELS respondents.

Table 3: Distribution of Participants by Racial Group and Languages Used in the Home

Child's race	Number of responses	Percent of responses	Percent of Cases
Race			
African American	13	8.7%	9.3%
American Indian or Alaska Native	5	3.3%	3.6%
Asian	7	4.7%	5.0%
White	123	82%	87.9%
Don't Know	2	1.3%	1.4%
Total Cases (140)	**150**	**100%**	**107.1%**
Languages used in the Home			
English is used regularly in the home	104	41.9%	65.8%
Spanish is used regularly in the home	13	5.2%	8.2%
ASL is used regularly in the home	107	43.1%	67.7%
Signed English is used regularly in the home	24	9.7%	15.2%
Total Cases (158)	**248**	**100%**	**157%**

Multiple responses allowed. 140 respondents provided answers to the question about race. 158 provided answers to the question about language.

Household Income. Table 4 shows the distribution of EELS parents according to their reported family income category (156 responses out of 160). 46% of the 156 parents responding to this question reported more than $50,000 in total family income in the last year. This number is highly consistent with US Census estimates for 2012, which indicate

the median family income for US residents is $52,762. Thus the median income levels for EELS families are just below that of U.S. residents, as reported to the U.S. Census. The EELS data show a fairly uniform income distribution across income categories below $50,000, and indicate considerable diversity of socio-economic status in the EELS sample.

Table 4: Distribution of Household income

	Frequency	**Percent**
Less than $15,000	18	11.5%
$15,001 to $30,000	26	16.7%
$30,001 to $40,000	24	15.4%
$40,001 to $50,000	16	10.2%
More than $50,000	72	46.2%
Total	156	100%

Cochlear Implant Usage. The EELS Wave 1 sample included 57 children with cochlear implants, which comprised 28.6% of the 199 children for whom data regarding their cochlear implant use were available. It should be noted that, while 160 family background surveys were returned to the EELS office, we pursued, via the telephone, responses to the CI question for parents of Wave 1 children who had participated in the direct assessments, but whose parents had not returned completed family background surveys. In doing so, we were able to add data for an additional 39 parents.

Child's Functional Hearing Ability. Table 5 shows the distribution of parental responses to a question that asks about the child's functional hearing level. For this project, we employed the Gallaudet Scale (U.S. Department of Health and Human Services, 1994), an 8-point scale in which parents are asked to rate their child's ability to hear along a continuum from "can hear and understand what someone says without seeing the person's face when whispered to across a quiet room" to "can's hear anything at all." This scale has been validated against audiological data, and has been used in numerous national health surveys conducted by the U.S. Department of Health and Human Services. As reported previously, we designed EELS primarily to examine the learning trajectories of children whose hearing loss was in the severe to profound levels, i.e., those who had little to no ability to hear and understand speech. As can be seen from Table 6, 71.4% of our participants were reported in the bottom three categories, indicating, that at best most could distinguish different types of sounds, but not hear and understand speech. While this indicates that our sample was strongly weighted in the direction of higher levels of loss (as we intended), almost 30% of the sample reportedly had some ability to hear and understand speech, though many required the speech be loud and spoken directly into the ear. Clearly, as different statistical analyses are carried out in the future using the EELS data set, researchers will have to be cognizant of the impact that possessing some ability to hear and understand speech

might have on the observed statistical relationships among other variables for roughly 30% of the sample.

Table 5: Distribution of Parents' Ratings of Their Children's Functional Hearing Ability

	Frequency	**%**
My child can usually hear and understand what someone says without seeing the person's face when whispered to across a quiet room	2	1.3%
My child can usually hear and understand what someone says without seeing the person's face when spoken to in a normal voice across a quiet room	13	8.3%
My child can usually hear and understand what someone says without seeing the person's face when shouted to across a quiet room	17	10.8%
My child can usually hear and understand when someone speaks loudly into my child's better ear	13	8.3%
My child can usually tell one kind of noise from another	5	3.2%
My child can usually hear loud noises	42	26.8%
My child can't hear anything at all	65	41.4%
Total	**157**	**100%**

School Program Type. Table 6 shows the distribution of responses to a question asking parents to designate which type or types of educational programs their child was currently attending. This question allowed for multiple responses, as some children may have been attending more than one type of program. Two columns of percentages are presented in Table 5: the first column shows percentages based on the total number of responses to the multiple response question. The second column is based on the total number of cases. A total of 119 respondents responded affirmatively to at least one of the program types listed. The majority of children were attending a preschool program in an elementary school. Very few children were attending a childcare center, a child development center, or were receiving home-based services.

Table 6: Distribution of Types of School Program Attended, as Reported by Parents

	Number of Responses	Percent of Responses	Percent of Cases
Elementary school	22	17.1%	18.5%
Preschool program in an elementary school	67	51.9%	56.3%
Early childhood or preschool center, or a nursery school	33	25.6%	27.7%
Child care center	3	2.3%	2.5%
Child development center	2	1.6%	1.7%
Home-based services	2	1.6%	1.7%
Total Cases (119)	**129**	**100%**	**108.4%**

Multiple responses allowed. Number of parent respondents = 119.

Discussion

The EELS study represents the first in-depth longitudinal investigation of deaf children in preschool and early elementary education. The project tracked the acquisition of language and early literacy skills from the ages of three to seven and therefore has the potential for yielding valuable information regarding the trajectories of language, cognitive, and literacy growth using multiple measures, repeated over time. The EELS sample includes a broad national sample of young deaf children that can be used to test a range of hypotheses related to factors contributing to language and literacy development of children who are deaf.

For example, included are measures of sound-based phonological knowledge, as well as measures of ASL and fingerspelling. We included an extensive number of questions about cochlear implant use, as well as questions about the extent of exposure to sign language in the home. It is our hope that the data will be used to further theories of learning and literacy development for young deaf children, by allowing researchers to test specific hypotheses regarding anticipated outcomes and their antecedents.

While children from minority racial and ethnic backgrounds were somewhat under represented among EELS participants, the socioeconomic levels, as reflected in family income, were consistent with recent US Census data, and urban and rural settings were both well represented, suggesting that these data may have relatively broad applications. Both oral and signing educational settings were represented, and a significant number of children were

reported to be cochlear implant recipients, allowing for further investigation of the impacts of the language approaches and recent hearing technology on the language and literacy development of deaf children.

While there are a range of limitations, including a relatively small sample (although larger than many studies reported for this low-incidence population), and the prevalence of missing data across the different sources of information, this data set and the additional data generated in the subsequent years of the project will allow for the investigation of the impacts of a range of demographic, educational, and linguistic characteristics on the literacy development of deaf children in the US.

Preliminary investigations of this data set have been presented at national conferences and have been submitted for publication. Early analyses show that both receptive ASL skills and fingerspelling are strongly related to emergent literacy skills (author, 2013). Linguistic competence and social emotional development show strong connections (author, 2012). In addition, the *Beliefs and Attitudes about Deaf Education (BADE)* scale has been subjected to psychometric analysis, published (author, 2013), and is available for use on the center's website. Comparisons between the children's receptive ASL and English skills are currently under investigation. New analyses are investing sustained visual attention and its relationship to communication practices in the home, and are evaluating possible interactions between home communication practices and cochlear implant use, using longitudinal EELS data.

Conclusion

In summary, the EELS database provides an important opportunity to further our understanding of factors, both fixed and malleable, that contribute to the enhancement of literacy among children who are deaf. In turn, this understanding will inform the creation and improvement of educational and family practices that will prepare these students to enter school ready to learn.

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