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Speech Sound–Production Deficits in Children With Visual Impairment: A Preliminary Investigation of the Nature and Prevalence of Coexisting Conditions

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Speech sound production (SSP) is dependent on a myriad of cognitive–linguistic and perceptual processes (Bernthal, Bankson, & Flipsen, 2009; McLeod, 2007). From a psycholinguistic perspective, SSP begins with speech perception (Perkell et al., 2004; Vance, Stackhouse, &

ABSTRACT: **Purpose:** The purpose of this study was to explore the prevalence of occurrence of speech sound–production (SSP) deficits in school-age children with vision impairment (VI).
Method: A survey of 18 VI professionals from 5 states provided estimates of the percentage of their 120 students with VI who have coexisting SSP deficits. Survey questions probed the characteristics of the students, including the severity of VI, age of onset of VI, cognitive abilities, and severity of the SSP deficits.
Results: Statistical analyses of the responses showed that the percentage of students with VI who at some time had received SSP intervention was higher than expected when compared to the percentage of students in the general population who had received speech-language intervention. The severity of the VI was related to the severity of the SSP deficits in students with typical cognition but not in students with mild intellectual disabilities. The onset of VI was not related to the severity of SSP deficits or to receiving SSP intervention.
Conclusion: VI professionals reported a relatively high percentage of children with VI as having SSP deficits. There is a need for future study of the coexistence of VI and SSP deficits.

KEY WORDS: articulation, phonology, speech sound production, speech sound disorder, visual impairment, vision

Wells, 2005). During early speech acquisition, children perceive and process the acoustic features of speech, use auditory discrimination to match speech input with known phonological forms, and map speech sounds to articulatory gestures (Levelt, 1998). Inefficient or ineffective speech perception, auditory discrimination, and/or phonological mapping can negatively influence children's SSP.

SSP deficits may represent linguistic impairment, motor speech impairment, or both (Strand & McCauley, 2008). When SSP deficits represent a linguistic impairment, children struggle to learn the rule-governed system of phonology. Children with motor speech impairments have difficulty planning and programming speech movements. The term *speech sound disorders* is a blanket term that is used to represent the broad range of disorders involving SSP (Strand & McCauley, 2008).

We decided to study the SSP of children with vision impairment (VI). In contrast to the well-researched effects of hearing loss on SSP, there is considerably less information available on SSP in children with a different type of perceptual impairment—VI. In the United States, 0.6% of persons under the age of 18 have a VI that is characterized by blindness in one or both eyes or by vision that cannot be corrected by glasses. This represents 448,000 children and youth (Lighthouse International, n.d.b). One in every 20 preschool children has a VI that can affect his or her learning abilities. An estimated 189,000 children ages 6–14 years, which is 0.5% of this age group, have difficulty seeing ordinary newsprint even when they are wearing corrective lenses. Of these, 42,000 have a severe VI, which is defined as unable to see ordinary newsprint, and 147,000 have a nonsevere VI. Approximately 2,600 children younger than 5 years of age and approximately 51,000 between the ages of 5–19 are legally blind (Lighthouse International, n.d.b).

It is widely accepted that auditory information and visual information are integrated during speech perception (Jiang & Bernstein, 2011; McGurk & MacDonald, 1976). A number of studies have demonstrated that, in adults (Jesse, Vrignaud, Cohen, & Massaro, 2000) and children (Massaro & Bosseler, 2003), visual cues enhanced the intelligibility of speech. In a study comparing sighted and nonsighted adults, visual cues enhanced the precision of the speaker's speech and the variety of speech contrasts that the speakers produced (Menard, Dupont, Baum, & Aubin, 2009). Visual cues provide visible information that complements the auditory signal. Listeners can more effectively identify speech sounds when they receive redundant visual and auditory cues.

Several studies of adult and child speakers with VI revealed that their speech discrimination abilities differed from those of sighted adult speakers (Gougoux et al., 2004; Hugdahl et al., 2004) and child speakers (Lucas, 1984). Menard et al. (2009) suggested that differences in persons' auditory discrimination abilities might have an impact on their SSP. In another study, during the perception of stop-plosives, adult listeners demonstrated attention to the time between visual observation of consonant release and auditory detection of vocal onset (Breeuwer & Plomp, 1986). In addition, visual cues can assist listeners when discriminating between two phonemes with largely similar phonemic properties. For example, the auditory signal generally conveys the voicing and manner features of phonemes (Summerfield, 1987), whereas the detection of the place of articulation is often supported by visual cues (Miller & Nicely, 1955). Visual cues have been shown to influence children's production of vowels, consonants, and syllables (Mills, 1987).

There is evidence that young children innately use visual supports as a prominent component of early speech perception and subsequent speech sound imitation (Hunnius & Geuze, 2004; Wills, 1979). Lewkowicz and Hansen-Tift (2012) noted that this visual attention to speech articulators "enables infants to gain access to redundant audiovisual cues that enable them to learn their native speech forms" (p. 1,431). Lewis (1975) reported that babies with VI who were in the prebabbling stage produced less imitation of labial speech gestures. Elstner (1983) and Mills (1987) reported various studies that documented phonological delays and phonological disorders in older children with VI. Mills reported phonological confusion of the dissimilar consonants /b/ and /k/ in syllables that were produced by 1- and 2-year-old children with VI. Menard et al. (2009, pp. 1406–1407) suggested that

> apart from differences in discrimination abilities between congenitally blind speakers and sighted speakers, the lack of access to visual information might also induce differences in the use and/or control of the speech articulators (especially the visible ones).

It seems reasonable, then, to hypothesize that children who lack visual cues may be at risk for SSP difficulties. Although research investigating the SSP of children with VI is limited, there is some support for this hypothesis. For example, Mills (1987) compared the speech acquisition patterns of three German children with VI with the patterns of age-matched peers with typical vision. No difference in the acquisition and production of visually salient phonemes (e.g., labial and labiodental placement) or nonvisually salient phonemes (e.g., palatals and

velars) was found, but the children with typical vision exhibited greater overall articulatory accuracy than the children with VI. Mills concluded that a lack of visual information impedes the global speech acquisition process.

James and Stojanovik (2007) used a parent checklist to investigate coexisting communication disorders in eight children with VI between the ages of 7 and 17 years. They explored the children's use of vocabulary, language structures such as grammar, and articulation. The children's mean percentile rank was 34.4, placing them in approximately the lower third of performance abilities and suggesting the presence of communication disorders. LeZak and Starbuck (1964) analyzed the speech samples of 173 children who attended a residential school for students with VI and found that 37% of the children exhibited speech disorders. House (2000) used a standardized speech sound assessment and an oral reading passage to compare the speech of 12 adults with VI to 12 age-matched peers with typical vision. The participants with VI scored significantly lower on standardized speech measures and exhibited a greater number of visible errors (e.g., lingual protrusions as errors in articulatory placement) than the age-matched peers.

Other research has established that verbal development in children with VI is generally subject to some delay. Brambring (2007) compared the ages at which four children with congenital blindness acquired 29 verbal skills. The results indicated only small developmental delays but a high degree of variability within and across the children's development of nine categories of verbal skills, although the overall sequence of development was similar to that of children without VI.

One significant difficulty that researchers face is, as Elstner (1983) observed, that there really is no homogeneous population of persons with VI to research. Persons with VI may be difficult to compare to one another. Differences in SSP can vary considerably within a population that is diverse in the etiology of the disorder, presentation of impairment, and severity of impairment, as well as in the occurrence of comorbid conditions.

In summary, although the research to date is not fully supportive of a link between VI and SSP deficits, the mixed evidence provokes compelling reasons to hypothesize that access to visual cues supports early speech perception and subsequent auditory discrimination and phonological mapping. Children with VI may be at a disadvantage compared to sighted peers depending on the degree of vision loss, as children with VI have limited or no access to visual cues to aid auditory discrimination and to visual models of articulatory gestures. It is unknown whether other factors related to VI, such as the age of onset or severity of the VI, are associated with SSP deficits.

Current Study

Given the limited information on the prevalence and nature of SSP deficits in children with VI, the purpose of this preliminary study was to explore the presence of SSP deficits in children with VI and to identify some of the variables that may coexist with SSP deficits. We asked the following research questions:

- Per the report of VI professionals, what percentage of a sample of students with VI exhibits coexisting SSP deficits? Are there any age-related trends? What are the cognitive abilities of the students with SSP deficits?
- What is the relationship of two vision variables—(a) onset of VI and (b) severity of VI—to the VI professionals' reports of coexisting SSP deficits?

We obtained the data to address these questions by surveying VI professionals who provide consultative or direct services to students with VI. The rationale for using a survey methodology is that VI professionals have a unique vantage point for identifying what is known about the development of children with VI. Surveying VI professionals rather than speech-language pathologists (SLPs) allowed us to approach primary service professionals who efficiently and effectively could yield information about a relatively low-incidence population. Children with VI are typically a very small proportion of SLPs' caseloads, and SLPs are secondary service providers. This survey is an indirect measure that can yield some initial evidence and begin the groundwork for more detailed direct investigations of SSP in children with VI.

In the present study, we used the term *SSP deficits* in a general way to identify children who exhibit difficulty producing speech sounds. We did not use the term *speech sound disorder* because the children may not have received an actual diagnosis of a disorder. In addition, the survey respondents may not have had access to information that indicated whether their students' deficits were a function of phonology disorders and/or motor speech disorders. Because the respondents may not have been knowledgeable about the complex and varied nature of speech sound disorders and their differential etiologies, the survey questions were delimited to whether the VI professionals were cognizant of any general deficits in how the students produce speech sounds.

METHOD

We surveyed a sample of VI professionals who provide consultative or direct services to students with VI. All of the professionals were female, and all signed a participant consent form that had been approved by the institutional review board of the first author's university.

Participants

In order to obtain a subset of the 50 states, we e-mailed state-level administrators of VI educational programs from 16 states representing all U.S. regions. The e-mail requested that the administrators invite VI professionals within their states to participate in the survey. Follow-up e-mails were sent to administrators who did not respond to the initial request. Five administrators, equivalent to 31% of those solicited, from Colorado, Iowa, Michigan, Nebraska, and South Dakota, representing the diverse Midwest, Great Plains, and Rocky Mountain regions of the country, responded and agreed to send e-mail invitations to potential participants. We encouraged the administrators to invite all VI professionals who served ages birth through 21 years, but we did not have access to monitor how the administrators selected whom to e-mail and exactly how many professionals they e-mailed. Based on correspondence with the administrators, we estimate that 40 VI professionals were actually sent invitations. We do not know whether the administrators e-mailed every potential participant or used a selection process.

Eighteen VI professionals responded to the survey invitation. The respondents had diverse work assignments, representing rural, suburban, and urban settings. Their job titles were (a) teacher consultant for the blind/visually impaired, (b) vision consultant, or (c) teacher of the blind/visually impaired. All of the respondents were involved in the development and implementation of the students' individualized educational plans (IEPs); as such, they were aware of all of the children's testing and performance data, including the reports furnished by SLPs.

Despite various job titles, the roles of the respondents were similar: to provide direct services to the students. These professionals were among the children's principal educational service providers. They have regular opportunities to interact with the children they serve and to hear the children's speech productions. The survey (Appendix) offered a response of *not sure* for instances when the respondents lacked familiarity with the children's characteristics. This response was selected only three times across all survey responses obtained, and all were in regard to judgments of the severity of SSP errors. The infrequent use of the not sure option reinforces the assurance that the respondents were familiar with the children on their caseloads.

Next, the first author provided the respondents with training on how to complete the survey. Each respondent received training in one of two ways: (a) Respondents and the researcher engaged in personal phone calls (n = 12) or (b) respondents viewed an electronically accessed training video (n = 6) that we had produced. The two methods of training were used to accommodate respondents and prevent barriers to participation. The training conducted by phone followed the same script as the video training, such that the two methods were alike. The trainer taught key words and concepts in a user-friendly manner. Specifically, the trainer taught the respondents how to rate SSP as *clear and age appropriate, mildly impaired,* or *moderately to severely impaired*. The trainer offered many explanations, descriptions, and examples of SSP deficits. Essentially, the trainer showed persons who are not SLPs how to identify articulation errors by illustrating the contrast between articulation errors and age-appropriate developmental speech errors.

The trainer trained the respondents how to review their students' records in order to establish that the children presently receive or had received SSP intervention. The trainer stressed that the respondents should review their student records and, if they had questions, consult reliable reporters such as parents, past teachers, and SLPs. This caution applied as well to questions pertaining to the students' history of onset and severity of VI. After training, the trainer provided the VI professionals with an online link to access the Web-based survey.

Instrumentation

We used the hypotheses and research questions to construct the survey questions. Specifically, we developed survey questions pertaining to the quality of children's SSP, age of onset of VI, and severity of VI.

Before distributing the Web-based survey to the 18 respondents, we conducted a pilot test. Three VI professionals pilot tested the survey for length, clarity, and other potential concerns. Feedback was positive, and no revisions were made. The three professionals who piloted the survey ultimately participated in the current study a few months later. Although this small subset of respondents saw the survey twice, their responses were counted only once. It is possible that they might not have answered the same way twice, but this does not appear to have introduced error. The nature of the questions—straightforward demographics and identifications pertaining to the

children on their caseloads and whose IEPs they had written—would make it less likely that a respondent could have a substantially different response upon re-administration of this tool.

The survey included questions about the students' demographic information, including their age, gender, and ethnicity; vision status, including the onset and severity of VI; hearing status, as either unimpaired or impaired; SSP deficits; cognitive status, as either typical cognition or cognitive skill that indicates mild, moderate, or severe intellectual disabilities; and the presence of other conditions, such as autism. The respondents' judgments of the severity of their students' SSP deficits are not meant to be interpreted as precise speech intelligibility measurements; rather, these are the reasonable judgments of professionals who are familiar with the children on their caseloads.

The VI professionals categorized each student's SSP as (a) clear and age appropriate; (b) demonstrating some speech sound errors, which was rated as mild severity (i.e., *mild* suggests errors that do not impair general intelligibility, are few in quantity, are infrequently produced, are less prominent, are subtle, or appear in the context of words that are more difficult to say); or (c) demonstrating many speech sound errors, which was rated as moderate or severe (i.e., *moderate to severe* suggests errors that impair general intelligibility, are many in quantity, are frequently produced, are prominent, and appear in most or all speaking contexts). If the VI professionals were not confident in their severity judgments, the training phone calls and videos had directed them to select not sure.

Data Analysis

The survey questions were intended to yield frequency data. Descriptive analyses explored the respondents' report of the percentage of occurrence of SSP deficits in this sample. Frequencies tabulated included the demographics of the students; the severity of the students' VI according to their age groups; the percentage of the sample of students with VI that exhibited coexisting SSP deficits, according to their age groups and the students' cognitive abilities; and the severity of their SSP deficits. Exploratory correlational analyses investigated whether two VI variables—onset of VI and severity of VI—were related to the children's SSP deficits and/or to receiving SSP interventions.

Severity of VI in the Reported Sample

We developed the VI severity ratings based on South Dakota's special education eligibility guidelines (South Dakota Department of Education, 2012, pp. 22, 23, 125, 138–140) and in consultation with the three VI professionals who piloted the survey. The South Dakota definition is drawn from the Individuals with Disabilities Education Act (IDEA, 2004) regulations (Part 300/A/300.8/c/13). Other descriptive criteria for severity were drawn from the American Optometric Association guidelines (2007, p. 71) and the International Statistical Classification of Diseases and Related Health Problems, known as the ICD-9 codes, for blindness and low vision (Chrisendres.com, 2009). Vision loss includes blindness and partial eyesight even with the use of corrective devices.

The following categories were used to describe the severity of VI in the sample:

- *Low vision* (20/60 to 20/200): a moderate visual impairment, not necessarily limited to distance vision. Includes difficulty reading at a normal viewing distance and seeing details.
- *Legally blind or severe low vision* (20/200 to 20/500): Gross orientation and mobility generally adequate, but difficulty with traffic signs, bus numbers, and so forth. Reading requires high-power magnifiers and/or very short reading distances.
- *Blind* (20/500 to no light perception): Greater problems with visual orientation and mobility, vision unreliable except under ideal circumstances, or possibly no light perception.
- *Functions at the definition of blindness:* Visual functioning is reduced by a brain injury or dysfunction, and visual acuity is not possible to determine using the eye chart.

RESULTS

The VI professionals reported data for 271 students on their caseloads. All of the respondents attested that they had reported on the entirety of their case-loads, which controls for possible selection bias within caseloads. The first consideration in data analysis was to rule out those students with moderate or severe intellectual disabilities because it would be difficult to establish strong conclusions about the relationship between VI and SSP deficits if other severely limiting developmental factors were at play. The last three survey questions (see the Appendix) were used to rule out intellectual disabilities and autism.

Only children with typical cognition or a mild intellectual disability (n = 120) were included in the current analyses. All 120 students were reported to have hearing within normal limits. No student was on the caseload of more than one VI professional who participated in the study; there was no possibility of double counting any student.

To provide context for the significance of 120 responses, it is important to establish that VI is a low-prevalence condition. A total of 1,648 children with VI have been reported in Colorado, Iowa, Michigan, Nebraska, and South Dakota combined (National Center for Education Statistics, 2011; South Dakota Department of Education, personal communication, January 8, 2013). The overall sample of 271 students accounts for approximately 16% of the states' students with VI. The delimited sample of 120 students who have unimpaired cognition or mild intellectual disabilities represents a little more than 7% of all of the students with VI in these states.

A sample size of 120 is appreciable. The 120 students described in the present study actually exceed or meet the number of students with VI in some of the states: The total in Iowa is 79; in South Dakota, the total is 122; and in Nebraska, the total is 232.

Table 1 shows respondents' severity of VI according to their age group: early childhood (ages 0–5), early elementary (ages 6–9), and late elementary and adolescence (ages 10 and older). The majority of the students (n = 71, 59%) were classified as low vision, 36 (30%) were legally blind, and 12 (10%) were blind. The students' ages are relevant because speech production expectations differ markedly according to children's ages.

Demographics

Table 1 reports the demographics of the students as described by the respondents. Sixty-nine of the students were male, and 51 were female. A large proportion of the children (90%) had been diagnosed with VI at birth, which is an occurrence rate that is similar to that found in an epidemiological study by Mervis, Yeargin-Allsopp, Winter, and Boyle (2000). (Some common conditions are prenatal cataracts, optic nerve atrophy, infantile glaucoma, retrolental fibroplasia, retinitis pigmentosa, and retinopathy of prematurity [see Gogate, Gilbert, & Zin, 2011; Lighthouse International, n.d.a; National Center to Prevent Blindness, 2011]). Most of the children were Caucasian (85%), with children who were Asian (4%), Hispanic (3%), Native American (3%), African American (2%), and Pacific Islander (2%) represented in the sample.

Statistical Results

The report of the VI professionals indicated the percentage of the sample of students with VI that exhibited coexisting SSP deficits. Responses revealed age-related trends and the cognitive abilities of the students with SSP deficits. Statistical analyses examined the relationship of two vision variables—onset of VI and (b) severity of VI—to the VI professionals' reports of coexisting SSP deficits.

First, we used descriptive analyses to explore the respondents' report of the percentage of occurrence of SSP deficits in this sample. Second, we used exploratory correlational analyses to investigate whether the two VI variables were related to SSP deficits and/or to receiving SSP intervention.

Percentages of coexisting VI and SSP deficits. Table 2 presents the percentage of children with VI who, according to the VI professionals' review of the students' IEP records, were receiving SSP intervention at the time of the study as well as the percentage of children with VI who had previously received SSP intervention. The percentage of children currently with SSP deficits was higher in early childhood (52%) than at the early elementary age (32%) and at the late elementary age and adolescence (18%). Across all ages, an average of 29% of the sample was receiving SSP intervention. For students who had received SSP intervention in the past, the figures were 32% in early childhood, 45% at early elementary age, and 45% at late elementary age and adolescence. Across all ages, an average of 42% of the sample had previously received SSP intervention.

To compare these percentages of occurrence to the percentage of children in the general population in these five states who were receiving SSP interventions at the time of the study, we requested state-level data on the percentage of students who had IEPs that mandated speech-language services. All five states reported that they do not track differentiated

Table 1. Student characteristics by age group, vision impairment (VI) status, and gender.

		Vision impairment status			*Gender*	
Age group	n	*Low vision*	*Legally blind*	*Blind*	*Male*	*Female*
Early childhood, ages 0–5	25	4	10	17	12	13
Early elementary, ages 6–9	32	4	10	17	16	16
Late elementary/adolescence, ages 10 and older	63	39	19	5	41	22
Total	120	71	36	12	69	51

Table 2. The percentages of students who were receiving or had received speech sound–production (SSP) intervention and the range of severity of children's SSP deficits.

	Services			*Severity*		
	Currently receiving SSP intervention	*Previously received SSP intervention*	*Combined total: currently and previously received SSP intervention*	*Clear and age-appropriate speech production*	*Some SSP errors present (mild)*	*Many SSP errors present (moderate or severe)*
Early childhood, ages 0–5 (n = 25)[a]	52 (n = 13)	32 (n = 8)	84 (n = 21)	40 (n = 8)	35 (n = 7)	25 (n = 5)
Early elementary, ages 6–9 (n = 32)	32 (n = 10)	45 (n = 14)	77 (n = 24)	56 (n = 18)	38 (n = 12)	6 (n = 2)
Late elementary/adolescence, ages 10 and older (n = 63)[b]	18 (n = 11)	45 (n = 28)	63 (n = 39)	77 (n = 47)	20 (n = 12)	3 (n = 2)
Average across all ages (n = 120)[c]	29 (n = 34)	42 (n = 50)	71 (n = 84)	65 (n = 73)	27 (n = 31)	8 (n = 9)

[a]Early childhood: Five cases are missing from the severity totals. [b]Late elementary/adolescence: Two cases are missing from the severity totals. [c]Average across all ages: Seven cases are missing from the severity totals.

diagnoses within the category of speech-language impaired (Colorado Department of Education, personal communication, January 18, 2013; Iowa Department of Education, personal communication, January 8, 2013; Nebraska Department of Education, personal communication, May 23, 2012; South Dakota Department of Education, personal communication, January 8, 2013; Michigan Center for Educational Performance and Information, personal communication, January 22, 2013). Therefore, it was not possible to determine the percentage of students in these five states who were receiving speech-language services specifically for SSP deficits. However, South Dakota officials reported that 8.3% of all students within the state were receiving speech-language services under a primary diagnosis of speech-language impaired or as a related service, and Nebraska's reported percentage was 9.4%. These figures represent the percentage of all children in these states who were receiving speech-language services to address any type of speech or language disorder; therefore, the percentage of children receiving SSP interventions would be a subset of these reported averages. Colorado, Iowa, and Michigan officials reported that their states only collect state-level data related to primary diagnosis, so it was not possible to calculate the percentages of students who were receiving speech-language services within these states (i.e., if a child's secondary or tertiary area of need is speech-language, the child is not counted in this verification system, so the total number of students receiving speech-language services is ambiguous). However, the percentages of students who were receiving special education services of any kind under IDEA (2004) Parts B and C were as follows: Colorado, 10%; Iowa, 14%; and Michigan, 14% (Data Accountability Center, 2012). Again, the percentage of students who were receiving SSP interventions would be a smaller proportion of these rates.

The averages of 29% of students with VI who were currently receiving interventions and 42% who had previously received intervention are far greater numbers than are seen in the general population who receive speech-language services to address any type of speech or language disorder or who receive special education services for any reason, which is the reported 8.3% to 14.0% of the general population within the five states under study. The averages also far exceed the prevalence figure of 8% to 9% for speech sound disorders in children in the general population (National Institute on Deafness and Other Communication Disorders [NIDCD], 2010).

An even more marked contrast is shown by comparing the general population figures to the respondents' report that 52% of the children with VI ages 0 through 5 years were receiving interventions for SSP, and 32% of the children ages 0 through 5 years had received intervention for SSP at some time. These combined data would suggest that SSP deficits are evident in 84% of young children with VI. The respondents accounted for 77% of students ages 6

through 9 and 63% of students ages 10 and older as having either presently or previously receiving SSP services. On average, 71% of the students with VI had received interventions for SSP at some time.

In order to estimate the possible sampling error that would affect the accuracy of this 71% average figure, we entered the present data into a sample error calculator (Decision Support Systems [DSS], 2012). The sample size obtained, 120, was used as a basis for the calculation. The total population entered into the calculation was 1,648, which is the total number of children with VI in Colorado, Iowa, Michigan, Nebraska, and South Dakota combined (National Center for Education Statistics, 2011). Using a 95% confidence interval, the result is an 8.6% sampling error. This means that the finding that 71% of students with VI have received intervention for SSP at some time could statistically vary by 8.6%. The figure could be 79.6% or 62.4%. Notably, even the lower end of this range far exceeds the NIDCD prevalence figure of 8% to 9%, as well as the South Dakota report that 8.3% of all students within the state were receiving speech-language services under a primary diagnosis of speech-language impaired or as a related service, and Nebraska's report that 9.4% of all children were receiving speech-language services to address any type of speech or language concern.

SSP deficit severity ratings. The severity ratings of the students' SSP deficits are presented in Tables 2 and 3. As would generally be expected, the degree of reported severity decreased with age, in that 40% of the early childhood group was judged to have clear and age-appropriate speech compared to 56% of the early elementary group and 77% of the late elementary and adolescent group.

Across all age groups, the speech severity ratings were less severe for the students with typical cognition compared to the students with intellectual disabilities. Because students with intellectual disabilities are more likely than students with typical cognition to be diagnosed with SSP disorders (Kumin, 1996; Shriberg & Widder, 1990; Stoel-Gammon, 1997), we disaggregated the data into two groups in Table 3: students with intellectual disabilities and students with typical cognition. Overall, 56% of the children with mild intellectual disabilities were receiving SSP intervention compared to 18% of the children with typical cognition. The 18% of children with typical cognition who were receiving SSP intervention well exceeded the NIDCD prevalence figure (8% to 9%) as well as the figures in South Dakota (8.3%) and Nebraska (9.4%) for children receiving any speech-language services.

Correlation between vision variables and speech variables. We computed Pearson product–moment correlation coefficients for the two vision variables—onset of VI and severity of VI—as related to the two SSP variables—receiving SSP intervention and SSP severity judgments. The correlations for students with typical cognition are presented in Table 4, and the correlations for students with mild intellectual disabilities are presented in Table 5.

Onset of VI. The onset of VI was not correlated with either of the speech variables for any of the students. (Significant correlations reported in Table 5 show that VI onset and VI severity were correlated in students with mild intellectual disabilities [which may have some relationship to the origin of the VI]).

Severity of VI. As shown in Table 4, the results of the Spearman rank correlational analyses indicate that the severity of VI was related to the severity of

Table 3. The percentage of students who were receiving SSP intervention versus the percentage of students with clear and age-appropriate speech disaggregated by cognitive level.

	Mild intellectual disabilities			*Typical cognition*		
	n	*% Receiving SSP intervention*	*% Exhibits clear and age-appropriate speech*	n	*% Receiving SSP intervention*	*% Exhibits clear and age-appropriate speech*
Early childhood, ages 0–5	8	75	25	17	41	50
Early elementary, ages 6–9	8	75	25	24	17	67
Late elementary/adolescence, ages 10 and older	18	39	58	45	9	84
Total	34	56	41	86	18	68

Table 4. Correlations between VI and SSP intervention in children with typical cognition.

	1. VI severity	*2. VI onset*	*3. Speech severity*	*4. Receiving SSP intervention*
1. VI severity	—	.13 (p = .118)	.24* (p = .017)	.027 (p = .807)
2. VI onset		—	.12 (p = .143)	.07 (p = .532)
3. Speech severity			—	.68** (p = .000)
4. Receiving SSP intervention				—

*p < .05, **p < .01.

the SSP deficits in students with typical cognition, r = .24 (df = 77, p = .017). (The other significant correlation indicated that the severity of the SSP deficits correlated with receiving intervention services.) As shown in Table 5, the severity of VI was not correlated with the severity of the SSP deficits in students with mild intellectual disabilities.

DISCUSSION

It seems reasonable to suspect that insufficient visual input contributes to children's risk for SSP deficits. In the five states where the present data were collected, the percentage of students with VI who were receiving SSP intervention at the time of the study or who had previously received SSP intervention was higher than the percentage extrapolated for the general population. It must be noted that the comparison figures cited arose from local decision making regarding eligibility decisions and are therefore not uniform decisions across the five states. Nevertheless, this elevated rate is consistent with previous studies that described the occurrence of SSP deficits in children with VI (House, 2000; James & Stojanovik, 2007; LeZak & Starbuck, 1964; Mills, 1988).

The percentage of older children with SSP deficits was higher than expected when compared to state service delivery data, NIDCD estimates, and the rate of occurrence described in prominent speech acquisition studies of children presumably without VI. For example, Smit, Hand, Freilinger, Bernthal, and Bird (1990) found that 9-year-old children in their study produced all phonemes with greater than 90% accuracy, with most phonemes produced with greater than 97% accuracy. However, 23% of the children in the current study ages 10 and older exhibited SSP deficits that were mild, moderate, or severe (see Table 2).

The current results describe subsets of children with VI by cognitive levels, onset of VI, and severity of VI, which have not been described in the previous literature. The onset of VI was not correlated to the severity of the children's SSP deficits or to whether the children were receiving or had received SSP intervention. The survey dichotomously asked whether a child's VI was present at birth or not. It is possible that in cases where VI was not present at birth that the onset of VI in early childhood would have a similar effect on the development of SSP. Moreover, a large majority of the sample had VI at birth, reducing the variance within this dichotomous variable. More specific questioning may have revealed a better estimate of the influence of age of VI onset on children's SSP.

The severity of VI had a statistically significant relationship to SSP severity ratings for children with typical cognition. It is reasonable to conclude that children with typical cognition and less severe VI are more likely to exhibit typical SSP. However, it is unexpected that the severity of VI did not relate to the severity of SSP deficits in children with mild intellectual disabilities. Even so, a higher percentage of students with mild intellectual disabilities were receiving SSP intervention. It may be that VI, regardless of its severity, complicates SSP for children with mild intellectual disabilities.

Table 5. Correlations between VI and SSP intervention in children with mild intellectual disabilities.

	1. VI severity	*2. VI onset*	*3. Speech severity*	*4. Receiving SSP intervention*
1. VI severity	—	.47** (p = .005)	.16 (p = .371)	.03 (p = .882)
2. VI onset		—	.18 (p = .652)	.03 (p = .868)
3. Speech severity			—	.85** (p = .000)
4. Receiving SSP intervention				—

**p < .01.

Practical Significance of the Study

SLPs who serve children with VI may find utility in the results of this study. It is important for practitioners to note that the reported number of students with VI who were currently receiving or had received speech-language services for speech sound intervention far exceeded the number of students within the general school population who were receiving or had received speech-language services to address any type of speech or language disorder or who were receiving or had received special education services for any reason. Given this rate of need for intervention, practitioners need to be aware that students with any degree of VI should be carefully assessed and monitored to ascertain a need for intervention. Among children with mild intellectual disabilities, the data showed that the need for SLPs' involvement is even greater. In addition, in the present study, the severity of VI correlated with the severity of SSP deficits in children with typical cognition; therefore, an SLP cannot assume that a child with VI who has typical cognition will develop appropriate SSP.

The need for early intervention is crucial. Not only were proportionately more young children with VI reported to be in need of speech services when compared to the general school population, but more of the older children with VI were also reported to continue to need speech services. The resolution of SSP deficits may take more time, and this protraction may have a long-term impact on literacy development. The American Foundation for the Blind (2014) provides information for educators and parents on developmental trajectories in children with VI, with relevant information offered regarding literacy acquisition. Careful consideration of the trajectory of development is particularly necessary for SLPs who provide interventions for students with VI.

SLPs can participate in serving children with VI by educating VI professionals and parents on typical SSP and on reasons for referral for assessment. SLPs can provide regular screenings and conduct in-class observations to supplement teachers' judgments. Classroom enrichment services to enhance students' speech and language development can be beneficial to students who do not qualify for direct services. The SLPs' careful selection of evidence-based intervention strategies and application of interventions with optimal intensity (cf. Allen, 2013) are relevant for providing children with VI with appropriate treatment. However, more efficacy research on applying treatments that are successful with children without VI to children with VI is warranted.

Study Limitations

As can occur in any survey research, the present study could be subject to biased reporting. Many sources of bias are possible, and it impossible to determine what, if any, forms of bias were introduced by this sample of respondents.

The first limitation is the possibility of selection bias, in that this was not a random sampling of VI professionals. Second, the response rate of VI professionals could have been influenced by the nature of the study. VI professionals who had students with SSP deficits on their caseloads might have been more likely to respond to a survey about speech concerns, and VI professionals who did not have students with speech concerns may not have been interested in responding. Third, three pilot participants remained as participants in the final administration of the survey.

Fourth, although the training provided to participants sought to reduce or eliminate the under- or overreporting of SSP errors, participants may have overreported the presence of *some SSP errors* owing to a well-meaning attempt to have their students represented in the research. Alternatively, perhaps the VI professionals may have overreported by misjudging typical speech sound errors as being inappropriate. Conversely, it is possible that the occurrence of SSP deficits was underreported or the severity of students' SSP deficits was underestimated. Respondents may have overlooked some speech concerns in an attempt to give students ratings that are more *normal*. The VI professionals may have thought they could be supportive of their students by not labeling them as having speech problems.

Fifth, the higher prevalence of SSP deficits is based on data reported by VI professionals, not SLPs, although past research has established the general credibility of judgments made by education professionals about speech-language development (Botting, Conti-Ramsden, & Crutchley, 1997).

These possible sources of bias represent factors that could limit the interpretation of the findings. However, data obtained by this study, even with limitations, reinforce the predicament that it is not easy to obtain data about the VI population. There seem to be more questions than answers. For example, could VI sometimes be responsible for delays or difficulties in a person's cognitive development? If a child with VI could see, would his or her cognition progress normally? If so, this would mean that there is not a true cognitive limitation in this child. Similarly, VI could affect speech development without there being a direct and primary speech sound disorder. If a child with VI could see, would his or her speech progress normally? These are links that need to be explored.

The current findings are predicated on the subjective nature of the SSP judgments that were made by the VI professionals. Even though a more direct observational method of studying the SSP of the students with VI might have been preferable, it is realistic to accept that the VI professionals had sufficient experiential and educational background to make adequate SSP severity judgments and sufficient opportunities to hear these students' SSP. All of the respondents had regular interactions with the students on their caseloads and participated in IEP meetings where the student's SSP was considered. We trained the respondents on how to make SSP severity judgments and instructed them to make only confident judgments. Even with these precautions; however, the precision of these judgments is not optimal and should be interpreted conservatively.

Another limitation of the current study is that the comparison figures that were used to identify the percentage of children in the general population who were receiving speech-language intervention arose from local decision making regarding eligibility decisions and are therefore not uniform across the five states. Even though eligibility guidelines may differ across states, it seems clear that the children in the sample were receiving or had received SSP intervention at a rate that is elevated when compared to the percentage of children in the general population who were receiving and had received speech-language intervention and special education services. Despite these limitations, this study extends the current literature regarding coexisting VI and SSP deficits.

Future Research

It may be that VI negatively influences children's SSP, or perhaps the children's decreased vision inhibits the effectiveness of SSP interventions that are provided to this population. Research into phonological development continues to explore how children learn to plan the motoric gestures and program the movements needed for SSP; the study of auditory–perceptual encoding and phonological memory storage and retrieval are ongoing as well (Shriberg et al., 2009). Until the development of SSP processes in typical children is fully understood, an adequate understanding of the development of SSP processes in children with VI remains in the future.

The findings of the current study substantiate the need for future research related to the influence of VI on children's SSP and on the effectiveness of SSP interventions for children with VI. Future studies of the VI population could compare survey responses given by SLPs with responses given by VI professionals, or could involve direct observations of students' speech by SLPs. These investigations may provide a better understanding of the role that vision plays in the SSP process and may contribute to the pursuit of improved SSP outcomes for children with VI.

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APPENDIX. SAMPLE SURVEY QUESTIONS FOR SPEECH, VISION, AND COGNITIVE VARIABLES

Each question is to be answered for each child with VI.

Student's Initials: _____

Age
a. Early childhood, age 0–5
b. Early elementary, age 6–9
c. Late elementary/adolescence, age 10 and over

Gender
a. Male
b. Female

Student race/ethnicity
a. African American
b. Caucasian
c. Asian
d. American Indian
e. Pacific Islander
f. Hispanic/Latino
g. Other

Severity of vision impairment
a. Low vision
b. Legally blind
c. Blind
d. Functions at the definition of blindness

Vision impairment present since birth
a. Yes
b. No
c. Unsure

Hearing Status
a. Normal hearing
b. Mild hearing loss
c. Moderate hearing loss
d. Severe hearing loss
e. I am not sure

Does this student wear hearing aids?
a. Yes
b. No
c. Unsure

Does the student have a speech sound–production impairment (i.e., meets state criteria for speech services)? (Child produces sounds incorrectly, e.g., lisp, difficulty articulating certain speech sounds such as "l" and "r")
a. Not receiving services, has received previous speech therapy
b. Not receiving services, has not received speech therapy in the past
c. Receiving services

For students not receiving speech sound intervention:
a. Speech is clear and age appropriate.
b. Some speech errors present, but I would consider them mild.
c. Many speech errors, I would consider them moderate or severe.
d. I am not sure.

For students receiving speech sound intervention:
a. Some speech errors present, but I would consider them mild.
b. Many speech errors, I would consider them moderate or severe.
c. I am not sure.
d. The child is nonverbal.

Cognitive abilities/intellectual disability (e.g., IQ)
a. Student appears to have normal cognitive development or has completed an IQ assessment confirming normal cognitive development.
b. Student appears to have impaired cognitive development or has completed an IQ assessment confirming intellectual disability.

Severity of intellectual disability
a. Mild intellectual disability
b. Moderate intellectual disability
c. Severe intellectual disability
d. I am not sure of the severity.

Does the student have a coexisting disability (e.g., autism)?
a. Yes
b. No
c. Not sure