AJSLP

Clinical Focus

Identifying Residual Speech Sound Disorders in Bilingual Children: A Japanese-English Case Study

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Purpose: To describe (a) the assessment of residual speech sound disorders (SSDs) in bilinguals by distinguishing speech patterns associated with second language acquisition from patterns associated with misarticulations and (b) how assessment of domains such as speech motor control and phonological awareness can provide a more complete understanding of SSDs in bilinguals.
Method: A review of Japanese phonology is provided to offer a context for understanding the transfer of Japanese to English productions. A case study of an 11-year-old is presented, demonstrating parallel speech assessments in English and Japanese. Speech motor and phonological awareness tasks were conducted in both languages.
Results: Several patterns were observed in the participant's English that could be plausibly explained by the influence of Japanese phonology. However, errors indicating a residual SSD were observed in both Japanese and English. A speech motor assessment suggested possible speech motor control problems, and phonological awareness was judged to be within the typical range of performance in both languages.
Conclusion: Understanding the phonological characteristics of the native language can help clinicians recognize speech patterns in the second language associated with transfer. Once these differences are understood, patterns associated with a residual SSD can be identified. Supplementing a relational speech analysis with measures of speech motor control and phonological awareness can provide a more comprehensive understanding of a client's strengths and needs.

Key Words: bilingualism, articulation, residual speech sound disorders, assessment, speech motor control

One challenge in the accurate identification of speech sound disorders (SSDs) by speech-language pathologists (SLPs) may occur when a child is learning multiple languages. Phonetic accuracy of the sounds of English is generally mastered prior to 8–9 years of age by monolingual speakers (Sander, 1972; Smit, Hand, Freilinger, Bernthal, & Bird, 1990); therefore, frequent misarticulations of one or more speech sounds after this age would generally be considered a residual SSD (Shriberg, 1994, 2009; Shriberg, Austin, Lewis, McSweeny, & Wilson, 1997b). Residual SSDs in English commonly involve mispronunciation of later developing sounds, such as liquids and sibilants (Shriberg, 1994, 2009). However, determining whether a bilingual child has a residual SSD can be complex, and research is lacking to guide the assessment process of residual SSDs in bilinguals. Clinically, parents or teachers may report that a bilingual child is difficult to understand but attribute this to an accent. In this report, we argue that appropriately diagnosing a residual SSD in a bilingual child involves a careful approach that minimally requires a relational analysis of (segmental) speech production (i.e., one in which a child's speech patterns are compared with the target sounds of the language); this analysis must take into account the patterns plausibly related to the influence of the phonology of the child's other language (here, Japanese; see Yavas & Goldstein, 1998, for a discussion of such procedures). Additionally, we intend to demonstrate that attention to related domains which may be impaired in some children, such as speech motor skills and phonological awareness (PA), can provide supplemental information about the child's speech system. A case study approach is used to outline decision-making processes that may aid in forming clinical judgments about the relative strengths and weaknesses in the speech system of a bilingual child suspected of having a residual SSD.

Residual SSDs are of clinical interest, in part, because of deficits related to the phonological bases of literacy. That is, residual SSDs are known to be associated with low PA (Pascoe, Stackhouse, & Wells, 2006; Preston & Edwards, 2007; Stackhouse, 1982), a skill causally related to reading acquisition (e.g., Wagner & Torgesen, 1987). However, not

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Editor: Laura Justice
Associate Editor: Shelley Velleman
Received June 18, 2010
Accepted February 20, 2011
DOI: 10.1044/1058-0360(2011/10-0057)

all children with residual SSDs have PA skills outside of the range of typical performance, indicating the need for detailed assessment of these skills on an individual basis.

Residual SSDs have also been associated with speech motor impairments in some studies (e.g., McNutt, 1977; Preston & Edwards, 2009); however, not all children with residual SSDs exhibit clear weaknesses in speech motor control. Specifically, deficits associated with planning/programming movements of speech may be signs of a subtype of SSD, childhood apraxia of speech (CAS; see American Speech-Language-Hearing Association [ASHA], 2007). CAS is a motor speech disorder and often involves misarticulation of speech sounds along with other symptoms such as disrupted transitions between sounds and syllables, token-to-token inconsistency, and prosodic disturbances.[1] Disrupted transitions between sounds may be evidenced by slow and/or inaccurate productions of rapid syllable sequences during oral diadochokinetic tasks, which have been observed in some studies of residual SSDs (McNutt, 1977; Preston & Edwards, 2009; Thoonen, Maassen, Gabreels, Schreuder, & de Swart, 1997; Thoonen, Maassen, Wit, Gabreels, & Schreuder, 1996). Token-to-token inconsistency (i.e., inconsistency on repeated productions of a word) may also be present in some individuals with SSDs (ASHA, 2007; Marquardt, Jacks, & Davis, 2004). Therefore, there is critical need for assessments of speech motor skills of each child suspected of having a residual SSD to determine whether such deficits are present. However, the application of these types of speech motor assessments to bilingual populations is lacking in the literature.

Bilingual Assessment

Relational Speech Analysis

Clinically, a relational speech analysis is often the basis for identifying SSDs. That is, if there is a mismatch between the target segments of the word and the child's production, the mismatch is generally attributed to misarticulations in monolingual speakers. However, bilingual speakers may produce mismatches (i.e., phonetic patterns that differ from a "standard" second language production) that can reasonably be attributed to acquiring a second language. It is therefore important to differentiate between patterns associated with second language acquisition and those associated with an SSD. In this report, we use the term *transfer* (cf. Fabiano-Smith & Goldstein, 2010; Paradis & Genesee, 1996) to describe the influence of phonological patterns in one language on the productions of a second language (here, the influence of Japanese on learning English). For example, Fabiano-Smith and Goldstein (2010) concluded that typically developing bilingual 5-year-olds simultaneously learning English and Spanish showed some indication of segmental transfer between English and Spanish, evidenced by transfer of low-level phonetic properties from Spanish to English productions (e.g., prevocalic voiceless stops, which are typically aspirated in English, were produced without aspiration).

Surprisingly few clinical studies exist addressing how to separate residual speech errors from patterns that are associated with transfer, perhaps because there are many sources of influence on a child's speech production. For example, individuals who learn the second language early in life tend to show less influence of the native language on second language productions, and the relative exposure to and use of each language are clearly important in developing "native-like" speech patterns (Flege, 1987; Piske, MacKay, & Flege, 2001). Additionally, the patterns of transfer to a speaker's productions will clearly depend on the phonological characteristics of the native language and the language being learned (e.g., phonotactic properties or phonemic inventories; Purcell & Suter, 1980).

The literature also provides relevant examples of "interlanguage," whereby a speaker learning a language produces speech patterns that are neither those of the target second language nor those of the native language (Dickerson, 1975; Selinker, Swain, & Dumas, 1975). Many of these patterns tend to be rule-based and relatively predictable within a particular context, although they may even be idiosyncratic for a given learner of a second language (Dickerson, 1975). Thus, the speech patterns observed in any bilingual speaker may be influenced by a multitude of factors that include transfer, interlanguage, and/or speech impairment.

With a focus on Spanish-English bilingual preschoolers, Goldstein and colleagues (Goldstein, 1996, 2006; Goldstein, Fabiano, & Washington, 2005; Yavas & Goldstein, 1998) have argued that conducting a speech assessment in both the native language and the second language is important in identifying young bilingual children with SSDs. Thus, a relational analysis in both languages provides a more thorough understanding of the child's speech system. The present report extends these principles to the study of Japanese-English bilingual assessment, with a focus on residual SSDs. It should be noted that it is not the role of the SLP to treat speech patterns associated with a foreign accent (unless the client requests this); however, a critical role of the SLP is to differentiate speech errors due to a disorder from speech differences associated with learning a second language (see ASHA, 1985, 1993, 2003).

It remains unclear to what extent errors for shared sounds (those present in both languages) show symmetry in their accuracy or in their error patterns. For example, group data from typically developing bilingual preschoolers reported by Goldstein et al. (2005) showed that the average occurrence of some error patterns (e.g., stopping and cluster reduction) appeared to be relatively similar in both languages spoken by Spanish-English bilinguals at age 5. However, individual data do not necessarily show the same trend; for example, the bilingual children who produced patterns of liquid simplification or stopping in one language did not necessary apply those same patterns in the other language. Thus, it is not necessarily the case that bilingual children show symmetry in phonetic accuracy for particular sounds or sound classes across languages. However, for sounds that are shared among languages (particularly for sequential bilinguals), a similar phonetic motor plan may be utilized (e.g., Flege, 1987). If a particular class of sounds (e.g., sibilants) is misarticulated in one language, misarticulations of that same

[1] Although prosodic disturbances are also a common feature of CAS, they are not addressed here.

class of sounds might be observed in the second language. The present study addresses this notion.

Assessment of Related Domains

In addition to relational analyses of phonetic production, clinical assessments of children with SSDs may also include other targeted speech processes that are theoretically and clinically motivated. That is, some speech-related processes have been found to be different in children with SSDs, including speech motor control and PA.

Speech motor control. Some aspects of motor control might be viewed as language-neutral because these measures may not be directly related to proficiency with either language. Although some speech motor behaviors (such as speaking rate and articulatory durations) may be influenced by proficiency with a language, variability of articulatory productions from token to token appears to be substantially less affected by proficiency with a second language (see Chakraborty, Goffman, & Smith, 2008, for adult kinematic evidence of this). Thus, consistency of repeated productions of words may be a useful indicator of speech motor control that is not strongly dependent on knowledge of the second language. Productions of lexical items that are phonetically inconsistent from token to token in repetitive sequences may be indicative of speech motor planning/programming deficits (ASHA, 2007; Marquardt et al., 2004) and may help detect speech motor control problems in children with SSDs. In a bilingual Italian-English case study of two 4-year-olds, Holm and Dodd (1999) demonstrated that high token-to-token inconsistency, when it is observed in a child's speech, may be evident in both languages. Assessment of this form of inconsistency can be conducted in both languages using transcription-based measures and involves comparing the speaker's phonetic forms to his or her own productions (thus avoiding complications of comparing a speaker's productions to the underlying form of the language).

Another type of inconsistency that may be present in children with speech motor impairments involves inconsistent productions of a target phoneme (Iuzzini & Forrest, 2010). Thus, some authors argue that variability in the realization of a target sound (e.g., /s/ being realized as [t, d, ʃ, ʧ, z] or deleted) might also reflect speech motor impairment. This approach does not take into account how phonetic context interacts with the production of the target sound.

Additionally, oral diadochokinetic tasks assess rapid sequencing of articulatory gestures (e.g., Fletcher, 1972; Williams & Stackhouse, 1998, 2000). Several studies have used this task as a measure of speech motor control, demonstrating that it distinguishes groups of children with and without SSDs (Henry, 1990; McNutt, 1977; McNutt & Hamayan, 1984; Preston & Edwards, 2009). In particular, performance on this task may help to identify speech motor impairments associated with CAS (Crary & Anderson, 1990; Thoonen et al., 1996, 1997). Although not every child with an SSD exhibits clear deficits in speech motor control, the accuracy and consistency with which children produce syllable sequences may be useful in the assessment of speech motor skills of bilingual children suspected of having a residual SSD. Thus, the speech motor assessment described here involves two primary components: token-to-token consistency of phonologically complex words and accuracy on a diadochokinetic task.

PA. Children with residual SSDs may also exhibit poor PA, which involves metalinguistic awareness of the sound structure of words in a language (Pascoe et al., 2006; Preston & Edwards, 2007; Stackhouse, 1997). PA is a robust predictor of literacy skills, even in adolescents (Shaywitz et al., 1999) and in children who learn to read nonalphabetic scripts such as Japanese (Seki, Kassai, Uchiyama, & Koeda, 2008). Assessing PA provides a more complete understanding of the child's phonological system from a clinical perspective (as a domain that might be targeted for remediation). Many theoretical accounts posit that poor PA may be an index of poorly specified phonological representations (Elbro & Pallessen, 2002; Rvachew & Grawburg, 2006) and that these poorly specified representations may be associated with inaccurate articulation (Pascoe et al., 2006; Preston & Edwards, 2007; Rvachew & Grawburg, 2006; Sénéchal, Ouellette, & Young, 2004). Assessing PA in older children often involves tasks that require analysis and manipulation of sounds (Pascoe et al., 2006; Preston & Edwards, 2007) and can be completed in both languages for bilingual children.

Understanding the Phonology of Japanese in a Bilingual Assessment

Because data are lacking for identification of residual SSD in bilingual speakers, the present study addresses this topic in the context of a Japanese-English case study. We provide a brief overview of Japanese phonology and describe segmental features commonly observed in a Japanese English language learner.

Japanese phonology and the "accent" of Japanese-English speakers. Although Japanese is notable for its moraic structure and geminate consonants that do not exist in English (Ota, 2006), the present report focuses primarily on segmental (specifically, consonantal) rather than temporal aspects of speech. The Japanese phonemic inventory includes a smaller set of vowels than English and includes /i, e, ɯ, o, a/. Consonants include stops /p, b, t, d, k, ɡ/, fricatives /ɸ, s, z, ʃ, ʒ, ç, h/, affricates /ts, dz, ʧ, ʤ/, nasals /m, n, ŋ/, glides /w, j/, and the flap /ɾ/ (Ota, 2006). As can be seen in Table 1, several sounds are unique in each language.

As described by Tsujimura (2007), [ts] and [ʧ] are considered allophones of /t/ ([ts] usually occurs before /u/, [ʧ] usually occurs before /i/); /z/ and /dz/ are in free variation, and phoneme /z/ includes allophone [ʤ] ([ʤ] usually occurs before /i/, and /z/ does not occur before /i/); and [ʃ] is an allophone of /s/ ([ʃ] occurs primarily before /i/). Because the phonetic contexts of the allophones are predictable, many developmental studies report the acquisition of these allophones separately (see Table 1), and studies of developmental misarticulations consider substitution of one allophone for another to be a sound error (similar to English, which has allophones of /t/ such as /t^h, ʔ, ɾ/ that occur in predictable contexts; it would be considered atypical if

TABLE 1. Consonant inventories for English and Japanese by developmental stage.

Stage	English	Japanese	
Early	m, b, j, p, h, w, d, n,	m, b, j, ,p, k, g, t, ʧ, ʤ	m, n, ŋ, p, b, d, k, g, ʧ, ʤ, t
Middle	k, g, t, ʧ, ʤ, ŋ, f[a], v[a]	h, w, d, n/ŋ, ɾ, ç[a]	
Late	s, ʃ, z, ð[a], θ[a], l[a], r[a]	s, ʃ, z, dz[a], ts[a]	h, ç[a], ɸ[a], ɾ, s, z, dz[a], ts[a]
Source	Shriberg (1993)	Noda et al. (1968)	Ota (2006)

Note. English data include phonemic inventory. For completeness of understanding the Japanese system, Japanese data include phonetic inventory (some allophones develop earlier than others).

[a]Unshared sounds (unique to the language).

these allophones were produced outside of the predicted context).

Fricatives that are not present in Japanese but are found in English include /θ, ð/ and /f, v/. Evidence of transfer in fricative production may be seen if Japanese-English bilinguals produce substitutions of native sounds for nonnative sounds (e.g., /θ/ → [s], as in *thumb* /θʌm/ →[sʌm]).

English liquids are frequently difficult for Japanese-English bilinguals to master (Aoyama, Flege, Guion, Akahane-Yamada, & Yamada, 2004), given that /r/ and /l/ are not present in Japanese. The sonorant /ɾ/ is present in Japanese and may have allophonic variations similar to [l, r]. The flap is often substituted for /r/ and /l/ when native Japanese speakers speak English (Riney, Takada, & Ota, 2000).

With regard to phonotactic constraints, Japanese does not include consonant clusters and very few codas (only nasals); most syllables are CV, V, or syllabic C. Thus, native Japanese speakers who are learning English may separate consonant clusters by inserting a vowel (e.g., [ə]) to retain the more familiar CV pattern (e.g., *spoon* [səpun]). They may also show evidence of weakening or omission of English codas (e.g., Dickerson, 1975), presumably because these are rare in Japanese.

Japanese phonological acquisition. By the age of 2, most monolingual Japanese children achieve 90% accuracy in the production of vowels. The nasals [m, n, ŋ], stops [p, b, t, d, k, g], and palatal-alveolar affricates [ʧ, ʤ] are acquired early, while the allophones of /h/ [h, ç, ɸ], the flap /ɾ/, and alveolar sibilants /s, z, ts, dz/ are acquired later (Ota, 2006). (Noda, Iwamura, Naito, & Asukai, 1968) reported the age at which Japanese children achieve 90% accuracy as from 3;0 (years;months) to 3;11 for /m, p, b, k, g, t, j, ʧ, ʤ/, 4;0 to 4;11 for /h, ç, n, ŋ, ɾ, w, d/, and 5;0 to 5;11 for /s, z, ʃ, ts, dz/ (see Table 1). Other reports suggest that, by age 5;0, 80% of children correctly produce all sounds except /ɾ/ (40%–59% of children) and /dz/ (60%–79% of children; Language-Speech-Hearing Committee, 1989). Thus, similar to English (Sander, 1972; Shriberg, 1993; Smit et al., 1990), sibilants are acquired later.

The flap /ɾ/ is generally acquired by approximately age 5;6 (Nakanishi, Owada, & Fujita, 1972). Substitution patterns may include /d/ for /ɾ/ in word-initial position and glides /j, w/ for /ɾ/ in medial (intervocalic) position (Imai, 2007; Nakanishi, Owada, & Fujita, 1972).

During the acquisition of Japanese phonology, substitution errors of affricates /ts, tʃ/ for fricatives /s, ʃ/ are sometimes observed (Toyama, 1992). Palatalization patterns (/s/→[ʃ], /ts/→[ʧ], /dz/→[ʤ]) are also frequently observed in young Japanese children (Toyama, 1992) and may persist until about age 5 years in typically speaking Japanese children (Okazaki, Osawa, & Kata, 1998). Noda et al. (1968) reported that correct production of alveolar sibilants typically occurs by 6 years; if errors remain after this age, the speaker may be considered to have an SSD. As in English, these later-developing lingual phonemes tend to be more frequently in error among Japanese speakers with SSDs (e.g., Suzuki et al., 1995).

This information on Japanese phonology and its acquisition may be useful in the assessment of Japanese-English sequential bilinguals. The following case report outlines the procedures, results, and interpretations of an assessment to demonstrate clinical decision making for a bilingual child suspected of having a residual SSD.

Case Report

KT, our case study participant, was age 11;4 at the time of assessment. Although much of his formal education was in English, his native language was Japanese, and he spoke Japanese with his family. He was the firstborn child of Japanese parents, though he was born in the United States. Both parents were native Japanese speakers who grew up in Japan and moved to the United States for professional employment. The family moved back to Japan when KT was 5 months old, and he went to a Japanese day nursery. His mother spoke to him in English and Japanese, although his father, grandparents, and babysitter spoke to him only in Japanese. His mother spoke fluent English with a slight Japanese accent. KT started to speak single words in Japanese, and some in English, before 12 months. He produced two-word sentences around 24 months. KT had no reported hearing problems and reached developmental milestones on time. Beginning at age 3, he entered an international preschool in Japan and started to learn English. There was no speech problem noticed in preschool, but he was reportedly reticent when interacting with peers.

KT entered an international primary school in Japan at age 6, where he was educated in both English and Japanese. Outside of school, he primarily used Japanese. The family moved to the United States (western Connecticut) when he was 8 years old, and he entered a public elementary school, speaking only English during the day from Grades 2 through 5. He began at a private school when he was 11 years old, as a fifth grader. During the months prior to the assessment, KT was attending a Japanese supplementary school on weekends to continue to learn Japanese reading and writing. KT and his brother, who was 2 years younger, primarily spoke Japanese at home. His brother was born in Japan, and his family spoke to him primarily in Japanese from the beginning; after he started to speak English, no speech problem or learning difficulties in either language were reported for KT's brother.

After KT moved to the American private school, his teacher observed academic and communication difficulties (low performance in reading and writing in English, and a poor English vocabulary). He was referred to the school SLP for a screening; the SLP noticed sound distortions in KT's English, in addition to difficulty with vocabulary and problems understanding questions asked of him. Although the SLP reported problems in his speech intelligibility, it was suggested that these patterns were likely the influence of KT's dual languages. She recommended a full speech and language evaluation with more in-depth assessment in English and Japanese to further determine KT's performance in each language; however, no further speech assessment was provided by the school. He was provided supplemental instruction for vocabulary at school.

KT's mother was concerned that he might have general speech and language learning difficulties, rather than language differences associated with being a second language learner. She was aware that his articulation of Japanese had not matured by age 11, and she was concerned about his social-emotional functioning because he had difficulties communicating with his classmates in English. There were also significant concerns about his performance on classroom- and state-administered standardized tests of reading and writing.

In this article, we report the results of a bilingual speech assessment; Appendixes A and B provide supplemental information on KT's performance on language and literacy tasks. English language and literacy tasks were administered by a native English-speaking clinical researcher (the first author), and Japanese tests were administered by a native Japanese-speaking clinical researcher (the second author). The session was recorded using a Shure WH20 head-mounted microphone and a Marantz PMD670 digital recorder. The testing protocol was approved by the local institutional review board, and informed consent was obtained.

Intelligibility and Articulation Testing

Estimates of intelligibility were obtained by computing the percentage of intelligible (identifiable) words spoken in conversational speech in a 5-min period (cf. Shriberg & Kwiatkowski, 1985). Native speakers of the respective languages made these intelligibility judgments based on the audio recordings. In addition, consonantal accuracy was assessed in both languages from picture naming and connected speech samples.

English. The Goldman Fristoe Test of Articulation—Second Edition (GFTA–2; Goldman & Fristoe, 2000) was administered to obtain a speech sample (although qualitative relational analyses were employed rather than relying on standard scores). Conversational speech and sentence imitation (the Recalling Sentences subtest of the Clinical Evaluation of Language Fundamentals, Fourth Edition [CELF–4; Semel, Wiig, & Secord, 2003]) were also elicited to obtain a larger speech sample. All responses were recorded and transcribed later.

Japanese. The Japanese Articulation Test—Revised (Japanese Speech-Language-Hearing Association, 1994) was used for assessment. This is a test for clinical assessment of articulation for young children (preschool-age). Although standard scores are not provided, the percentage accuracy of each phoneme is published based on an earlier version of the test (Language-Speech-Hearing Committee, 1989). The following subtests were administered: (a) assessment of natural speech, (b) the single-word subtest (picture naming of highly familiar items containing multiple tokens of all Japanese syllables as onsets), (c) the syllable repetition subtest (repetition of single syllables separately), and (d) the sentence subtest (repetition of short sentences of a story, which contains common Japanese syllables).

Speech Motor Assessment

Although traditional measures of oral diadochokinesis evaluate the rate of repeated productions of syllable sequences, it has recently been argued that the accuracy with which children can sequence sounds may be more sensitive to speech development (Williams & Stackhouse, 2000) and disorders (Preston & Edwards, 2009) than rate measures. Thus, accuracy on an oral diadochokinetic task was examined by eliciting four strings of the trisyllable /pʌtʌkʌ/ to quantify the participant's variability in production (Preston & Edwards, 2009). Additionally, a brief speech motor assessment involving rapid repeated productions of multisyllabic words was conducted to examine articulatory sequencing and consistency of rapid productions. KT first named each picture and was then instructed to repeatedly produce the target as quickly as possible (one repetition string of each word, eliciting up to 12 productions: *cheeseburger, butterfly, triangle,* and *gorilla*). Token-to-token consistency was evaluated using a transcription-based measure, the Total Token Variability (TTV) index reported by Marquardt et al. (2004). Only the first eight productions of each word were used for the TTV analysis.

In addition, KT's consistency of productions of multimoraic Japanese words (words with six to eight morae) was assessed. He was shown pictures of 10 objects and was asked to repeatedly speak the names quickly. Because he was able to spontaneously name six of the pictures, we limit the analysis to those six items that he named without a model. These were *vending machine* /ʤidohanbaiki/, *flashlight* /kaiʧɯdento:/, *paper dolls hanging outside to pray for nice weather* /terɯterɯbo:dzɯ/, *colored pencils* /iɾoenpitsɯ/, *corn* /to:moɾokoshi/, and *tadpole* /otamadʒakɯʃi/.

PA

English. PA in English was assessed via the Elision and Blending Words subtests of the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999). Elision requires the deletion of segments from a word, and Blending requires the synthesis of sounds into words. Responses were audio-recorded and later scored by making allowances (i.e., not counting errors) for speech patterns that were consistent with KT's residual misarticulations (cf. Preston & Edwards, 2007) or the influence of speech patterns that could plausibly be due to transfer from second language learning (see Table 2). Thus, standard scoring procedures were not followed.

Japanese. There are no standardized tests for PA in Japanese, although several tests have been used by researchers (Hara, 2001; Seki et al., 2008). The test set used was developed by a national research team based on previous studies to assess children with reading difficulty in Japanese. It consists of two subtests: mora deletion and word reversal. PA skills at the mora level are easily acquired by the beginning of elementary school, but PA deficits on more complex tasks are associated with poor reading/spelling in Japanese just as in English (Seki et al., 2008). Thus, word reversal was used, as it has been found to be a sensitive measure for detecting weaknesses in phonological representations (Seki et al., 2008). The task consisted of only common nouns that are familiar to Japanese preschoolers. The word reversal task consisted of five 3-mora words and five 4-mora words. An examiner presented words orally and asked the child to repeat the word backward (with the morae reversed). For example, *watch* /to-ke-i/ should be repeated as /i-ke-to/. The mora deletion task consisted of five 4-mora words and five 5-mora words. An examiner presented words orally and asked the child to delete a target mora (CV).

Results of Intelligibility Assessment, Articulation Testing, and Relational Analysis

Subjectively, KT's speech was judged to be intelligible much of the time, although there were noticeable instances when he needed to repeat himself to be understood. KT's speech intelligibility in English was judged by two native English speakers (unfamiliar with his speech) by listening to 5 min of audio-recorded conversation. He was judged to be 89% and 90% intelligible by these two listeners. Two native Japanese speakers independently listened to 5 min of audio recording of KT's conversational speech in Japanese, and both judged him to be 89% intelligible. These results suggest that there were occasional instances in which his speech production might hinder his ability to be understood by a native listener of either language.

TABLE 2. Examples of English patterns plausibly attributed to influence of Japanese.

Speech pattern	Word	Participant's production
Phonotactic		
Epenthesis	blue	[bəlu]
	clown	[kəlaʊn̥]
	drum	[ʤəwʌm]
Final devoicing/weakening	spoon	[spun̥]
	girl	[gɝl̥]
	plane	[pleɪn̥]
Phoneme inventory		
Approximant substitution	yellow	[jɛɾo]
	rabbit	[wæbɪt]
	carrot	[kɛwaʔ]
	orange	[ɔwɪnʧ]
	frog	[fwag]
	brush	[bwʌs]
	green	[gwin]
	drum	[dwʌm]
	crying	[kwaɪɪŋk]
Alveolarization of interdentals	thumb	[sʌm]
	bath	[bæs]
	this	[dɪs]
	feather	[fɛdɚ]

English. Some of the phonetic patterns in KT's English are presented in Table 2. Differences in the phonotactics of the languages may provide a reasonable account of some patterns in KT's English. For example, it is hypothesized that KT showed evidence of transfer of Japanese phonology to production of English words by implementing Japanese phonotactic patterns that resulted in CV sequences. Patterns of epenthesis in which KT added a schwa [ə] in the middle of two elements of English consonant clusters might reasonably be attributed to the fact that his more familiar language, Japanese, does not include consonant clusters. Thus, to represent both consonant elements of a /bl/ cluster in the word *blue,* KT inserted a schwa between the consonants and retained a phonotactic pattern (CVCV) similar to his native Japanese.

Similarly, because Japanese syllables are generally open syllables, weakening of final consonants could plausibly be attributed to the influence of Japanese patterns on English. Devoicing/weakening of word-final obstruents is common in English, but KT also showed patterns of devoicing of final sonorants (e.g., final consonants in *girl* and *spoon*).

By considering sounds that are present in English but not in Japanese (see Table 1), we can devise a plausible account of some other speech patterns associated with transfer. For example, interdental fricatives are found in English but not in Japanese. Thus, KT's substitution of alveolar sounds for interdentals may be accounted for by producing a closely "matching" sound that is in the Japanese language (i.e., a voiceless coronal fricative). Similarly, liquid consonants /r, l/ are not present in Japanese but are found in English, and approximants such as [ɾ] or [w] may be the closest "match" to English liquids (cf. Riney et al., 2000). Thus, the flap substitution for /l/ in KT's production of *yellow* and the [w] substitution in several words such as *rabbit* and *drum* could logically be accounted for by the fact that /r, l/ are not present in Japanese. These might be considered instances of transfer, whereby a sound that exists in one language is transferred to the phonetic output of a second language (Fabiano-Smith & Goldstein, 2010).

Allowing for these patterns that were plausibly related to the influence of Japanese on his productions of English (i.e., not counting these as errors), KT's percentage of consonants correct (Shriberg et al., 1997a; Shriberg & Kwiatkowski, 1982) derived from the GFTA–2 word set was 85%. His percentage of consonants correct—revised (which does not count distortions as errors; Shriberg et al., 1997a) was 92%. These values are substantially outside the projected norms devised for connected speech assessment for English-speaking 11-year-olds (Campbell, Dollaghan, Janosky, & Adelson, 2007), whose percentage of consonants correct—revised scores should be close to 100%.

As can be seen in Table 3, KT's sibilant errors in English involve substitution/distortion patterns. It should be noted that Table 3 includes only examples of errors and is not an exhaustive list. Palato-alveolar sibilants [ʃ, ʧ] were sometimes produced as alveolar sounds [s, ts], a pattern of "depalatalization" commonly found in younger English-speaking children (e.g., Edwards & Shriberg, 1983). Some errors on target /s/, however, show the same pattern that was observed in KT's Japanese errors on /s/, with alveolar sibilants being produced as palato-alveolars. This may represent a case of transfer of sound errors from one language to another. However, there were instances of correct productions of each of these target sounds (e.g., *scissors* [sɪzɚ] and *spoon* [spun]).

Because the primary sound class with errors involved sibilants, the percentage accuracy of these sounds was computed from the GFTA–2 and the Recalling Sentences subtest of the CELF–4. KT's accuracy on alveolar sibilants in English was 70%; on palato-alveolar sibilants, his accuracy was 57% (ignoring word-final devoicing patterns). We then sought to examine whether errors were predictable and context-specific, which might support the notion of KT developing his own phonological rules in English, or an "interlanguage" (Dickerson, 1975). In single words, alveolar sibilants were sometimes correct with respect to place and manner in word-initial position (*scissors*), in intervocalic position (*glasses*), and in consonant clusters (*basketball, spoon, stars, slide,* and *swimming*). However, there were errors that did not appear to be systematic or highly predictable. For example, word-final alveolar sibilants were sometimes correct (*this* [dɪs] and *stars* [stɔɚs]) and sometimes dentalized (*house* [haʊs̪] and *flowers* [floɚs̪]). Similarly, in the sentence imitation task, /s/ clusters were sometimes correct (*stop* [stap], *stay* [ste], *student* [studɪn], and *school* [skul]) but sometimes platalized (*stopped* [ʃtapt], *stories* [ʃtoɹis], *asked* [æʃkt], and *most* [moʃt]). Postvocalic /z/ was sometimes correct in place and manner but sometimes incorrect (*was* produced both as [wʌz] and [wʌʃ]). This inconsistency on a particular sound or phonetic context may have indicated that KT was in the process of learning the distinction, or it might also have reflected speech motor control difficulties (cf. Iuzzini & Forrest, 2010). Notably, KT was 100% accurate in word-initial singleton /s/ in English but made errors on /s/ clusters and word-final /s/; thus, it is possible that these phonetic contexts are somewhat less familiar (given the typical CV syllable structure of Japanese) and require longer to learn correct production in English. The same could not be argued for palato-alveolar sounds, however, which were in error in several prevocalic/intervocalic contexts (e.g., *shovel* and *fishing*). Thus, there did not appear to be highly predictable contexts in which errors were observed, suggesting to us that these sibilant errors might be more strongly related to speech motor control difficulties (cf. Iuzzini & Forrest, 2010) than to more rule-governed patterns associated with developing an interlanguage.

Other infrequent errors were noted, including deletions of syllables and voicing errors (see Table 3). These might also reflect speech motor difficulties (i.e., sequencing syllables or coordinating voicing with oral articulation).

Japanese. Examples of KT's articulation errors in speaking Japanese are listed in Table 3 (note that there were several instances of correct productions of these target sounds). In his productions of Japanese, KT made several substitution of /s/→[ʃ], /ts/→[ʧ], and /dz/→[ʤ] (palatalization). These substitutions occurred at both word-initial and word-medial positions, in natural speech, picture naming, syllable repetition, and the sentence test. As mentioned above, such errors are common among younger Japanese speakers but are rare past age 6 (Toyama, 1992). For example, KT was 60% accurate on /s/ in the picture-naming subtest of the articulation test and was 75% accurate on /s/ in conversational speech. The affricate /ts/ was 50% correct on the articulation test and 36% in conversation, and /dz/ was 100% correct on the articulation test but 50% correct in conversational speech. Palato-alveolar fricatives and affricates (/ʃ, ʧ, ʤ/) were produced with 100% accuracy in picture naming and in conversation, suggesting that palato-alveolar sounds were problematic in KT's English productions but not in his Japanese productions.

In connected speech, there were instances where KT deleted or substituted the glide [w] for the target /ɾ/ in the middle of a word (e.g., /to–ɾa/→[to–a] and [towa], and /pɯ–ɾa–sɯ/→[pɯ–a–sɯ]). This error pattern was observed

TABLE 3. Examples of patterns plausibly attributed to misarticulations.

Speech pattern	English		Japanese	
Fricative errors	/ʃ/ → [s]	shovel [sʌvɛʊ]		
		fishing [fɪsɪŋk]		
		brush [bwʌs]		
	/s/ → [s̪]	house [haʊs̪]	/s/ → [ʃ]	fish /sakana/ → [ʃakana]
	/s/ → [ʃ]	most [moʃ]		juice /ʤɯ:sɯ/ → [djɯʃɯ]
		asked [aʃkt]		plus /pɯrasɯ/ → [paʃɯ]
	/z/ → [s̪]	flowers [floɚs̪]		
Affricate errors	/ʧ/ → [ts]	watch [wats]	/ts/ → [t]	next /tsɯgi/ → [tɯgi]
			/ts/ → [ʧ]	block /tsɯmiki/ → [ʧɯmiki]
				fifth /itska/ → [itʃka]
	/ʤ/ → [s]	cage [ges]	/dz/ → [ʒ]	for a long time /dzɯto/ → [ʒɯto]
Voicing errors	/v/ → [f]	vacuum [fakjum]	/k/ → [g]	drum /taɪko/ → [taɪgo]
	/k/ → [g]	cage [ges]		
Approximant errors			/ɾ/ → [w]	tiger /toɾa/ → [towa], [to–a]
Deletions		telephone [tɛfon]		insect /mɯʃi/ → [ɯʃi]
				plus /pɯrasɯ/ → [pasɯ]

in only 18% (10/56) of tokens in connected speech and was not detected in single words in which he articulated more carefully. However, he also was observed to delete consonants or syllables and to produce voicing errors in both connected speech and single words.

Similarities. Errors on sibilants, which are later developing in both languages and are commonly in error among children with SSDs in both English and Japanese, were in error in KT's Japanese and English productions. Although many of these sibilants are shared in both languages, prior work has shown that phonological error patterns are not necessarily identical across languages within a given speaker (Goldstein et al., 2005).

Voicing errors were inconsistently observed in both languages, with evidence of prevocalic devoicing in English (vacuum [fa:kjum]) and intervocalic voicing in Japanese (/taɪko/ → [taɪgo]). These may reflect subtle difficulties with speech motor coordination, such as timing of laryngeal and oral articulatory gestures. Taken together, these infrequent (but developmentally inappropriate) patterns, as well as the more frequent errors on sibilants, would implicate a residual SSD.

Results of Speech Motor Assessment

Repeated productions of target multisyllabic words were transcribed and analyzed using the TTV measure described by Marquardt et al. (2004). This measures variability of a target word by computing a proportion of the number of different variations of a word divided by the number of attempts at the word (TTV = [number variants – 1])/[number tokens – 1]). A TTV of 0 would indicate that every time the word was spoken, it was said the same way, whereas a TTV of 1.0 would indicate that every time the word was spoken, it was produced differently. For comparability, we scored only the first eight renditions of each target word. The average TTV from repeated productions of these four English words was 0.50 (range = 0.43–0.57). Table 4 provides examples from both English and Japanese of KT's variability in repeated productions of words. Normative data for this measure do not exist, but KT's score is within the range of values reported by Marquardt et al. for three children with CAS. Similarly, his repeated production of six Japanese multisyllabic words (words with six to eight morae) yielded an average TTV of 0.71 (range = 0.5–1.0). Thus, the TTV in both languages yielded relatively high values, suggesting possible speech motor planning deficits (i.e., symptoms associated with CAS).

Performance on the oral diadochokinetic task (production of trisyllable [pʌtʌkʌ]) was examined following procedures described by Preston and Edwards (2009) in which the number of different realizations of the syllable sequence was examined. Four strings of repeated productions of /pʌtʌkʌ/ were elicited, and the first 10 attempts at the trisyllable were phonetically transcribed in each of the four strings. In these 40 attempts, KT produced 14 different realizations of /pʌtʌkʌ/ (ignoring vowel deviations), including [pʌtʌgʌ, pʌtʌɢʌ, fʌtʌgʌ, pʌtʌɣʌ, bʌtʌɣ, pʌtʌxʌ, bʌtʌɢʌ, bʌkʌt, pʌtʌkxʌ, pʌtʌkʌɫ, fʌtʌɣʌ, bʌtʌgʌzʌ, bʌtʌxʌ, and bʌtʌkʌtʌ]. Data from Preston and Edwards (2009) showed that all 14 typically speaking children age 10–14 years produced no more than six error types of /pʌtʌkʌ/ (M = 4.6), whereas children with residual speech errors produced between one and 17 error types (M = 7.9). Thus, KT's performance was

TABLE 4. Total Token Variability (TTV) examples from repeated productions of English and Japanese multisyllabic/multimoraic words.

Word	Number of occurrences	Word	Number of occurrences
English			
s/bʌtɝflaɪ/(butterfly)		/gəɹɪlə/(gorilla)	
[bʌtəflaə]	5	[ɢɔɹilə]	4
[bʌtflaɪʊ]	1	[ɢɔɹirə]	1
[ˈvʌˈtɝˈflaɪ]	1	[gɔɹilə]	2
[bʌtɚpweɪ]	1	[ʔɔɹirə]	1
Number variants	4	Number variants	4
Number tokens	8	Number tokens	8
TTV	(4 – 1)/(8 – 1) = 3/7	TTV	(4 – 1)/(8 – 1) = 3/7
Japanese			
/terɯterɯbowdzɯ/(paper doll)		/to:morokoʃi/(corn)	
[tetebozɯ]	1	[tʌmərʌkos]	1
[teətebos]	3	[tɔmɔkəs]	1
[teəteɪwʌɪs]	1	[tɔm. ɹukəs]	1
[teətevʌs̺]	2	[tɔ:m:ərʌəs]	1
[teətevʌt]	1	[to:molokolə.si]	1
		[to:mʌkoləɪ]	1
		[to:molokosiə]	1
		[toməlokos]	1
Number variants	5	Number variants	8
Number tokens	8	Number tokens	8
TTV	(5 – 1)/(8 – 1) = 4/7	TTV	(8 – 1)/(8 – 1) = 7/7

Note. For comparability, we report only the first 8 productions of each target word, even in instances where KT made more attempts.

similar to that of English-speaking children with residual SSD. Variability in productions on the diadochokinetic task and on the TTV measure was therefore judged to reflect speech motor control difficulties.

Results of PA Assessment

It should be noted that the CTOPP scoring procedures were modified by allowing for speech error patterns (as described above), and pseudostandard scores are reported by comparing KT's results with normative data that were not developed for assessment of bilingual speakers. However, with these caveats in mind, results of the PA assessment in English suggested no significant concerns with elision (standard score of 10) or blending (standard score of 8). Similarly, KT's performance in Japanese revealed PA skills within normal limits for both mora elision (0.35 *SD* of the mean) and word reversal (–0.17 *SD* of the mean). Thus, his ability to analyze and manipulate the phonological features of words was not a significant concern, and his performance reflected adequate phonological representations of words.

Summary and Implications

This case report demonstrates that identification of SSDs in bilinguals relies on an initial understanding of speech patterns that may be plausibly related to a speaker learning a second language (e.g., Yavas & Goldstein, 1998). That is, not all of KT's speech patterns reflect those of a residual SSD, as many differences in production may be reasonably accounted for by transfer of native language (Japanese) patterns to second language (English) productions. Examples included epenthesis in consonant clusters, substitution of the flap for liquids, and substitution of alveolar fricatives for interdentals (see Table 2). However, he demonstrated errors on sibilants in both languages, pointing to a residual SSD. This residual speech impairment may have been overlooked by clinicians or teachers who attributed his speech patterns to being a second language learner (cf. Schmid & Yeni-Komshein, 1999).

Relational analyses were helpful in first understanding patterns plausibly attributed to being a second language learner. These relational analyses revealed errors on the same broad classes of sounds (sibilants) in both languages. Place and manner of production were inconsistently in error, and there was a lack of consistency/predictability in KT's sibilant errors as described above (e.g., palatal and dentalized productions of word-final /s/). Yet, some specific patterns of errors (i.e., /s/ →[ʃ]) may be indicative of segmental transfer of error patterns; in particular, palatalization of /s/ is common in Japanese phonological acquisition (and was evident in KT's productions in Japanese), and the presence of this error in some of KT's English productions of /s/ may reflect transfer of an error pattern in one language (Japanese) to another (English). Thus, some evidence of transfer of error patterns might indicate that a common phonetic motor plan may be used in both languages (Flege, 1987).

A clear determination of the source of all of KT's speech patterns cannot fully be determined; however, supplemental information about his speech motor control guided our hypotheses about the source of some of the phonetic patterns observed. That is, relational analyses might not always capture all of the relevant features of a child's phonological and speech motor system. Although transfer and/or idiosyncratic rules associated with an interlanguage may account for some of the observed phonetic patterns (Dickerson, 1975; Selinker et al., 1975), clinicians are often left to speculate that the remaining deviant phonetic patterns are indicative of an SSD. Obtaining supplemental information about the speech motor system and PA skills aided the assessment process, allowing us to hypothesize that a residual SSD affecting sibilants might be co-occurring with symptoms of CAS. Speech motor control difficulties were suspected given the high token-to-token variability in speech output in both languages, variable errors when the speech motor system was stressed on the diadochokinetic tasks, and the inconsistent voicing errors and deletions of sounds and syllables in both languages.

This case study points to the potential utility of speech motor assessment as a useful tool in the assessment of SSDs in bilingual children. KT was relatively inconsistent in his phonetic realizations of repeated productions of English and Japanese multisyllabic/multimoraic words, as well as in his productions of the nonsense syllable sequence /pʌtʌkʌ/. In particular, we propose that assessing token-to-token consistency on repeated productions of syllable sequences and phonologically complex words might be viewed as a "language-neutral" task, because token-to-token consistency (a) provides an understanding of speech motor control but does not require a relational analysis that would be subject to the influence of transfer or idiosyncratic interlanguage patterns, (b) may not be strongly influenced by proficiency with a language, and (c) appears to be similar across languages of bilinguals (Chakraborty et al., 2008; Holm & Dodd, 1999). Unfortunately, few normative data exist for clinical assessment of token-to-token inconsistency (but see Dodd, Hua, Crosbie, Holm, & Ozanne, 2002, for younger children). Future studies should explore the clinical utility of these measures, as they provide information about speech skills that can be conducted without reference to the specific phonological properties of the native language or second language (i.e., token-to-token consistency can be observed regardless of the languages being learned).

PA was a relative strength in both languages. This is consistent with KT's performance within normal limits on English word and nonword reading, as well as spelling of English words (see Appendixes A and B). Adequate phonological representations, as evidenced by good PA, suggest that KT's errors may not be primarily associated with how speech is represented. However, because several of KT's speech patterns appeared to reflect speech motor control difficulties, CAS might reasonably be suspected. Treatment targets might include consistent production of sibilants and multisyllabic/multimoraic words in both languages.

In sum, identification of clinically significant speech patterns in second language learners can be effectively conducted but requires an understanding of the phonology of the native language to differentiate patterns associated with speech differences and those associated with speech disorders (ASHA, 2003). Patterns of performance on speech motor tasks and PA tests can aid in the understanding of additional areas of strength or weakness. Further investigation of measures that could serve as clinical indicators of speech skills beyond traditional relational analyses would be of value.

Acknowledgments

This research was supported in part by National Institute of Child Health and Human Development Grants 5P01HD001994 and T32HD7548 to Haskins Laboratories (C. Fowler, principal investigator) and Grant-in-Aid for Scientific Research 195370 from the Ministry of Education, Culture, Sports, Science and Technology, Japan. We are grateful to the participant and his mother who provided consent for this case study. Thanks to Leah Fabiano-Smith for comments on the manuscript.

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Appendix A

Supplemental Information on Language and Literacy

Tests normed on monolingual speakers do not provide a reliable estimate of a bilingual's proficiency relative to peers of similar background. In an academic setting, however, bilingual students are often compared to their monolingual peers and expected to achieve the same academic benchmarks. We therefore present pseudostandard scores from language and literacy tasks normed on English and Japanese-speaking populations to estimate KT's performance relative to his peers (see Appendix B).

Oral receptive vocabulary. English receptive vocabulary was assessed via the Peabody Picture Vocabulary Test—III (Dunn & Dunn, 1997). KT's standard score (compared to English-speaking children) was 84, which, although somewhat low, would not necessarily be in a range of clinical concern.

Oral receptive vocabulary in Japanese was measured by the Picture Vocabulary Test (Ueno, Utsuo, & Iinaga, 1991), which is similar to the Peabody Picture Vocabulary Test in that a child chooses one picture from a field of four that matches an orally presented word. KT's score on this test was relatively low (vocabulary age of 7;10). Additionally, the Standardized Comprehension Test of Abstract Words (SCTAW; Uno, Haruhara, & Kaneko, 2003), which requires choosing a picture from a field of six that matches a spoken word, was administered to assess more advanced receptive vocabulary in Japanese. His score on the SCTAW was also low (–1.9 *SD*). Thus, there appeared to be an advantage for English vocabulary, presumably because much of his recent academic instruction occurred in English.

Reading. Reading accuracy of English words was assessed by the Woodcock–Johnson III Letter-Word Identification subtest (Woodcock, McGrew, & Mather, 2001), and reading of nonwords was assessed with the Word Attack subtest. Speeded reading of single English words was assessed using the Sight Words subtest of the Test of Word Reading Efficiency (Torgesen, Wagner, & Rashotte, 1999), which requires rapid reading of words of progressing difficulty. Both Forms A and B were administered. The session was audio-recorded and scored later, making allowances for pronunciation differences in oral reading that might be due to the influence of speech errors or pronunciation differences. As can be seen in Appendix B, KT's reading of English words and nonwords was estimated to be within normal limits.

Reading of Japanese phonograms (kana) was assessed using the Kana Reading Tasks (Kobayashi et al., 2010). It consists of four subtests: sequential letter reading, words reading, nonwords reading, and reading short sentences. A child reads each subtest aloud, and the reading time and the number of reading errors are measured separately. KT's reading of Japanese kana was in the normal range for all subtests (reading speed and accuracy). This is consistent with his performance in reading English words.

Writing/spelling. The Woodcock–Johnson Spelling subtest was administered to assess spelling of English words of progressing difficulty. This subtest revealed adequate spelling skills.

The writing words subtest of the Screening Test of Reading and Writing (STRAW; Uno, Haruhara, Kaneko, & Wydell, 2006) was administered to assess writing in Japanese. This test assesses writing skills of three Japanese orthographies: *hiragana, kanakana,* and *kanji*. In this test, different level words are assessed according to the child's grade, and kanji words were chosen from those learned two grades below the test grade. Although KT's kanji knowledge was not expected to be the same as other Japanese students (because he was not exposed to grade-level kanji), hiragana and katakana are expected to be mastered by age 8, when KT left Japan. The STRAW revealed low scores in hiragana and kanji. Two of his four errors in hiragana were for sounds that can be written in two different letters (はなぢ/じ[dʒi] and ちず/づ[dzɯ]), and these errors may be due to less exposure to written Japanese words. His low score in writing kanji may also be related to the lack of exposure to Japanese orthography. His writing of katakana, which is sensitive to dyslexia in Japanese children (Uno, Wydell, Haruhara, Kaneko, & Shibuya, 2009), was within the normal range. Considering his educational environment, KT did not appear to have specific difficulty in writing Japanese but demonstrated writing performance of a child with limited exposure to Japanese orthography.

Appendix B

Results of Standardized Japanese and English Language and Literacy Tests

Construct	Japanese test	Score (*SD*)	English test	Score (*SD*)
Receptive vocabulary	PVT	7;10[a]	PPVT–III	–1.07
	SCTAW	–1.9		
Reading	Kana Reading Tasks		TOWRE Sight Words A	–0.27
	Hiragana letters	2.2	TOWRE Sight Words B	0.13
	Hiragana words	–0.4	WJ III Letter-Word Identification	–0.53
	Hiragana nonwords	1.8		
			WJ III Word Attack	–0.6
Spelling/writing	STRAW		WJ III Spelling	–0.13
	Hiragana words	–2.5		
	Katakana words	–1.1		
	Kanji words	<–3.2		

Note. PVT = Picture Vocabulary Test; PPVT–III = Peabody Picture Vocabulary Test—III; SCTAW = Standardized Comprehension Test of Abstract Words; TOWRE = Test of Word Reading Efficiency; WJ III= Woodcock–Johnson III; STRAW = Screening Test of Reading and Writing.

[a]In years;months.