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Cross-Language Transfer of Phonological Awareness and Letter Knowledge: Causal Evidence and Nature of Transfer

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ABSTRACT

Using a randomized control trial, this study examined the causal evidence of cross-language transfer of phonological awareness and letter knowledge (names and sounds) using data from multilingual 1st-grade children (N = 322) in Kenya. Children in the treatment condition received an 8-week instruction on phonological awareness and letter knowledge in Kiswahili. The comparison group received business-as-usual classroom instruction. Children in the treatment condition showed greater improvement in phonological awareness and letter-sound knowledge in Kiswahili *and* English (positive transfer; effect sizes from .37 to .95), whereas a negative effect was found in letter-name knowledge (interference; effect size, g = .27). No effects were found in reading, nor did the results vary by moderators (e.g., Kiswahili vocabulary). Path analyses revealed divergent patterns of results for different outcomes. Results provide causal evidence for cross-language transfer of phonological awareness and letter knowledge and offer important theoretical and practical implications.

Early literacy development is a key foundation for ensuring later literacy achievement as well as academic achievement (Adams, 1990; Shanahan & Lonigan, 2010). A child's early literacy skills improve as a function of development of essential skills such as phonological awareness and letter knowledge; this is the case not only for children learning to read in a first or familiar language (L1; Adams, 1990; Ehri, 2005; National Institute of Child Health and Human Development, 2000; Ziegler & Goswami, 2005) but also for bilingual children or children learning to read in a less familiar language (L2; e.g., August & Shanahan, 2006; Durgunoğlu, Nagy, & Hancin-Bhatt, 1993).

One of the important findings in literacy acquisition in L2 is that phonological awareness and reading skills transfer from L1 to L2. For example, phonological awareness in L1 was correlated with phonological awareness in L2 and with word reading skills in L1 and L2[1] (e.g., August & Shanahan, 2006; Branum-Martin, Tao, Garnaat, Bunta, & Francis, 2012; Goodrich, Lonigan, & Farver, 2014). A similar conclusion was drawn for children learning to speak and read in more than L2s. For instance, Liow and Poon (1998) found that students who had high levels of phonological awareness in L1 Bahasa Indonesian displayed high levels of phonological awareness in Chinese (L2) and English (L3). Despite consistent correlational evidence of across languages, *causal* evidence of cross-language transfer is lacking. The present study aimed to contribute to this gap in the literature by conducting a randomized control trial with multilingual first-grade children in Kenya whose L1 is a local ethnic dialect used in Kenya; who spoke the dominant language of Kiswahili, the East African Lingua Franca; and who were learning English in school.

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Cross-language transfer of metalinguistic awareness

According to the developmental or linguistic interdependence hypothesis (Cummins, 1984), human languages comprise distinct surface features with common underlying proficiencies. Therefore, the level of competence in L2 is partly attributed to the competence the children had attained in L1 by the time the L2 was introduced (Cummins, 1979, 1984). Metalinguistic awareness skills have received much attention as underlying competencies that would transfer between languages (e.g., Jessner, 1999). In particular, one such skill that is considered to be shared across languages, and therefore is expected to transfer between languages, is phonological awareness. Supporting the hypothesis is moderate to strong correlations between L1 and L2 phonological awareness (e.g., Bialystok, Luk, & Kwan, 2005; Kim, 2009; Kuo, Uchikoshi, Kim, & Yang, 2016; see Branum-Martin et al., 2012, and Melby-Lervåg & Lervåg, 2011, for reviews).

Despite the theoretical and practical importance of cross-language transfer, very few studies have been conducted to date to demonstrate causal evidence of cross-language transfer. One exception is Vaughn et al. (2006), who used a randomized control design to explore the effects of comprehensive literacy programs (e.g., targeting emergent literacy skills, word reading, fluency, and reading comprehension) among Spanish–English bilingual, at-risk first-grade children in the United States. They found that students who received the comprehensive literacy instruction in Spanish improved their phonological awareness and letter-sound knowledge in English. In addition, a recent study examined the causal effect of literacy intervention for multilingual first- and second-grade children in Kenya (Piper, Zuilkowski, & Ong'ele, 2016). In this study, children who were taught literacy in only English and Kiswahili (not L1) also improved decoding skills in L1, indicating the transfer from L2 to L1. Unfortunately, however, the authors did not examine phonological awareness as an outcome.

These few studies employing a randomized control trial design do provide some causal evidence for cross-linguistic transfer. However, these studies provided instruction on comprehensive, multiple skills, and therefore it is not clear exactly what ingredients or elements of instruction caused improvements in the other language outcomes. A more recent study by Wise, D'Angelo, and Chen (2016) addressed this issue by training children on phonological awareness and letter-sound knowledge in English and found that the students' phonological awareness and word reading in French improved. However, the number of students in the treatment condition in this study was extremely small (n = 7).

Previous studies on cross-language transfer primarily focused on phonological awareness, although literature is certainly expanding to other metalinguistic awareness such as morphological awareness and orthographic awareness (e.g., Kahn-Horwitz, Shimron, & Sparks, 2005; Wang, Cheng, & Chen, 2006). Another potential key emergent literacy skill for cross-language transfer that has received little empirical attention is alphabet letter knowledge (i.e., letter-name and letter-sound knowledge). We hypothesize that letter knowledge is a candidate skill for transfer but the nature is likely to differ for letter-name versus letter-sound knowledge. Although both involve knowledge about alphabet letters, letter-name knowledge is knowledge of labels for orthographic symbols and, therefore, is essentially vocabulary acquisition (e.g., labels for objects). In contrast, letter-sound knowledge involves understanding the alphabetic principle, or the fundamental principle of cracking the code in an alphabetic writing system, which involves metalinguistic awareness about the relation between orthographic symbols and sounds.

For letter-name acquisition in multiple languages, the extent of similarity in letter shapes and names in target languages would play a role in the nature and extent of transfer. The same letters (e.g., Roman alphabet letters) between two target languages would facilitate acquisition of shapes. However, the extent of dissimilarity in the names for the same letter shapes would result in competition and confusion, and thus might result in a negative transfer. That is, if two target languages employ the same orthographic symbols but have different names for them, knowing letter names in one language might interfere with learning letter names in the other language.

In contrast to letter-name acquisition, metalinguistic awareness about how graphemes represent sounds (letter-sound knowledge) is likely to have a positive transfer because once the student learns systematic relations between graphemes and phonemes, this awareness is likely to apply to learning letter sounds in another language. Although sounds of individual orthographic symbols may be orthography specific, the recognition of the alphabetic principle is a metalinguistic awareness, and therefore is likely to positively transfer between languages. To our knowledge, no previous studies have explicitly addressed the question of cross-language transfer of letter-name and letter-sound knowledge. However, findings from Vaughn et al. (2006) do support our hypothesis because they found a positive transfer of letter-sound knowledge but not of letter-name knowledge.

Potential moderators of cross-language transfer

The lexical restructuring model purports that growth in vocabulary relates to the development of phonological awareness through phonological restructuring of the lexicon (Metsala & Walley, 1998). According to the lexical restructuring model, as vocabulary increases, children gain the ability to explicitly segment words to phonemes because children continuously engage in the act of distinguishing words previously stored in memory from new words for meaningful and successful recognition. Data from correlational studies did show a relation between vocabulary and phonological awareness in L1 (e.g., Bowey & Francis, 1991; Lonigan, 2006) and between L1 vocabulary and L2 phonological awareness (Anthony et al., 2009; Atwill, Blanchard, Christie, Gorin, & García, 2010). Furthermore, a study suggested that the relation of L1 vocabulary with L2 phonological awareness might vary as a function of the level of L1 vocabulary. In a study with Spanish-speaking English learners in kindergarten, children with an average L1 vocabulary exhibited a positive and moderate cross-language correlation between English and Spanish (r = .57) whereas children with below-average L1 vocabulary had a weaker cross-language correlation (r = .30; Atwill et al., 2010).

Another potential moderator is whether the language spoken at home matches the language of instruction. In multilingual contexts, many children's L1 is not the language of instruction at school (Kim, Boyle, Zuilkowski, & Nakamura, 2016). Therefore, the training effect of metalinguistic awareness, and phonological awareness in particular, might differ for children whose L1 is the same as the language of instruction compared to those whose L1 is different because the former might have higher proficiency in the language of instruction, which might influence the training effect. For example, Uwezo (2012) reported that reading achievement for Kenyan children was higher for those whose home language was identical to the language of instruction.

Finally, the number of school absences might influence the intervention effect. Many Kenyan schools, like many other low-income countries, experience the challenge of absenteeism particularly with lower primary grade children (Uwezo, 2012). Although absenteeism deters learning (Moyi, 2013; Suryadarma, Suryahadi, Sumarto, & Rogers, 2006), whether cross-language transfer would be impacted by absenteeism has not been examined.

Characteristics of the kiswahili language and writing system, and early literacy practices in kenya

Kenya is a multiethnic, multilingual society where 67 languages are spoken (Ethnologue, 2017), with Kiswahili and English being two languages used widely. On average, a Kenyan child speaks at least three languages: a mother tongue, which is the language used in the home with parents and caregivers; a dominant language, which is the language widely used in the community (Kiswahili); and English, as a third or fourth language (Nyaga & Anthonissen, 2012; Uwezo, 2011).

Kiswahili is ranked as the seventh most widely spoken language in the world, with approximately 45 million people who use it as their first language and 100 million who use it as a second language (Commeyras & Inyega, 2007). Kiswahili is a Bantu language in which the syllable is a salient phonological unit with clear and easily predictable syllable boundaries. The syllable structure in Kiswahili is

vowel (V), consonant–vowel (CV), and CCV (in prenasalized consonants) or CCVC (non-Bantu loan words; Polomé, 1967). Kiswahili has an alphabetic writing system. Like English, Kiswahili uses the Roman alphabet with a slightly different set of letters and graphemes: 25 consonant graphemes composed of 17 single letters and eight digraphs (e.g., ch for /tʃ/; dh for /ð/) and five vowel letters (see Polomé, 1967). Unlike English, the phoneme–grapheme relationship is highly consistent in Kiswahili (e.g., the letter a consistently represents /a/). In addition, all letter names in Kiswahili are represented in a consistent manner, with the letter sound articulated first followed by the phoneme /a/ in the final position (e.g., /na/ for n, /pa/ for p, /ʃa/ for a digraph sh; Mutonyi, 2000).

Formal literacy instruction in Kenya begins in Grade 1. The language-of-instruction policy in Kenya mandates that instruction from first through third grades must be in a child's catchment area language—ethnic languages in rural areas and Kiswahili in the urban areas (Muthwii, 2004). However, English was reported to be the more prevalent language of instruction in Kenya, which is attributed to multiple factors, including lack of instructional materials in mother tongues (L1), inadequate teacher training on instruction in L1, and high status of English in the society along with linguistic and ethnic heterogeneity (Dubeck, Jukes, & Okello, 2012; Piper & Miksic, 2011; Trudell & Piper, 2014; see Kim et al., 2016, for a review).

In response to extremely low literacy performances even after years of schooling (Gove & Wetterberg, 2011; Piper, 2010; Wasanga, Ogle, & Wambua, 2010), the Kenyan Ministry of Education Science and Technology launched the USAID-funded Tusome Early Grade Reading activity on a national scale for first- and second-grade classes in 2015 (RTI International, 2015). In the Tusome program, daily whole-class learning activities in the first and second grades target skills in the areas of phonological awareness, alphabetic principle, vocabulary, reading fluency, comprehension, and writing. In all classrooms, teachers are to teach using the Tusome scripted lesson plans in literacy instruction in English and Kiswahili. Therefore, the same standard practice is implemented in all schools nationwide.

The present study

The primary research questions were as follows:

(1) How does phonological awareness and letter knowledge training in Kiswahili influence *Kiswahili* phonological awareness, letter knowledge, and reading skills for multilingual first-grade children in Kenya?
(2) How does phonological awareness and letter knowledge training in Kiswahili influence *English* phonological awareness, letter knowledge, and reading skills for multilingual first-grade children in Kenya?
(3) Does the effect of phonological awareness and letter knowledge training in Kiswahili vary as a function of vocabulary knowledge in Kiswahili and English, language spoken at home, or absences from school?
(4) If there are causal effects of Kiswahili instruction on English outcomes, what are pathways of their relations?

To address these questions, a randomized control trial was implemented in which children were randomly assigned to treatment and control conditions. We hypothesized that phonological awareness and letter knowledge training in Kiswahili will result in improved phonological awareness, letter knowledge (letter-sound knowledge, in particular), and word reading abilities in Kiswahili. We further hypothesized that training in Kiswahili will improve phonological awareness, letter knowledge, and word reading abilities in English. However, we did not have specific hypotheses about moderating effects, given sparse prior evidence.

Method

Sites

Participants of the present study were drawn from four public primary schools in a multicultural cosmopolitan region in Keyna in which children have linguistic competence of, on average, three languages: an ethnic home language, and Kiswahili and English as additional languages. Kiswahili is the common language of communication and is used for instruction in first through third grades. In this region children are also formally exposed to English from first grade, as English is taught as a subject.

Participants

A total of 322 multilingual first-grade students (M age = 6.71 years old; 53% male) from areas of relatively low-socioeconomic family backgrounds participated in the study. All these children were typically developing with no identified hearing, visual, or speech impairments. Approximately 72% of the participants indicated that they speak the same language at home and at school (i.e., Kiswahili). The other languages spoken at home in the sample included Kikuyu, Kisii, Lubukusu, Maragoli, Tiriki, Kikamba, Dhuluo, and Turkana—all Bantu and Nilotic languages that are different from Kiswahili.

A stratified random assignment procedure was used to assign participants to the treatment or comparison group. Children enrolled in the same school were matched to form pairs by ranks based on their pretest scores in the Kiswahili phonological awareness tasks: oddity and blending tasks (see the Measures section). One student from each pair was randomly assigned to the treatment group (n = 165) and the other student to the comparison group (n = 157). Note that neither random assignment nor intervention instruction was at the classroom level; both were at the child level within the school.

At the end of the study, 310 children completed pretest and posttest data, and 12 participants (3.7%) had missing data on all the posttest variables. Complete case analysis using the Little's Missing Completely at Random test was not significant, χ^2 (94) = 102.97, p = .25, indicating that the hypothesis that missing cases were completely at random cannot be rejected. A multivariate analysis of variance indicated that there were no statistically significant differences on the demographic characteristics and pretest scores as a function of treatment status, Wilks's λ = 0.93, F(21, 288) = 1.02, p = .43.

Procedures

The participants were tested on nine tests in Kiswahili and in English in pretest (mid-May) and posttest (mid-July to August; the academic year starts in January in Kenya). The tests in Kiswahili and the tests in English were administered in two separate sessions, 2 to 3 days apart, with each session lasting approximately 20–30 min. Each child was tested individually in a quiet classroom. All the assessments were administered using a tablet-based assessment tool, the Tangerine-TM (RTI International, 2012) by the first author and five research assistants, who were Kiswahili language and literature educators but were not currently teaching at schools and who were trained rigorously on how to administer the assessment battery. The assessors spoke in only English or Kiswahili during the English and Kiswahili assessments, respectively. All the assessors were blind to the children's treatment status during both testing occasions.

Measures

The Early Grade Reading Assessment (EGRA), which includes emergent literacy skills and reading skills of children in the early grades and has been implemented in more than 100 developing countries (Gove & Wetterberg, 2011), was used. The EGRA measures in English and in Kiswahili in the present study were developed, validated, and implemented in previous studies in Kenya (Piper & Miksic, 2011). Although the original EGRA measures are timed tasks, in the present study, the tasks were not timed with the exception of text/oral reading fluency. In addition, for phonological awareness, a blending task was used in both English and Kiswahili. However, the other task differed such that an oddity task was used in Kiswahili and a detection task was used in English. Although identical tasks would have been ideal, these were part of the EGRA assessments and therefore were used in the present study. In addition to the EGRA assessments, a receptive vocabulary task in Kiswahili was developed, pilot tested, and used in the present study to examine its moderating effect (see the Measures section). All the measures were dichotomously scored (1 = *correct*, 0 = *incorrect*). All the reliabilities reported herein are from the present sample and ranged from *adequate* to *excellent* (see Tables 1 and 2). Measures in Kiswahili and English were highly similar. Next is a description of measures in Kiswhahili; a description oF English measures is found in the appendix.

Letter Name Knowledge

Children were presented with a set of 100 randomly ordered uppercase and lowercase letters, all presented on a single page, and were asked to say the names of the letters in Kiswahili. Some

Table 1. Descriptive statistics for Kiswahili measures by treatment status

		Comparison		Treatment						
		Pretest	Posttest	Pretest	Posttest		Pretest		Posttest	
Variables	α	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	Min-Max	Skew	Kur	Skew	Kur
Letter name	.99	31.67 (35.14)	56.89 (27.06)	27.35 (32.20)	72.06 (23.71)	0–100	0.65	−1.12	−0.58	−0.15
Letter sound	.99	42.47 (38.27)	66.85 (32.09)	36.80 (37.32)	85.90 (17.46)	0–100	0.17	−1.68	−1.54	1.54
Syllable reading	1.00	46.16 (43.06)	66.06 (38.12)	45.82 (41.57)	70.64 (35.54)	0–100	−0.01	−1.83	−0.92	−0.80
PA: Oddity	.70	3.86 (2.03)	3.58 (1.63)	3.88 (3.75)	4.79 (2.17)	0–10	4.58	35.76	0.72	0.52
PA: Blending	.82	5.99 (2.38)	7.35 (2.77)	6.08 (2.32)	10.08 (2.77)	0–15	1.16	2.91	0.25	−0.79
Word reading	.99	15.01 (20.05)	28.28 (21.58)	14.69 (18.80)	30.63 (20.93)	0–50	0.77	−1.15	−0.45	−1.61
Nonword reading	.99	12.21 (17.62)	26.00 (20.38)	12.43 (17.01)	28.47 (19.51)	0–50	1.04	−0.50	−0.32	−1.63
Reading fluency	.96[a]	5.94 (9.80)	13.32 (15.06)	4.90 (8.23)	12.84 (14.08)	0–64	2.01	4.09	1.03	0.46
Vocabulary	.59	18.92 (2.78)	NA	18.89 (2.63)	NA	0–25	0.02	−0.07	NA	NA

Note. PA = phonological awareness; Skew = skewness; Kur = kurtosis.
[a]Reliability for reading fluency was measured by test–retest reliability.

Table 2. Descriptive statistics for English measures by treatment status

		Comparison		Treatment						
		Pretest	Posttest	Pretest	Posttest		Pretest		Posttest	
Variables	α	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	Min-Max	Skew	Kur	Skew	Kur
Letter name	.99	31.60 (35.70)	39. 32 (33.41)	25.54 (32.52)	28.21 (31.49)	0–100	0.66	−1.21	0.49	−1.18
Letter sound	1.00	42.07 (40.00)	63. 74 (33.20)	41.05 (38.03)	81.22 (21.10)	0–100	0.08	−1.75	−1.47	0.99
PA: Phoneme detect	.92	3.80 (5.35)	4.67 (4.19)	3.36 (3.90)	7.97 (2.82)	0–10	1.80	5.38	−0.58	−1.30
PA: Blending	.86	7.90 (3.33)	10.35 (3.43)	7.92 (3.42)	11.63 (3.02)	0–15	−0.15	0.01	−1.10	1.06
Word reading	.99	8.60 (13.58)	18.72 (17.34)	7.50 (11.25)	17.92 (15.78)	0–50	1.58	1.54	0.27	−1.39
Nonword reading	.99	10.21 (16.82)	21.57 (20.04)	10.45 (16.44)	20.43 (19.30)	0–50	1.15	−0.41	0.10	−1.71
Reading fluency	.73[a]	6. 35 (12.03)	13.25 (15.14)	5.01 (7.91)	12.34 (12.96)	0–64	2.47	8.06	1.11	1.09
Vocabulary	.98	27.79 (7.79)	NA	27.78 (7.49)	NA	0–60	0.76	1.66	NA	NA

Note. PA = phonological awareness; Phoneme detect = phoneme detection task; Skew = skewness; Kur = kurtosis.
[a]Reliability for reading fluency was measured by test–retest reliability.

letters and digraphs were repeated. If the first 10 letters were named incorrectly, the task was discontinued.

Letter Sound Knowledge

The same stimuli for letter-name knowledge were used, but children were asked for letter sounds. The task was discontinued if the first 10 letter sounds were answered incorrectly. A child's total score for this task was calculated as the number of correct letter sounds.

Phonological Awareness

In the oddity task, assessors read aloud three words at a time, repeated them, and then asked the children to identify the word that begins with a different initial sound. There were three practice items and 10 test items. The task was discontinued if a child responded incorrectly or did not respond to the first five items. The blending task consisted of syllable and phoneme blending with three practice trials and 15 test items.

Syllable Reading

Children were asked to name 100 nonword single syllables (e.g., *zu, nde, wa*). After three practice items, this task was discontinued if a child responded incorrectly or could not identify the first 10 syllables.

Word Reading

Following three practice items, children were presented with a list of 50 randomly organized one-, two-, and three-syllable words and were asked to read them in the order presented. The assessment discontinued if the first five items were incorrect.

Nonword Reading

After three practice items, children were presented with a list of 50 one- or two-syllable nonwords and were requested to read them in order. The task was discontinued if the first five items were incorrect.

Text/Oral Reading Fluency

This task measured the ability to read aloud a connected text (i.e., a passage) with accuracy and speed. Children were asked to read aloud a passage of 64 words in 1 min. The task was discontinued if a child could not read any words on the first line correctly. A child's score was based on the number of correct words read in 1 min.

Moderators

Kiswahili Vocabulary

Children were shown four pictures and were asked to identify the picture that represents the word spoken by the assessor. There were 25 test items. This was administered at pretest only.

English Vocabulary

The Peabody Picture Vocabulary Test—Fourth Edition (Dunn & Dunn, 2007) was used. Children were presented with four pictures and asked to select a picture that best represents the meaning of the word spoken by the assessor.

Language Spoken at Home

Children were asked if they spoke the same language at home and at school (Kiswahili). Language spoken at home was dichotomously coded (1 = *use the same language at home and at school*; 0 = *otherwise*).

School Absences

Absence was the total number of days a child was absent from school during the intervention period.

Phonological awareness and letter knowledge training

Students in the treatment condition received phonological awareness and letter-knowledge training in Kiswahili for 8 weeks in addition to their regular classroom instruction. Children were pulled out of their classrooms (not during Kiswahili literacy instruction time) for each training session. Instruction was provided to groups of three children for 20 min, three times each week. The research-based principles of effective phonological awareness instruction (Foorman & Torgesen, 2001; National Institute of Child Health and Human Development, 2000; Vaughn & Linan-Thompson, 2004) were employed in the training, adapting metalinguistic games and exercises in *Phonological Awareness Assessment and Instruction* (Lane & Pullen, 2004). All of the lessons were highly scripted.

The phonological awareness instruction started with syllable tasks and progressed to phoneme tasks, using a variety of activities such as counting, matching, detecting, blending, segmenting, and deleting phonemes. As for letter knowledge instruction, the following consonant letters and digraphs were targeted: *p, v, ny, th, ng, ch, r*, and *sh*. These letters were selected from the Tusome first-grade book covered during the second term of the school year when the intervention was provided; therefore, the training provided reinforcement rather than teaching new letters. Children were taught one letter name and its letter sound each week. On the 1st day of each week, a letter name and its sound was introduced along with handwriting practice. On the 2nd day, the letter name and sound were reviewed with practice. On the 3rd day, the children had further practice with a letter-knowledge automaticity activity. Children who missed any of the training sessions received makeup instruction on alternate days.

Comparison Condition

Children in the comparison condition continued with the regular Tusome initiative curriculum according to which first-grade children learn the Kiswahili and English languages daily for 30 min in each language each week.

Fidelity of Implementation

The interventionists, who were not the same as the assessors, were Kiswahili language and literature preservice teachers in their final year of undergraduate training. They underwent a rigorous training for 4 days on the phonological awareness and letter knowledge instruction. Throughout the study period, the first author had weekly meetings with the interventionists to discuss strategies as well as the successes and difficulties encountered during their teaching sessions. In addition, the first author and one research assistant conducted observations of intervention sessions using the RTI–modified Stallings Snapshot tool (RTI International, 2015) to ensure fidelity. Each snapshot covered the three essential stages of learning activities—description of modeling instruction, guided practice activities, and independent practice activities. During the final 6 weeks of the intervention, each interventionist was observed by the researcher and the research assistant every other week in a random sequence. The interobserver reliability was above 97%. The implementation fidelity was scored on a Likert scale from 1 (*low*) to 4 (*high*) focusing on the quality of implementation The average fidelity value across the observations was 3.92, indicating that the intervention was implemented as intended.

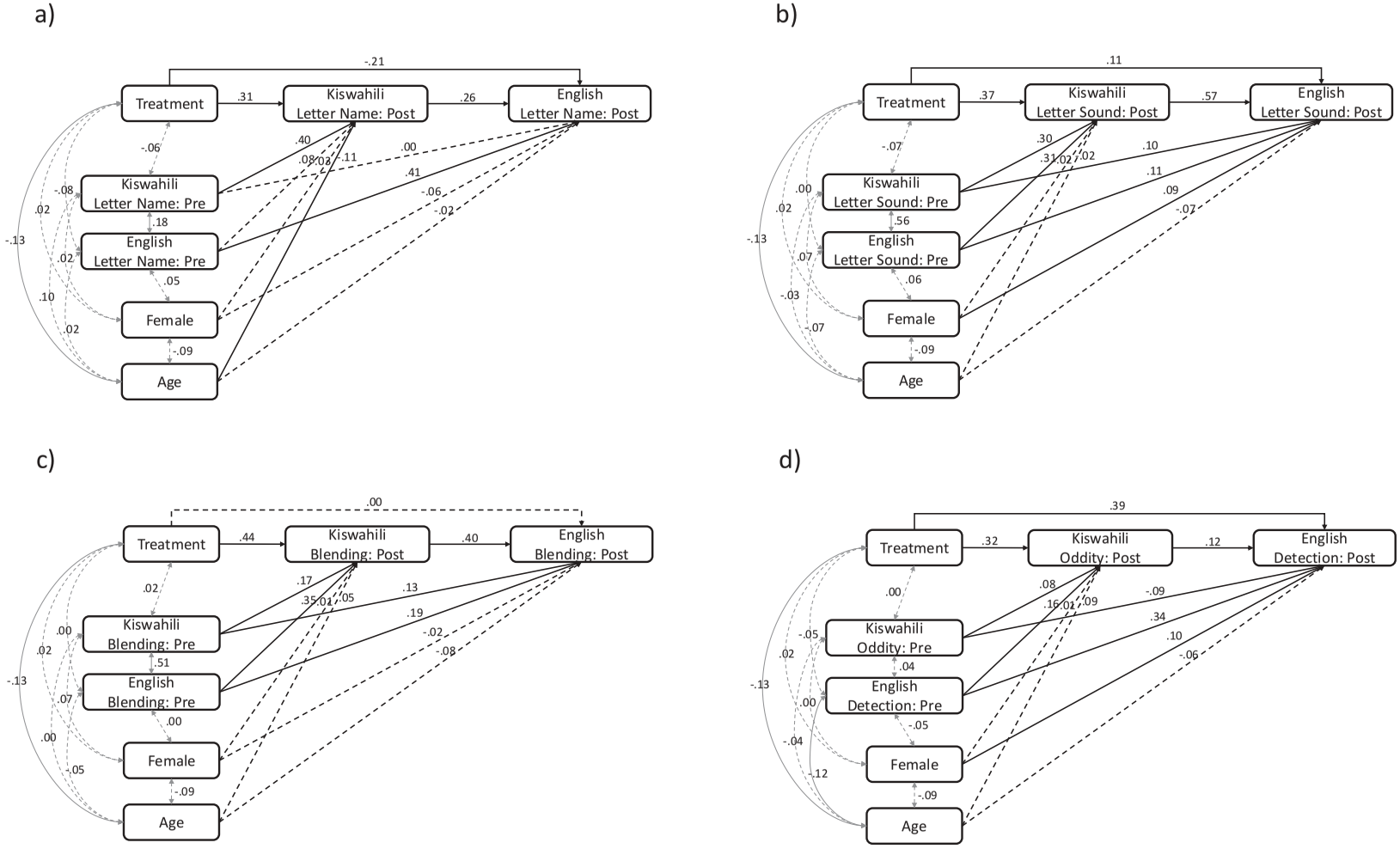

Figure 1. Path analyses in which treatment effects on English outcomes are mediated by Kiswahili outcomes. *Note*. Standardized path regression weights are shown. Solid lines represent statistically significant relations whereas dashed lines represent nonsignificant relations. Gray lines represent covariances. Post = posttest; Pre = pretest.

Data Analyses

The effect of the phonological awareness and letter knowledge training was analyzed using multilevel modeling (also widely known as hierarchical linear modeling), using SAS PROC MIXED procedures to account for students being nested within classrooms.[2] Pretest scores, age, and gender (1 = *female*, 0 = *male*) were included as covariates. The primary predictor was treatment status (1 = *treatment*, 0 = *comparison*). The moderator analyses were conducted by including interaction terms between treatment status and moderator variables (Kiswahili and English vocabulary, language spoken at home, and school absences). The effect size was derived using the Hedges's *g* coefficient (Hedges, 1981). The Benjamini–Hochberg correction for multiple comparisons was applied to adjust for a false discovery rate (Benjamini & Hochberg, 1995). To address the last research question, path analyses were conducted for English outcomes where effects were found. In these models, the treatment effects on English outcomes were hypothesized to be mediated by improvement in target skills in Kiswahili. Children's pretest performances in Kiswahili and English for the target skill were included as control variables as well as gender and age (see Figure 1). In Figure 1a, we examined whether treatment had a direct effect on English letter-name knowledge after accounting for its effect via Kiswahili letter-name knowledge, that is, whether Kiswahili letter-name knowledge completely or partially mediates the treatment effect. Figure 1b examined pathways of effects for letter-sound knowledge. For phonological awareness, in one model (Figure 1c), blending in Kiswahili and English was used, whereas in the other model (Figure 1d), oddity in Kiswahili and detection in English were used. As previously noted, partially different tasks for phonological awareness reflect available measures in the EGRA battery.

Results

Tables 1 and 2 present descriptive statistics by treatment status. There were no statistically significant differences in the Kiswahili pretest measures, Wilks's $\lambda = 0.98$, $F(9, 292) = .69$, $p = .72$, or in the English pretest measures, Wilks's $\lambda = 0.98$, $F(8, 291) = .92$, $p = .50$, between the treatment and comparison groups. Bivariate correlations across languages for pretest and posttest measures are presented in Tables 3 and 4, respectively. Reading skills were strongly related within and across languages ($.69 \leq rs \leq .80$). Between Kiswahili and English, letter-name knowledge was weakly related ($.18 \leq rs \leq .24$), letter-sound knowledge was moderately to strongly related ($.57 \leq rs \leq .71$), and the phonological awareness blending task was moderately related ($.49 \leq rs \leq .52$), whereas Kiswahili oddity and English phoneme detection were weakly to moderately correlated with each other and blending tasks ($.01 \leq rs \leq .44$).

Research Question 1: Effects in Kiswahili

Table 5 displays the results and effect sizes from multilevel models. Variation due to classrooms (i.e., intraclass correlations [ICC] = (level 2 variance) / (level 1 variance + level 2 variance)) was minimal such that intraclass correlations ranged from 0 to .10. Children in the treatment group significantly outperformed those in the comparison group in Kiswahili letter knowledge and phonological awareness after accounting for age, gender, and pretest scores: letter-name knowledge ($g = .60$), letter-sound knowledge ($g = .74$), oddity ($g = .57$), and blending ($g = .92$). However, there were no significant differences between treatment and comparison groups on the reading tasks (syllable reading, word reading, nonword reading, and text reading fluency; $.04 \leq gs \leq .12$).

Research Question 2: Effects in English

ICCs for the English outcomes were also relatively small, ranging from .02 to .13 (see Table 5). Children in the treatment group made significantly greater gains compared to their comparison counterparts in phoneme detection task ($g = .95$) and blending task ($g = .37$). In addition, children in

Table 3. Bivariate cross-language correlations between Kiswahili and English pretest measures

Kiswahili\Engligh	Letter Name	Letter Sound	Phoneme Detection	Blending	Word Reading	Nonword Reading	Reading Fluency	Vocabulary
Letter name	.18**	.18**	.27**	.16*	.44**	.47**	.40**	.27**
Letter sound	.18**	.57**	.28**	.28**	.53**	.52**	.48**	.32**
Oddity	−.02	−.01	.04	.01	.07	.09	.05	−.00
Blending	.12**	.28**	.28**	.49**	.44**	.42**	.31**	.27**
Syllable reading	.24**	.54**	.36**	.40**	.65**	.65**	.56**	.40**
Word reading	.20**	.49**	.39**	.40**	.73**	.76**	.69**	.40**
Nonword reading	.20**	.46**	.36**	.38**	.73**	.76**	.69**	.36**
Reading fluency	.13**	.46**	.36**	.32**	.69**	.74**	.73**	.34**
Vocabulary	.22**	.23**	.23**	.22**	.37**	.40**	.32**	.39**

*$p < .05$. **$p < .01$.

Table 4. Bivariate cross-language correlations between Kiswahili and English posttest measures

Kiswahili\Engligh	Letter Name	Letter Sound	Phonome Detection	Blending	Word Reading	Nonword Reading	Reading Fluency
Letter name	.24**	.49**	.50**	.46**	.57**	.58**	.55**
Letter sound	.14*	.71**	.52**	.49**	.53**	.54**	.49**
Oddity	.07	.24**	.28**	.29**	.23**	.26**	.28**
Blending	.18**	.47**	.44**	.52**	.46**	.44**	.45**
Syllable reading	.29**	.57**	.44**	.51**	.71**	.70**	.63**
Word reading	.31**	.60**	.46**	.53**	.77**	.77**	.71**
Nonword reading	.33**	.60**	.48**	.54**	.78**	.79**	.73**
Reading fluency	.33**	.47**	.38**	.50**	.78**	.79**	.80**

*$p < .05$. **$p < .01$.

the treatment group made greater gains in letter-sound knowledge than those in the control condition ($g = .62$). In contrast, there was a negative effect on the letter-name knowledge task ($g = .27$). No effects were found on any of the reading tasks in English ($.00 \leq gs \leq .08$).

Research Question 3: Moderators

None of moderators were statistically significant ($ps > .05$), indicating that the treatment effects did not differ as a function of Kiswahili and English vocabulary at pretest, language spoken at home, or school absences.

Research Question 4: Cross-language tranfer

Path models were examined for the four English outcomes where causal effects were found: letter-name knowledge, letter-sound knowledge, and phonological awareness (blending and detection). Results of these models (standardized path coefficients) are presented in Figure 1. Model fit indicators (e.g., comparative fit index, root mean square error of approximation) are not available, because these were just-identified models. When the outcome was English letter-name knowledge (Figure 1a), treatment had a direct positive effect on Kiswahili letter-name knowledge, which in turn was positively related to English letter-name knowledge. However, intervention itself had a negative, direct effect on English letter name ($\beta = -.21$, $p < .001$). When the outcome was English letter-sound knowledge (Figure 1b), treatement had a positive effect in Kiswahili letter-sound knowledge, which was positively related to English letter-sound knowledge. Treatment also had a direct effect on English letter-sound knowledge over and above its indirect effect via Kiswahili letter-sound knowledge. For English blending (Figure 1c), intervention effect was completely mediated by Kiswahili blending such that treatment improved Kiswahili blending, which, in turn, improved English blending. No direct effect of intervention on English blending was found after accounting for its

Table 5. Multilevel regression analysis for Kiswahili and English language and literacy measures

		Kiswahili				English			
Outcome Measure		*B*	*z*	*p*	ES	*B*	*z*	*p*	ES
Letter name	Intercept	67.58	7.34	< .001		39.53	3.29	.01	
	Pretest	.26	6.53	< .001		.41	8.34	< .001	
	Female	4.20	1.60	0.11		−.82	−.25	.80	
	Age	−2.73	−2.15	.03		−1.67	−1.05	.30	
	Treatment	15.18	5.77	< .001	0.60	−8.88	−2.69	.008	0.27
	−2LL	2594.0	—	—		2720.1	–	–	
	Level 2 variance	12.55	.96	.17		80.55	1.58	.06	
	Level 1 variance	484.13	11.82	< .001		757.31	11.79	< .001	
Letter sound	Intercept	63.09	7.20	< .001		62.34	6.14	< .001	
	Pretest	.30	8.67	< .001		.31	8.41	< .001	
	Female	1.91	0.78	0.66		8.24	3.00	.003	
	Age	−.93	−.79	.43		−1.94	−1.46	.15	
	Treatment	18.03	7.37	< .001	0.74	16.56	6.06	< .001	0.62
	−2LL	2551.8	—	—		2612.7	—	—	
	Level 2 variance	12.13	1.14	.12		48.84	1.52	.06	
	Level 1 variance	417.35	11.85	< .001		521.79	11.79	< .001	
Oddity/Detection[a]	Intercept	2.41	2.99	.02		4.64	3.39	.01	
	Pretest	.06	1.69	.09		.28	6.71	< .001	
	Female	.10	0.42	.67		.84	2.21	.03	
	Age	.13	1.22	.22		−.18	−.98	.33	
	Treatment	1.18	5.13	< .001	0.57	3.34	8.85	< .001	0.95
	−2LL	1190.3	—	—		1472.4	—	—	
	Level 2 variance	0	—	—		.23	.93	.18	
	Level 1 variance	3.71	11.98	< .001		9.91	11.81	< .001	
Blending	Intercept	4.50	4.03	.005		8.85	7.09	< .001	
	Pretest	.39	6.00	< .001		.35	7.12	< .001	
	Female	.10	.35	.73		.29	.90	.37	
	Age	.09	.65	.52		−.15	−.95	.35	
	Treatment	2.62	8.78	< .001	0.92	1.16	3.60	< .001	0.37
	−2LL	1347.9	—	—		1391.4	–	–	
	Level 2 variance	.25	1.26	.10		.56	1.57	.06	
	Level 1 variance	6.26	.53	< .001		7.32	11.82	< .001	
Syllable reading	Intercept	45.47	4.48	.003		—	—	—	
	Pretest	0.60	16.93	< .001		—	—	—	
	Female	.39	.14	.89		—	—	—	
	Age	−.73	−.54	.59		—	—	—	
	Treatment	4.29	1.53	0.13	0.12	—	—	—	—
	−2LL	2636.7	—	—		—	—	—	
	Level 2 variance	26.22	1.28	.10		—	—	—	
	Level 1 variance	556.89	11.83	< .001		—	—	—	
Word reading	Intercept	25.06	3.89	.006		9.25	1.98	.09	
	Pretest	.66	13.28	< .001		0.96	16.96	< .001	
	Female	2.63	1.44	.15		3.83	2.95	.004	
	Age	−.92	−1.05	.29		.09	.15	.88	
	Treatment	2.32	1.28	.20	0.12	−.04	−.03	.98	0.002
	−2LL	2383.6	—	—		2183.2	—	—	
	Level 2 variance	12.90	1.37	.09		6.29	1.41	.08	
	Level 1 variance	229.81	11.83	< .001		117.47	11.82	< .001	
Nonword reading	Intercept	25.25	4.24	.004		19.20	3.09	.02	
	Pretest	0.70	14.18	< .001		0.72	13.03	< .001	
	Female	2.26	1.37	0.17		3.57	2.05	.04	
	Age	−1.07	−1.35	.18		−.80	−.95	.34	
	Treatment	2.23	1.36	0.17	0.11	−1.19	−.68	.49	0.06
	−2LL	2330.4	—	—		2349.3	—	—	
	Level 2 variance	20.13	1.60	.06		10.38	1.34	.09	
	Level 1 variance	188.48	11.82	< .001		210.31	11.81	< .001	
Reading fluency	Intercept	8.00	1.94	.09		8.51	2.20	.06	
	Pretest	1.16	17.58	< .001		.97	17.99	< .001	
	Female	2.14	1.82	.07		1.86	1.80	.07	
	Age	−.25	−.45	.65		−.14	−.27	.79	
	Treatment	.55	.47	.64	.04	1.03	1.02	.31	.08
	−2LL	2130.6	—	—		2058.3	—	—	
	Level 2 variance	2.81	1.09	.14		10.84	1.70	.04	
	Level 1 variance	96.17	11.84	< .001		74.36	11.80	< .001	

Note. ES = effect size; −2LL = −2 log likelihood.
[a]Oddity task in Kiswahili & Detection task in English.

effect via Kiswahili blending. Finally, for English phoneme detection (Figure 1d), intervention had both direct and indirect effects such that intervention improved children's performance on the Kiswahili oddity task, which in turn positively influenced children's performance on the English detection task. Intervention also had a direct positive impact on the English phoneme detection task over and above the Kiswahili oddity task.

Discussion

We aimed to examine the causal evidence of cross-language transfer of phonological awareness and letter knowledge for children in multilingual contexts. Training in Kiswahili yielded large effects in phonological awareness and letter-sound knowledge in Kiswahili *and* English. Corroborating previous studies on L1 (e.g., Ball & Blachman, 1991; Boyer & Ehri, 2011; National Institute of Child Health and Human Development [NICHD], 2000; O'Connor, Jenkins, & Slocum, 1995; Shapiro & Solity, 2008), explicit and systematic instruction improved phonological awareness and letter knowledge in the language of instruction (Kiswahili), with effect sizes ranging from .60 to .92. Important to note, effects were found for phonological awareness and letter knowledge in English as well (effect sizes = .27–.95). Although a rich line of work has provided correlational evidence about L1–L2 relations in phonological awareness, causal evidence has been sparse. The present study adds to this literature by demonstrating causal evidence of cross-language transfer for multilingual learners in the context of Kenya. These findings together with earlier studies provide support for the central idea of the developmental interdependence hypothesis (Cummins, 1979; see also Jessner, 1999), at least for phonological awareness and letter-sound knowledge.

Beyond the causal effect of training in one language on another language, the present findings also revealed the nature of transfer. Results of path analyses revealed divergent patterns for different outcomes. When phonological awareness was measured by the same task in Kiswahili and English (i.e., a blending task), the intervention effect was completely mediated by performance in Kiswahili (see Figure 1c), providing strong evidence of cross-language transfer effect. When phonological awareness was measured by different tasks in Kiswahili versus English (an oddity task in the former and a detection task in the latter), improvement in the Kiswahili oddity task predicted the English detection task. In addition, there was a direct effect of treatment on the English detection task (Figure 1d), indicating that training in Kiswahili improved overall phonological awareness beyond what was captured in the oddity task in Kiswahili and positively impacted phonological awareness in English.

The present findings also highlight differential nature of cross-language transfer for letter-name knowledge versus letter-sound knowledge. We hypothesized differences between letter-name knowledge and letter-sound knowledge in terms of metalinguistic nature: Letter-sound acquisition involves metalinguistic awareness, whereas letter-name acquisition does not. Although similarity in letter shapes between Kiswahili and English would facilitate acquisition of the shapes, differences in the names of the letters might cause confusion, and thus might result in a negative transfer. The present findings, including path analysis (Figure 1a), supported this speculation as the intervention had a positive effect on Kiswahili letter-name knowledge but had a negative effect on English letter-name knowledge[3] (g = .27).

In contrast to letter-name knowledge, we hypothesized that letter-sound instruction would have a positive effect. This speculation was supported in the positive substantial effect of letter-sound training in Kiswahili on English letter-sound knowledge (g = .62). This finding is also in line with Vaughn et al.'s (2006) study, which provided a multicomponent literacy intervention in Spanish to Spanish–English bilinguals and found a positive effect on letter-sound knowledge in English. Results of the path analysis were also revealing. Intervention in Kiswahili improved Kiswahili letter-sound knowledge, which in turn was positively related to English letter-sound knowledge. In other words, Kiswahili letter-sound knowledge mediated the treatment effect. However, the mediation was partial, not complete such that intervention had a direct, positive causal effect on letter-sound knowledge in

English, indicating that the intervention improved something beyond grapheme-phoneme correspondences for taught graphemes—that is, children's understanding of alphabetic principle. Kiswahili letter-name knowledge also partially mediated the relations between the intervention and English letter-name knowledge. In contrast to the results for letter-sound knowledge, however, intervention had a direct, *negative* causal effect, indicating interference.

An alternative explanation for differential findings for letter-name versus sound knowledge is what we call a similarity/discrepancy account; the differential results are due to similarity or discrepancy of letter names and sounds between Kiswahili and English such that the positive effect for letter-sound knowledge may be attributed to greater similiarity between Kiswahili and English than that of letter names. According to the discrepancy logic, however, as long as there are discrepancies in letter names and sounds between Kiswahili and English, there would be interference, and consequently a negative transfer. This does not fit our present findings very well, as there are certainly discrepancies in letter sounds between Kiswahili and English.[4] Despite the discrepancies in letter sounds between Kiswhili and English, our findings revealed a *positive* causal impact of letter-sound training in Kiswahili on English letter-sound knowledge. Therefore, we believe that the positive effect is better explained by the metalinguistic account: Letter-sound knowledge instruction improves children's alphabet principle, which transfers positively to another language despite discrepancies in letter sounds across languages.

Unlike phonological awareness and letter knowledge, no effects were found in reading skills in either language. The lack of effects in Kiswahili reading outcomes is discrepant from previous training studies with L1 children that reported significant improvement in word reading among beginning readers and at-risk readers (e.g., Bowyer-Crane et al., 2008; Hatcher et al., 2006; Piper et al., 2016). Beyond L1 studies, training in L1 also improved L2 reading skills in Vaugh et al.'s (2006) study. However, there are several important differences between the present study and previous studies in terms of duration of intervention and explicitly targeted skills. Previous studies were conducted over longer durations, ranging from 5 to 24 months (Bowyer-Crane et al., 2008; Hatcher et al., 2006; Piper et al., 2016; Shapiro & Solity, 2008). Vaughn et al.'s study, which found a transfer effect in L2 word reading, had greater intensity with daily 50-min instruction for 8 months. Furthermore, training in the present study primarily focused on phonological awareness and letter knowledge but not on word reading, whereas previous studies included word reading instruction in addition to phonological awareness and letter knowledge. Therefore, 8-week instruction focusing only on phonological awareness and letter knowledge may not have been sufficient to detect significant effects on reading skills even in the language of instruction (Kiswahili), let alone a transfer effect in English reading.

Last, our findings revealed that effects did not vary as a function of Kiswahili and English vocabulary at pretest, language spoken at home, and school absences. The lack of a moderating effect of vocabulary was different from a suggestion from an earlier study, which found differential correlations between L1 vocabulary and L2 phonological awareness as a function of students' L1 vocabulary level (Atwill et al., 2010). However, the results cannot be directly compared, because the present study had an experimental design, whereas Atwill et al.'s (2010) did not. In addition, we did not find a moderating effect of the match between the language spoken at home and the language of instruction at school, or a moderating effect of school absences. Again, our results cannot be compared to previous studies due to a lack of prior evidence, and explanations are not clear, although for absenteeism the null effect found in our study might be due to the fact that we provided absent children with makeup sessions to the extent possible. Overall, our results indicate that with explicit and systematic instruction, effects on phonological awareness and letter knowledge in the language of instruction and on cross-language transfer are consistent across varying levels of students' vocabulary knowledge, match between students' language at home and the language of instruction, and school absences.

Although not the main focus of the present study, it is interesting to note that the correlation between Kiswahili and English vocabularies was moderate (r = .39). This contrasts previously

reported results of no relation or very weak relations between L1 and L2 vocabularies (Bialystok et al., 2005; Goodrich & Lonigan, 2017; Snow & Kim, 2007). This difference is likely due to contextual differences between previous studies and the present study. In many of the previous studies, children acquire L2 in a subtractive context where they are exposed to L1 at home and exclusively to L2 at school, and many children lose their L1 proficiency over time. In Kenya, in contrast, children are exposed to multiple languages (e.g., Kiswahili and English) in various contexts (community and schools) simultaneously across development. Given consistent exposure, then, a positive correlation between vocabularies in different languages is expected because underlying cognitive abilities that contribute to vocabulary learning (e.g., working memory; Gathercole & Baddeley, 1990; Kim, 2017; see also Geva & Ryan, 1993) would contribute to vocabulary acquisition in L1 as well as L2. In fact, magnitudes of correlations similar to those found in our study were reported in previous studies where both L1 and L2 languages were spoken in children's schools and homes, although there were variations across language groups[5] (e.g., Bialystok et al., 2005).

Limitations, future directions, and implications

The current findings should be interpreted with the study design and several limitations in mind. First, generalizability of the findings is limited to populations that are similar to the sample in the study—children learning to read in multiple languages that use alphabetic writing systems, in multilingual, resource-lean, and developing-country contexts. Second, the duration of the intervention may be reexamined in future studies. Although the 8-week intervention totaling 8 hour falls within the range of 5–18 hours of phonological awareness training that was found to yield the largest effects in prior research (NICHD, 2000), it may not have been sufficient to impact the children's *reading* ability in both Kiswahili and English. Therefore, a future study with greater intensity as well as a reading component is needed to explore its effect on reading skills in Kiswahili and cross-language transfer to English. Third, a delayed posttest would have been ideal to examine the stability of the intervention effects. This is particularly relevant to a potential Hawthorne effect because children in the treatment condition with a pull-out small group instruction may have been differentially motivated compared to those in control condition who remained in their classroom. Future studies where children in the control condition receive small-group training not related to the target skills and/or where children are followed up for durability of the transfer effects will be needed. Fourth, the reliability estimate of the Kiswahili receptive vocabulary task was low, and therefore the extent of measurement error might have influenced the current finding of no moderating effect. Finally, a future study replicating the results of letter-knowledge transfer would be highly informative, given the dearth of empirical evidence. In particular, the differential pattern of transfer for letter-name knowledge versus letter-sound knowledge should be further investigated to shed light on the nature of cross-linguistic transfer of letter-name and letter-sound knowledge.

The present positive effects on letter knowledge and phonological awareness add to a large body of evidence that indicates the importance of explicit and systematic instruction in these areas. The causal roles of phonological awareness and letter knowledge on early literacy skills are well established for languages with alphabetic writing systems (e.g., NELP, 2008; National Institute of Child Health and Human Development, 2000; see Kim et al., 2016; Kim, Lee, & Zuilkowski, 2018, for a review of evidence from developing countries). Moreover, the present findings offer practical implications regarding the language of instruction, which is a hotly debated, important policy issue in multilingual contexts such as Kenya. The present findings, along with previous work, indicate that explicit and systematic instruction on essential literacy component skills in the language children are more familiar with (e.g., Kiswahili) would promote their skills in a less familiar language (e.g., English).

In conclusion, the present findings provide causal evidence of cross-language transfer of phonological awareness and letter knowledge in multilingual children, supporting the developmental interdependence hypothesis, and provide important educational implications for literacy instruction in multilingual settings.

Notes

1. The relation between phonological awareness and word reading appears to vary as a function of the characteristics of writing systems (Koda & Reddy, 2008). Between alphabetic languages (e.g., English and Spanish), moderate and significant correlations are reported, whereas weak or negative correlations are apparent between an alphabetic language (English) and nonalphabetic language (e.g., Chinese; Bialystok et al., 2005; Wang, Park, & Lee, 2006; Wang, Yang, & Cheng, 2009). These findings suggest that L1 phonological awareness more strongly influences L2 word reading in languages with similar orthographic characteristics (e.g., alphabetic writing systems) than in languages with different orthographic characteristics.
2. Given that children were also nested with small groups in the treatment conditions, ICCs attributable to small-group nesting were estimated as follows: .08 for Kiswahili letter-name knowledge, 0 for Kiswahili letter-sound knowledge, 0 for Kiswahili Oddity task, .05 Kiswahili Blending task, .13 for English letter-name knowledge, 0 for English letter-sound knowledge, .08 for English Detection task, and .06 for English Blending task.
3. The weak but positive correlations between letter-name knowledge in Kiswahili and in English ($.18 \leq rs \leq .24$; see Tables 3 and 4) are not at odds with the negative result in Table 5 because the results in Table 5 accounted for differences in covariates, which included pretest scores.
4. In Bialystok et al.'s (2005) study, correlations were varied across language groups: .07 for Hebrew–English bilingual children, .19 for Spanish–English bilinguals, and .33 for Chinese–English bilinguals. It is notable that the magnitudes for the latter two groups are positive and range from small to moderate. All these were not statistically significant in the Bialystok's study, but this is likely due to the small sample sizes ($29 \leq ns \leq 33$).
5. For example, several digraphs in Kiswahili do not correspond to those in English (*dh* for /ð/). Discrepancies are particularly large for vowel letters, for which Kiswahili letters represent a single sound consistently, whereas English vowel letters represent multiple sounds (even the predominant sounds English vowel letters represent are different from the sound in Kiswahli; e.g., /æ/ and /e/ in English for letter *a*, which represents /a/ in Kiswahili).

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Appendix

English measures

Letter-name knowledge: The procedure for this task was similar to the Kiswahili letter knowledge task except that children were presented with a set of 100 randomly presented letters in English and asked to name the letters in English.

Letter-sound knowledge: The same stimuli for letter-name knowledge was used and children were asked to provide letter sounds in English.

Phonological awareness: In the phoneme detection task, the assessor read the target word twice and then asked the child to identify the first sound in the word (two practice items and 10 test items). The task was discontinued if a child responded incorrectly or did not respond at all to the first five items. The blending task was the same as that in Kiswahili but with English words and had three practice items and 15 test items.

Word reading: The procedure was the same as that for the Kiswahili word reading task, but stimuli were English single-syllable words.

Nonword reading: The procedure for this task was the same as that for the nonword reading task in Kiswahili, but words followed English orthotactic patterns. All words were monosyllabic words.

Text/oral reading fluency: Children were asked to read aloud a passage of 69 words in 1 min. The subtest was discontinued if a child could not read any words on the first line correctly. A child's score was based on the number of correct words read in 1 min.