Cross-linguistic transfer of oral language, decoding, phonological awareness and reading comprehension: a meta-analysis of the correlational evidence

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We present a meta-analysis of cross-linguistic transfer of oral language (vocabulary and listening comprehension), phonology (decoding and phonological awareness) and reading comprehension. Our findings show a small meta-correlation between first (L1) and second (L2) oral language and a moderate to large correlation between L1 and L2 phonological awareness and decoding. This is interpreted in terms of the complexity of oral language compared with phonological awareness and decoding, where the limited number of letter–sound combinations are easier to learn. There were also large variations in the L1–L2 correlations for all language domains. The variation of decoding was moderated by writing system and instructional language. Further, the meta-correlation between L1 decoding and L2 reading comprehension was small to moderate, and decreased reliably with age, while the correlation between L1 oral language and L2 reading comprehension was close to 0. Overall, we argue that the results can be explained from both interdependence and contrastive perspectives.

A large number of children start their educational careers facing the challenge of having to master two languages. The role of the first language (L1) in second language (L2) learning and literacy skills has therefore attracted a prevailing interest from both practitioners and researchers, and this has resulted in a number of studies that have addressed questions related to cross-linguistic transfer. Theoretically, understanding cross-linguistic influence will help us to grasp the nature of bilingualism and how learning two (or more) languages deviates from learning only one. Practically, it can enable us to design successful educational interventions that might help bilingual children. However, there is disagreement in the literature on the magnitude of cross-linguistic transfer. Both the literature that examines cross-linguistic transfer of oral language skills (aspects related to language comprehension) and that which examines cross-linguistic transfer of phonology (code-related skills such as phonological awareness and decoding) shows large variations in results between studies (e.g. Goetry, Wade-Woolley, Kolinsky & Mousty, 2006; LaFrance & Gottardo, 2005; Proctor et al.,

2006; Swanson, Rosston, Gerber & Solari, 2008). Because the variation between studies is large, a meta-analysis is needed both to examine the overall strength of the relationships and to examine moderator variables that may explain variation in the relationships between studies.

Two abiding frameworks are prominent in a modern understanding of cross-linguistic transfer (Genesee, Geva, Dressler & Kamil, 2006): linguistic interdependence (Coady, 1997; Cummins, 1979; Diaz & Klingler, 1991; Verhoeven, 1994) and contrastive analysis (Connor, 1996; Ellis, 1994; Lado, 1957; Odlin, 1989). With regards to linguistic interdependence, a main claim is that the L1 and L2 are interdependent and rests on a common underlying proficiency, which refers to a mutual central processing system from which both languages operate (Cummins, 1991). Development of the L1 can therefore affect and facilitate development of the L2 (Cummins, 1979). It is not entirely clear what this common underlying language proficiency actually is (e.g. Edelsky et al., 1983; Genesee, Lindholm-Leary, Saunders & Christian, 2006; MacSwan & Rolstad, 2005), but in line with both Genesee et al. (2006) and MacSwan and Rolstad (2005) we interpret the common underlying proficiency to mean language proficiency, thereby distinguishing it both from other knowledge systems and from underlying cognitive abilities.

Likewise, in contrastive analysis the focus is also on commonalities between L1 and L2, but in this case the emphasis is on structural similarities between languages. Within this perspective, the L1 and L2 are analysed with the purpose of identifying structural (e.g. phonology, syntax, semantic) similarities and differences (Odlin, 1989), which can either facilitate or impede the acquisition of the L2. Structural differences might lead to errors in the L2, because of erroneous inferences from the L1. Structural similarities might lead to an easier acquisition of L2 because the learner may recognise features (e.g. phonological forms, cognates) that are common for both languages. Consequentially, it should be easier to learn an L2 that is close to the L1 than a language that is distant and has a very different structure (Connor, 1996; Odlin, 1989). Thus, the amount of structural abilities should moderate the degree of transfer between L1 and L2.

Reading researchers commonly classify the different domains of language and literacy into oral language (aspects related to language comprehension) and phonology (code-related skills such as phonological awareness and decoding) (e.g. Hoover & Gough, 1990). There has been little discussion, however, about the important differences between these domains, and how these aspects might lead to different degrees of transfer between L1 and L2. Oral language is a complex domain with a number of subskills: it has been estimated that an average 15-year-old knows the meaning of about 13,000 words (Zechmeister, Chronis, Cull, D'Anna & Healy, 1995). As pointed out by Proctor, Carlo, August and Snow (2006), attaining this level of competence is a complex and multi-determined task, which may complicate transfer across languages. In comparison, phonological awareness and decoding are simple (lower-order) aspects of linguistic competence that involve learning a very limited number of sounds and letter–sound combinations, for which general strategies can be more effectively taught. Thus, oral language and phonology are not equally complex tasks, which has consequences for the amount of explicit instruction required in attaining each of these skills. Based on this line of argument, we hypothesise that the magnitude of cross-linguistic transfer is moderated by the domain of language examined. Thus, due to the complexity of the oral language domain, we predict that transfer in this domain will demonstrate lower correlations than studies of transfer in the less complex and more instructionally dependent domain of decoding/phonological awareness.

Following the interdependence hypothesis, we expect that socioeconomic status (SES) should moderate the effect sizes between studies within both oral language and phonology. This hypothesis suggests that both L1 and L2 are to a larger degree dependent on a common underlying language proficiency in cases where the child has already attained an academic L1 before intensive exposure of the L2 starts (e.g. at school). As this is more likely to be the case for children from middle and high SES backgrounds, which are both found to value and use this kind of language before the child starts school (Cummins, 1979), we should expect transfer to be larger in samples from middle/high SES than in samples from low SES backgrounds (Cummins, 2004). Following the same hypotheses, we should expect children who are given instruction in both languages (L1 and L2) at school to be more likely to develop an academic decontextual language for L1 and L2 in parallel and thereby develop a common underlying language proficiency that can serve as a source of transfer between the languages.

The idea that instruction in both languages can facilitate transfer, and thereby moderate the differences in effect size between samples, can also be said to be entertained by the contrastive hypothesis. More recent research within this framework has suggested that the mere existence of similar language structures is not necessarily enough to promote transfer between L1 and L2, but that the child also has to be aware of the similarities and to believe that the languages are similar in certain aspects (Genesee et al., 2006). It is reasonable to think that this awareness is both more common and easier to accomplish in a direct instructional setting. Within this framework, we should also expect transfer to be more common in samples where the L1 and L2 share many cognates and are close in origin (e.g. Indo-European languages) than in samples where the L1 and L2 are more distant. Likewise, the transfer between decoding and phonological awareness skills should be more common between alphabetic languages than between alphabetic and ideographic languages because alphabetic languages share a constituent knowledge in learning to read – the alphabetic principle.

Finally, on the matter of reading comprehension the predictions are more complex: as reading comprehension is often seen as product of oral language and decoding skills (Hoover & Gough, 1990), we expect that the moderators described above, for oral language and decoding skills, will also be important for reading comprehension. However, inherent in the product term of this 'simple view' of reading (Hoover & Gough, 1990) is the idea that the relative contribution of oral language and decoding skills will change over the developmental course. When the child is learning to read decoding will play a main role in reading comprehension, while later, when decoding skills are mastered at a certain level, the importance of oral language will gradually increase (Lervåg & Aukrust, 2010). Thus, we expect the impact of L1 decoding and oral language skills to change together with the age of the children: decoding skills in L1 should explain more variance in L2 reading comprehension in younger samples than in older samples. Likewise, oral language skills in L1 should explain less variance in younger samples than in older samples. Still, these predictions will only hold to the degree that there actually is transfer between L1 and L2 in these to domains of language. As we have hypothesised, if it is the case that transfer is stronger within the area of decoding than within the area of oral language skills, we expect stronger transfer from L1 decoding to L2 reading comprehension than from L1 oral language to L2 reading comprehension.

To summarise, the study seeks to empirically review the correlational findings of transfer between L1 and L2 skills within oral language, phonology and reading

comprehension skills. We anticipate that there is weaker transfer in complex language domains (i.e. oral language) than in simpler language domains (i.e. skills related to phonology). We further hypothesise, in accordance with the theoretical frameworks of interdependence (Cummins, 1979) and contrast (Odlin, 1989), that the variations found between samples will be moderated by SES, language of instruction at school and the closeness of the languages involved. Further, we expect the transfer from L1 oral language and decoding skills to L2 reading comprehension to follow the pattern found in these domains.

Method

Inclusion criteria, literature search and study coding

The inclusion, search and coding procedure are detailed in Figure 1. When selecting studies 'L2 learners' were operationally defined as children/youths that either use or study two languages, and are exposed to each language either regularly at home with at least one parent, or in school for at least 4 h/day. For the target constructs examined in the study (i.e. oral language, phonological awareness, decoding and reading comprehension), operational criteria were established to determine indicators that represented them. Thus, in order to be considered as a measure of phonological awareness, the task must involve manipulation, generation or judgement of phoneme, onset, rhymes and/or syllables in words. To be termed a decoding measure, the test should comprise reading fluency and/or reading accuracy of words, nonwords, sentence decoding or passage decoding. Finally, oral language measures encompass tests that aim to measure receptive vocabulary by the means of pictures, expressive vocabulary (e.g. by the means of word definition tasks) or listening comprehension (e.g. oral cloze). Our reasoning for using this broad oral language construct that also comprised listening comprehension was to increase the power of the meta-analysis. Treating vocabulary and listening comprehension as one construct is also supported in a latent variable study by Lervåg (2010) which showed that after taking measurement errors into account, listening comprehension was highly related to expressive and receptive vocabulary (in 7-year-olds), and they all loaded on the same factor. For reading comprehension, studies that comprised measures where a child read a passage or sentence, and in turn answered questions in relation to the text, were included.

A search of abstracts were conducted in the computerised databases for publications in English from 1975 to 19 May 2009 with the descriptors bilingual[*] (truncation), L1 learners, L2 learners, English language learners, English L2, English additional language, language minority, limited English proficient, limited English speaking and multilingual[*] paired with phon[*] awareness, vocabulary, oral language, reading and decoding. Abstracts for peer-reviewed studies, non-peer-reviewed studies, book chapters, dissertations, conference proceedings and reports were all examined. The final sample of studies was based on correlations between L1 and L2 in L2 learners reported in 47 studies, with 52 different samples, comprising a total of 4,413 L2 learners.

In order to prevent violation of independence of observations (i.e. including data from the same sample more than once), studies by the same author were examined in order to detect duplicate samples. For longitudinal studies, the first time point was coded where possible. The possibility of coding longitudinal correlations was also considered, but there were too few comparable longitudinal studies for a meta-analysis on longitudinal
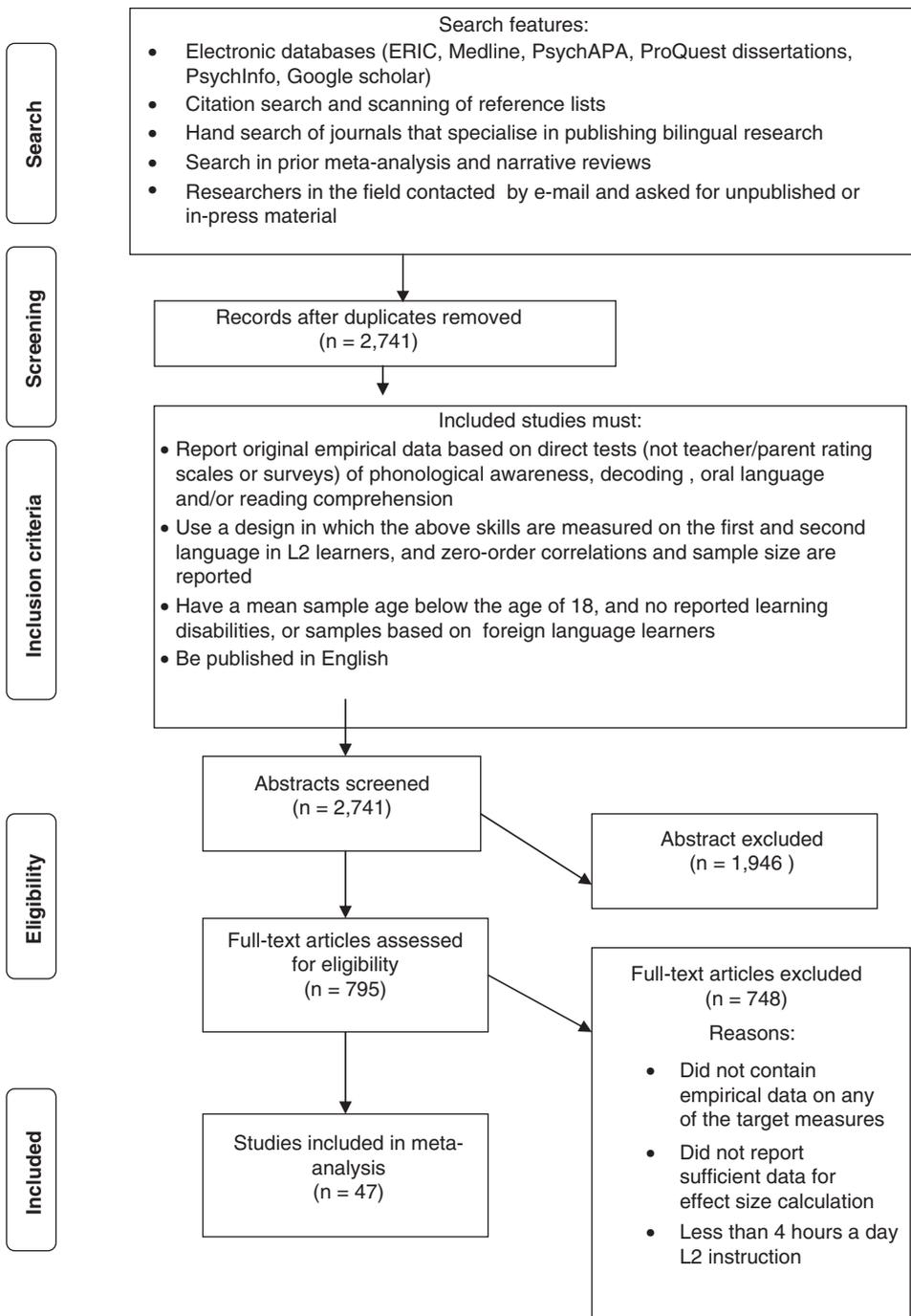
Figure 1. Flow diagram for the search and inclusion of studies (adapted from www.prisma-statement.org).

correlations. For experimental studies, only pre-test data were coded. Because some studies report multiple measures for each of the target constructs (i.e. oral language, phonological awareness, decoding and reading comprehension), a set of rules as to which indicator type that was to be coded were established. For phonological awareness, phoneme-based measures were coded before other types of phonological awareness measures, such as awareness for larger units (i.e. rhymes or syllables) or composite scores because a large number of studies have demonstrated that in late preschool and school age children, phoneme awareness is more highly correlated with decoding than awareness of larger units (MacMillan, 2002). If a study reported several phoneme-based measures, phoneme deletion was the chosen option, as studies have shown that this is a highly reliable measure (e.g. Muter, Hulme, Snowling & Stevenson, 2004). For decoding, real-word reading was coded before nonword reading, and single-word decoding was coded before passage reading. For oral language, picture vocabulary tests were coded before other measure types, because picture vocabulary tests (e.g. PPVT) in many studies have shown high reliability (e.g. Lervåg & Aukrust, 2010). For reading comprehension, individual tests were coded before group tests, and open-ended tests were coded before multiple-choice-based tests.

All studies were coded twice and intercoder reliability was estimated for a random sample of 30% of the studies by trained coders. Intercoder correlation (Pearson's) for the correlational outcomes was $r = .99$ and agreement rate is 96%, intercoder correlation for continuous moderator variables $r = .99$ and agreement rate is 97% and Cohen's κ for categorical moderator variables $\kappa = .93$. Disagreements were resolved by discussion or by consulting the original paper.

Moderator variables

We conducted a broad coding of a large number of moderators that could potentially be important to explain variation between studies. When fewer than five studies reported data on a moderator, the variable was excluded from the analysis. In addition to the moderators used in the analysis (listed below), decoding measure (fluency/accuracy), phonological awareness measure (rhyme or phoneme based), reading comprehension measure, nonverbal IQ, age of L2 acquisition, length of residence in the host country for children and parents, parental L2 fluency and motivational aspects were coded as moderator variables. The impact from these variables could not be analysed, because too few studies (less than five) reported data on these variables or on categories of these variables. Also, mean and standard deviation of oral language skills in L1 and mean and standard deviation for oral language skills L2 were coded as moderators. Because of uncertainty and lack of information in the original papers about whether the L1 and L2 tests were on psychometrically comparable scales, however, this was not used in the analysis.

Age. Mean ages of the L2 learners were coded. For studies that reported age range within a year, median years were coded. Studies that reported information about larger age range than 1 year or grade were excluded from the moderator analysis.

Language differences. Differences between languages were coded in two categories, Indo-European L1 and L2 and non-Indo-European L1/Indo-European L2.

Writing system. Whether L1 was based on an alphabetic or idiographic writing system was coded.

Instructional language. The language of instruction was coded in two categories: L2 or both.

Home language. Home language was coded in two categories: L1 only and both.

Socioeconomic status. Information on samples' socioeconomic status was separated in two categories: high/middle and low.

Oral language measure. Tests were separated in three categories: tests measuring listening comprehension, expressive–receptive vocabulary and receptive vocabulary.

Meta-analytic procedures

The computer programme 'comprehensive meta-analysis' (Borenstein, Hedges, Higgins & Rothstein, 2005) was used for the majority of the analysis. Correlations between the main target constructs (i.e. oral language, phonological awareness, decoding and reading comprehension) and the indicators for each of these constructs, mean and standard deviation oral language L1, mean and standard deviation oral language L2; age, socioeconomic status, language L1 and language L2, nonverbal IQ standardised mean; age of L2 acquisition, child and parental length of residence in the host country; parental L2 fluency as well as information about motivation for reading, home language and instructional language were coded from the studies, and entered into a predefined data sheet in the computer programme.

The effect sizes for the studies were displayed by the correlation coefficient Pearson's *r*. A 95% confidence interval (CI) was calculated for each effect size, to examine whether the correlation was different from zero. This means that if the CI did not surpass zero, the correlation was statistically significant. The overall correlation was estimated by calculating a weighted average of the correlations from each study. We used a random-effects model, which rests on the assumption that variation between studies can be systematic, and not only due to random error. Whether the overall correlation differed from zero was tested with a *z* test. A sensitivity analysis was conducted to examine the impact on the overall range of correlation when outliers were removed.

In order to examine whether the variation in correlations between studies was significant, the *Q* test of homogeneity was used (Hedges & Olkin, 1985). A significant value on this test indicates a reliable variability between the correlations in the sample of studies. I^2 was used in order to determine the magnitude of heterogeneity. I^2 is the proportion of total variation between the correlations that is caused by real heterogeneity rather than chance.

The difference in cross-linguistic correlation magnitude between the two language domains was tested for significance. In some cases, a study contained information about cross-linguistic correlations for more than one of the outcome correlations. Including more than one pair-wise correlation from the same sample in one analysis will violate the notion of independence. Therefore, in these cases the dependent samples were excluded from the analysis.

A meta-regression based on method of moments for random-effects models were used to predict study outcome from the moderator variables. In order to determine the strength

of the predictors on study outcome, percentage proportion of between-study variance explained, R^2 was used as an effect size. All computations of the meta-regression were carried out by macros developed for SPSS (Lipsey & Wilson, 2001; Wilson, 2006). For the categorical moderator variables, the studies were separated in subsets based on the categories of the moderator variable. The degree of differences between the subsets of studies was significance tested by a Q test, and by comparing the correlation magnitude with CIs between the study subsets.

A funnel plot for random-effects models was used to determine the presence of retrieval bias. In the funnel plot sample size is plotted on the y axis and effect size on the x axis. In the absence of retrieval bias, this plot should be expected to form an inverted funnel. In the presence of bias, the funnel will be asymmetric. In order to detect retrieval bias, funnel plots are examined for all analyses presented. The 'trim and fill' for random-effects models (Duval & Tweedie, 2000) was used in order to examine the impact from possible missing studies. The trim and fill method imputes values in the funnel plot to make it symmetrical and calculate an estimated overall effect size on this basis.

Results

Characteristics for each study included in the meta-analysis are presented in the supporting information Appendix S1. Only four of the studies examined transfer to an L2 other than English. As these studies examined different constructs the English–non-English distinction could not be used as a moderator.

Correlations between L1 and L2 oral language

Thirty-six independent correlations comprising 2,755 children (mean sample size = 74.45, $SD = 72.98$, range 19–453) examined the relationship between L1 and L2 oral language. The age of the samples ranged from 4:1 to 13:6 years. As apparent from Figure 2, the overall mean correlation was small, $r = .16$, 95% CI [.07, .24] but significant $z(35) = 3.47$, $p < .01$. The variation in correlations between studies was significant and large, $Q(36) = 171.59$, $p < .01$, $I^2 = 79.02$. A sensitivity analysis showed that after removing outliers, the overall correlation ranged between $r = .13$, 95% CI [.05, .22] and $r = .17$, 95% CI [.09, –.25]. The funnel plot indicated that publication bias did not affect the results.

As shown in Table 1, no moderators could reliably explain variation in correlation magnitude. Age had no significant impact on correlation size, $\beta = -0.21$, $p = .32$, $k = 25$, $R^2 = 0.04$. This means that the correlation between L1 and L2 oral language was stable across age range (here 4:1 to 10:8 years).

Correlations between L1 and L2 decoding

A total of 22 independent correlations comprising 2,013 children (mean sample size = 91.50, $SD = 95.27$, range 27–453) examined the relationship between L1 and L2 decoding. The age of the samples ranged from 5:6 to 14 years. As shown in Figure 3, the overall mean correlation was large, $r = .54$, 95% CI [.41, .65] and significant $z(21) = 7.03$, $p < .01$. There was a significant and large variation in correlations between studies $Q(21) = 274.26$, $p < .01$, $I^2 = 92.34$. After removing outliers by using sensitivity analysis, the overall correlation range was $r = .51$, 95% CI [.38, .62] to $r = .58$, 95% CI [.48, .67]. The funnel plot indicated that studies were missing to the left of the mean
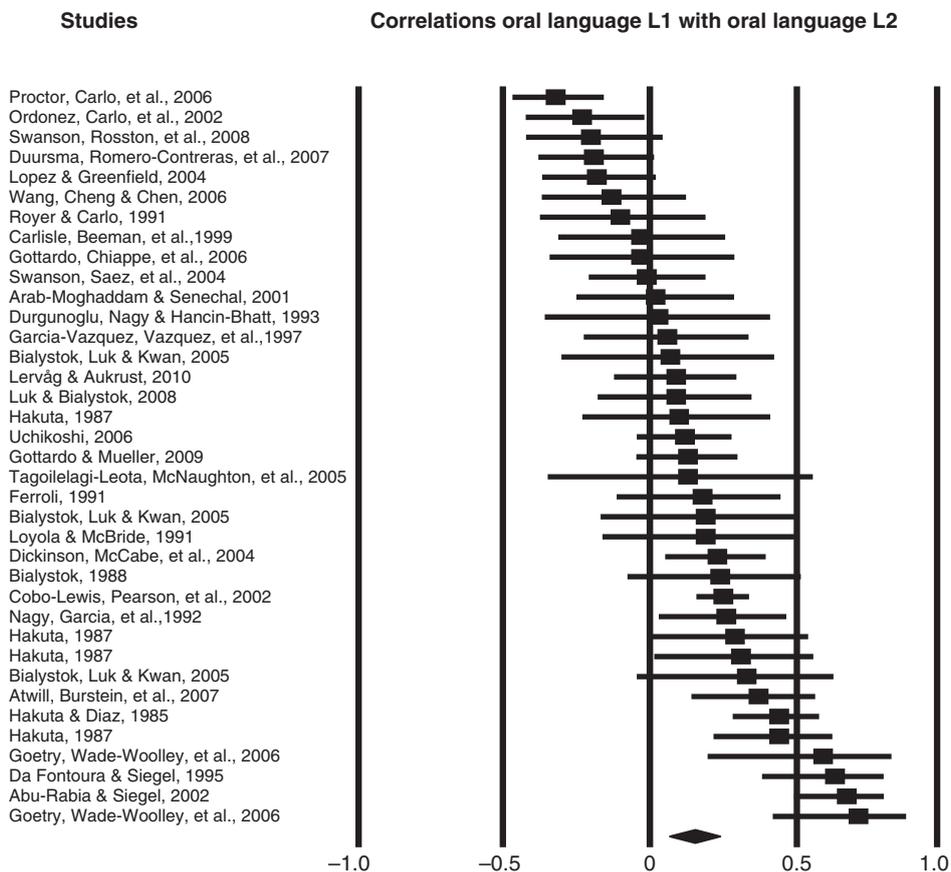
Studies   **Correlations oral language L1 with oral language L2**

Figure 2. Overall average correlation (displayed by ◆) and correlation with confidence interval for each study correlating first language (L1) and second language (L2) oral language.

(i.e. studies with correlations below the overall mean). In a 'trim and fill' analysis two studies were added, and the adjusted overall correlation was then $r = .49$, 95% CI [.34, .62].

The difference between correlation magnitude L1–L2 decoding and L1–L2 oral language was significant, $Q(1) = 20.74$, $p < .0001$. Table 2 shows that instructional language was a significant moderator variable, and studies with samples that were taught on both L1 and L2 demonstrate higher correlations between L1 and L2 decoding than samples with L2 as the only instructional language. This was also the case for writing system, in which samples with an alphabetic L1 demonstrate reliably higher correlations between L1 and L2 decoding than for children with an ideographic L1. It should be noted that all studies with an alphabetical L1 except one were based on English. Age had no significant impact on correlation size, $\beta = -0.16$, $p = .57$, $k = 15$, $R^2 = 0.03$ (age range 5:6 to 10:1 years).

Correlations between phonological awareness L1–decoding L2

A total of 14 independent correlations comprising 1,079 children (mean sample size = 77.07, $SD = 55.63$, range 27–227) examined the relationship between phonological awareness L1 and decoding L2. The age of the samples ranged from 4:10 to 14

Table 1. Number of correlations, correlation size, 95% confidence interval (CI), heterogeneity statistics, difference in r between categories and significance test of categories for moderators of the relationship between first language (L1) and second language (L2) oral language.

Moderator variable	Number of correlations (k)	Correlation (r)	95% CI	Heterogeneity (I^2)	Difference in r (highest−lowest category)	Significance test of difference $(Q$ test$)$
Socioeconomic status						
Low	21	.16**	.04–.28	84.02**		
High/middle	3	.07	− .10–.24	0.00	.09	.40
Instructional language						
Both L2 and L1	12	.11	− .06–.28	83.12**		
L2	16	.23**	.08–.37	77.39**	.12	.32
Oral language test type						
Listening comprehension	4	.34	− .13–.69	90.35**		
Composite expressive and receptive vocabulary	3	− .01	− .25–.22	53.09		
Receptive vocabulary	28	.15**	.05–.24	77.68**	.35	.32
Language type						
Indo-European L1 and L2	29	.15**	.05 –.24	80.08**		
Non-Indo-European L1/ Indo-European L2	8	.17	− .05–.38	77.21**	.02	.87

Note: I^2 = the proportion of total variation between the effect sizes that are caused by real heterogeneity rather than chance; r = correlation size (Pearson's r) for subsets of studies belonging to different categories of the moderator variable.
**$p < .01$.

years. As apparent in Figure 4, the overall mean correlation was moderate, $r = .44$, 95% CI [.27, .59] and significant, $z(13) = 4.68$, $p < .01$. The variation in correlations between studies was significant and large, $Q(13) = 128.08$, $p < .01$, $I^2 = 89.85$. After removing outliers by sensitivity analysis, the overall correlation range was $r = .39$, 95% CI [.25, .51] to $r = .48$, 95% CI [.33, .61]. The funnel plot indicated that studies were missing to the right of the mean (i.e. studies with correlations above the overall mean). In a 'trim and fill' analysis two studies were added, and the adjusted overall correlation was then $r = .50$, 95% CI [.34, .64].

The difference in correlation magnitude between phonological awareness L1–decoding L2 and L1–L2 oral language was significant, $Q(1) = 5.90$, $p < .01$, while the difference between decoding L1–L2 and phonological awareness L1–decoding L2 was not significant, $Q(1) = 1.95$, $p = .16$. As apparent from Table 3, no moderator had a reliable impact on correlation magnitude. Also, age had no significant impact on correlation size, $\beta = − 0.28$, $p = .40$, $k = 11$, $R^2 = 0.07$ (age range 4:10 to 10:0 years).

Correlations between L1 and L2 phonological awareness

A total of 16 independent correlations comprising 1,340 children (mean sample size = 83.75, SD = 46.67, range 30–219) examined the relationship between phonological
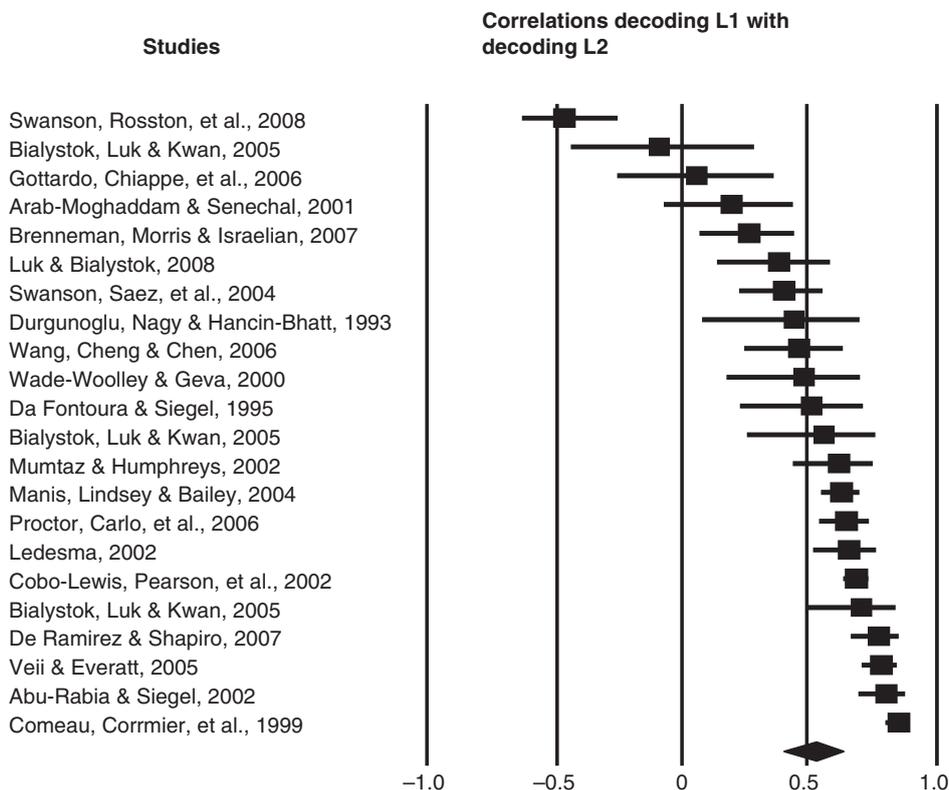
Correlations decoding L1 with decoding L2

Studies

Figure 3. Overall average correlation (displayed by ◆) and correlation with confidence interval for each study correlating first language (L1) and second language (L2) decoding.

awareness L1 and phonological awareness L2. The age of the samples ranged from 4:1 to 14 years. As shown in Figure 5, the overall correlation was large, $r = .60$, 95% CI [.49, .69] and significant, $z(15) = 8.50$, $p < .01$. The variation in correlations between studies was significant and large, $Q(16) = 134.32$, $p < .001$, $I^2 = 88.09$. After removing outliers by sensitivity analysis, the overall correlation was within the range of $r = .57$, 95% CI [.48, .64] and $r = .62$, 95% CI [.51, .71]. The funnel plot showed studies missing to the right of the mean (i.e. studies with correlations above mean). A trim and fill analysis filled in two studies and the adjusted overall mean correlation was then $r = .63$, 95% CI [.53, .72].

Difference in correlation magnitude between phonological awareness L1–L2 and oral language L1–L2 was significant, $Q(1) = 28.48$, $p < .0001$, while there were no differences in correlation magnitude between any of the correlations within the domain of phonology, $Q(2) = 2.53$, $p = .28$. As apparent from Table 4, no moderators had a reliable impact on the correlation between L1 and L2 phonological awareness. Also, age had no significant impact on effect size, $\beta = 0.01$, $p = .96$, $k = 14$, $R^2 = 0.00$ (age range 4:1 to 10:0 years).

Correlations between decoding L1–L2 and oral language L1–L2 with reading comprehension L2

Six independent correlations comprising 1,067 children (mean sample size = 177.83, $SD = 151.41$, range 96–453) examined the correlation between decoding L1 and reading

Table 2. Number of correlations, correlation size, 95% confidence interval (CI), heterogeneity statistics, difference in r between categories and significance test of categories for moderators of the relationship between first language (L1) and second language (L2) decoding.

Moderator variable	Number of correlations (k)	Correlation (r)	95% CI	Heterogeneity (I^2)	Difference in r (highest–lowest category)	Significance test of difference (Q test)
Socioeconomic status						
Low	8	.54**	.27–.73	94.34**		
High/middle	4	.39**	.05–.65	84.31**	.15	.45
Instructional language						
Both L2 and L1	8	.65**	.55–.73	72.65**		
L2	11	.37**	.11–.58	91.67**	.28	.02*
Writing system L1						
Alphabetic	17	.58**	.44–.69	92.86**		
Ideographic	4	.24	−.02–.48	68.28*	.34	.01**

Note: I^2 = the proportion of total variation between the effect sizes that are caused by real heterogeneity rather than chance; r = correlation size (Pearson's r) for subsets of studies belonging to different categories of the moderator variable.
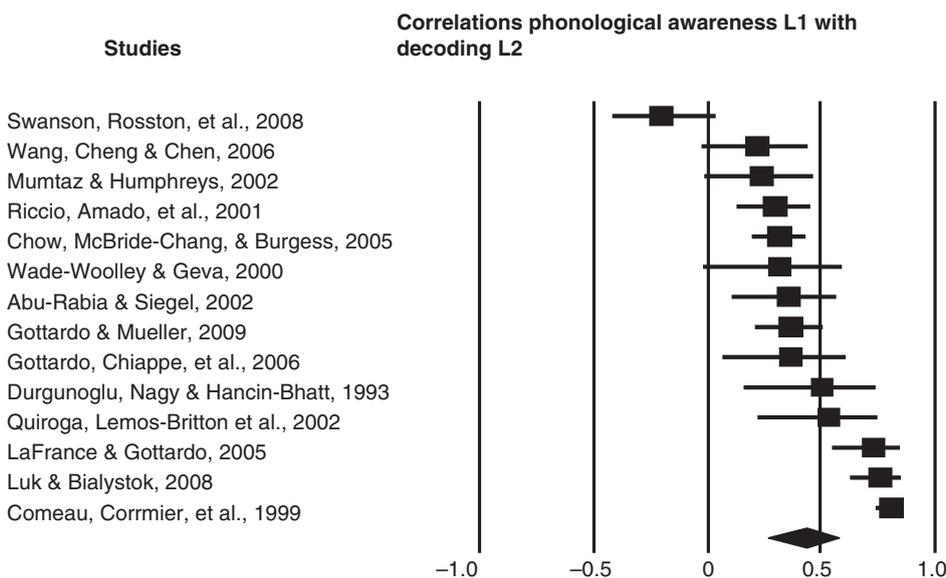*$p < .05$; **$p < .01$.

Figure 4. Overall average correlation (displayed by ◆) and correlation with confidence interval for each study correlating phonological awareness first language (L1) with decoding second language (L2).

comprehension L2. The age of the samples ranged from 5:6 to 10:1 years. The overall mean effect size was $r = .24$, 95% CI [.05, .41] and this was significant, $z(5) = 2.47$, $p = .01$. The variation in correlations between studies was significant and large, $Q(5) = 42.89$, $p < .01$, $I^2 = 88.34$. After removing outliers by sensitivity analysis, the overall correlation was within the range of $r = .18$, 95% CI [−.06, .40] to $r = .31$, 95% CI [.15, .45]. The funnel plot indicated that studies were missing to the right of mean

Table 3. Number of correlations, correlation size, 95% confidence interval (CI), heterogeneity statistics, difference in *r* between categories and significance test of categories for moderators of the relationship between phonological awareness first language (L1) and decoding second language (L2).

Moderator variable	Number of correlations (k)	Correlation (r)	95% CI	Heterogeneity (I^2)	Difference in r (highest–lowest category)	Significance test of difference (Q test)
Socioeconomic status						
Low	4	.26	− .06–.53	84.68[**]		
High/middle	3	.35[**]	.12–.54	0.00	.09	.64
Instructional language						
Both L2 and L1	3	.31[**]	.14–.47	0.00		
L2	7	.46[**]	.18–.67	89.46[**]	.15	.34
Writing system L1						
Alphabetic	10	.44[**]	.20–.63	91.30[**]		
Ideographic	4	.45[**]	.16–.67	87.29[**]	.01	.94

Note: I^2 = the proportion of total variation between the effect sizes that are caused by real heterogeneity rather than chance; r = correlation size (Pearsons r) for subsets of studies belonging to different categories of the moderator variable.
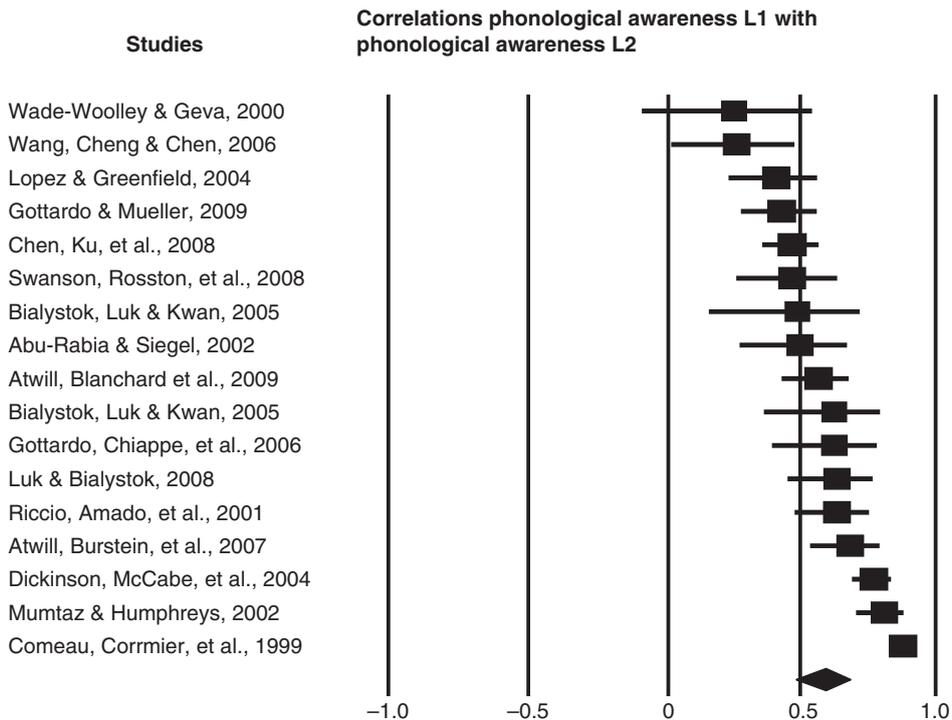[**]$p < .01$.

Figure 5. Overall average correlation (displayed by ◆) and correlation with confidence interval for each study correlating first language (L1) and second language (L2) phonological awareness.

Table 4. Number of correlations, correlation, 95% confidence interval, heterogeneity statistics, difference in r between categories and significance test of categories for moderators of the relationship between first language (L1) and second language (L2) phonological awareness.

Moderator variable	Number of correlations (k)	Correlation (r)	95% CI	Heterogeneity (I^2)	Difference in r (highest–lowest category)	Significance test of difference (Q test)
Instructional language						
Both L2 and L1	4	.43**	.19–.62	69.77	.08	.45
L2	8	.51**	.46–.56	0.00		
Home language						
L1 exclusively	5	.61**	.52–.68	0.00	.01	.89
Home language not reported	10	.62**	.46–.74	92.40		
Writing system L1						
Alphabetic	13	.62**	.49–.73	89.10**	.12	.22
Ideographic	4	.50**	.34–.64	65.90**		

Note: I^2 = the proportion of total variation between the effect sizes that are caused by real heterogeneity rather than chance; r = correlation size (Pearsons r) for subsets of studies belonging to different categories of the moderator variable.
**$p < .01$.

(i.e. studies with correlations above overall mean). In a trim and fill analysis, one study was added and the adjusted correlation was $r = .30$, 95% CI [.12, .47]. Further, age had significant impact on effect size, $\beta = -0.68$, $p < .05$, $k = 6$, $R^2 = 0.47$. This means that the correlation between L1 decoding and reading comprehension L2 decreases as children get older (age range 5:6 to 10:1 years).

In order to examine the relationship between decoding skills and L2 reading comprehension in relation to the simple view of reading, the correlation between L2 decoding and L2 reading comprehension was also examined. Six of the studies examined this relationship ($N = 882$, mean sample size = 147.0, $SD = 152.21$, range 64–453, age range 5:6 to 10:1 years). The overall mean correlation was large, $r = .54$, 95% CI [.32, .70] and significant $z(5) = 4.41$, $p < .001$. The variation in correlations between studies was significant and large $Q(5) = 58.30$, $p < .001$, $I^2 = 92.17$. After removing outliers by sensitivity analysis, the overall correlation range was $r = .45$, 95% CI [.23, .63] to $r = .59$, 95% CI [.39, .74]. The funnel plot did not indicate any publication bias. Further, age had significant impact on effect size, $\beta = -0.95$, $p < .01$, $k = 6$, $R^2 = 0.90$., that is, correlation between decoding L2 and reading comprehension L2 decreases as children get older.

Eight independent correlations comprising 1,039 children (mean sample size = 129.87, $SD = 134.84$, range 49–453, age range 6:6 to 6. grade) examined the correlation between oral language L1 and L2 reading comprehension. The overall mean correlation was very small, $r = .04$, 95% CI [$-.10, .17$] and not significant $z(7) = 0.55$, $p = .58$. The variation between studies was significant and large, $Q(7) = 26.35$, $p < .01$, $I^2 = 73.44$. After removing outliers by sensitivity analysis, the overall correlation range was $r = .00$, 95% CI [$-.12, .13$] to $r = .07$, 95% CI [$-.07, .20$]. The funnel plot did not indicate any publication bias. Further, age did not have significant impact on correlation size, $\beta = -0.48$, $p = .40$, $k = 5$, $R^2 = 0.22$.

The same eight studies also examined the relationship between oral language L2 and reading comprehension L2. The overall mean correlation was moderate to large, $r = .46$, 95% CI [.33, .57] and significant $z(7) = 6.25$, $p < .001$. The variation in correlations between studies was significant and large, $Q(7) = 35.44$, $p < .001$, $I^2 = 80.25$. After removing outliers by a sensitivity analysis, the overall correlation was within the range of $r = .41$, 95% CI [.33, .48] to $r = .49$, 95% CI [.36, .60]. The funnel plot did not indicate any publication bias. Age had significant impact on correlation magnitude, $\beta = 0.96$, $p < .01$, $k = 5$, $R^2 = 0.92$, that is, correlation between oral language L2 and reading comprehension L2 increases as children get older. Unfortunately, the number of studies was too small to analyse the impact from decoding and oral language on reading comprehension L2 simultaneously. This was also true for L1 and L2 reading comprehension.

Discussion

This systematic review has revealed several interesting findings about cross-linguistic transfer from L1 to L2 in the domains of oral language and phonology. First, there was a small, but reliable, overall correlation between L1 and L2 oral language skills. In contrast, the comparable overall correlations for the less complex language domain of phonology were reliably larger and in the moderate to large range. Second, there were large variations between studies in correlation magnitude for both language domains. For oral language, however, no moderator variables were reliably able to explain variation in correlation magnitude between studies. For decoding, both instructional language at school and closeness of the writing system were significant moderators: the correlations between L1 and L2 decoding were higher in samples where children were instructed in both L1 and L2 compared with L2 only. Likewise, the L1–L2 decoding correlation was higher in samples where both L1 and L2 were alphabetic than in samples where L2 was alphabetic and L1 was ideographic. No moderators were able to explain the variations between samples in the L1 phonological awareness–L2 decoding or the L1 phonological awareness–L2 phonological awareness correlations. Third, of the L1 constructs examined, only decoding was significantly correlated with L2 reading comprehension. This correlation was moderated by the age of the children: samples with younger children had higher correlations than samples with older children. Oral language skills in L1 did not correlate with L2 reading comprehension. Unfortunately, there were too few samples to correlate L1 reading comprehension with L2 reading comprehension.

Cross-language transfer of oral language and phonology

The fact that we found significant correlations between L1 and L2 on oral language, decoding and phonological awareness skills can be seen as evidence for cross-linguistic transfer. It should be noted, however, that the findings only demonstrate a relationship, and not the mechanism that causes it. Still, a relationship between variables is seen as a prerequisite for a causal relationship (Bollen, 1989) and in interpreting the mechanisms behind these findings, they seem to be partly in agreement with both the interdependence and the contrastive frameworks. According to the interdependence framework, the correlations between L1 and L2 can be seen as reflections of a common underlying proficiency that serves the skills in both languages: a child's efficiency in solving

language tasks, either in L1 or L2, is thought to partly depend on a common language knowledge base. For the contrastive perspective, the correlations between L1 and L2 are supposed to reflect similar structures between the languages themselves. The child recognises that some structures (cognates, phonemes, graphemes) are similar in both languages and thereby transfer knowledge of these structures from one language to another. Thus, the main findings can be explained within both frameworks and we do not see them as mutually exclusive.

Still, there was a significant difference in the magnitude of the correlations between the two domains of language. As we hypothesised, the correlations were reliably weaker for the more complex area of oral language than they were for phonology. We see several reasons for why we observed this differentiated pattern: in line with Proctor et al. (2006), we suggest that the complexity of the oral language domain makes transfer harder to detect (through a general correlation coefficient) here than within simpler domains like phonology. In light of the contrast perspective, it is likely that the percentage of similar words (cognates) between two languages is far less than the percentage of similar phonemes and graphemes in the same languages. Thus, the chance of detecting transfer through a general vocabulary test should be less than through a general decoding or phonological awareness test. Further, according to the interdependence framework, learning a general procedure that can be applied in a similar fashion for both languages should facilitate transfer between the languages. We believe that the alphabetic principle is such a procedure: learning that words can be divided into smaller units (like phonemes), and that these units can be used to decode text, should ease the process of learning to decode in an L2. Oral language skills are less likely to be represented by such a common process (Gottardo, Yan, Siegel, & Wade-Woolley, 2001) and might be more multi-determinate (Proctor et al., 2006). It is also suggested that learning an L2 will, in itself, raise metalinguistic awareness (Lambert & Tucker, 1972) which, in turn, will ease the learning to read an L2. An awareness of similarities between languages can also be raised through direct instruction and, therefore, instruction might be a mediating variable that facilitates cross-linguistic transfer (Proctor et al., 2006).

Moderators of oral language, decoding and phonological awareness

One explanation of why the L1–L2 transfer in oral language was so weak might be the fact that SES was low in many of the studies (21 studies). As suggested in the literature, the transfer between L1 and L2 oral language might be stronger in middle and high SES children because middle-class children are presumed to have a more decontextualised L1 that facilitates the learning of L2 (particularly in school settings) (Cummins, 1979, 2004). SES was not, however, a significant moderator of L1–L2 oral language correlation in the current meta-analysis. The three studies (129 children) that examined oral language, and reported middle or high SES, had a very low (.07) and nonsignificant L1–L2 meta-correlation. Still, as only three studies reported middle or high SES, it would be interesting to examine L1–L2 oral language transfer in more middle-class samples in future studies.

For decoding, both the instructional language at school and whether or not L1 was an alphabetic script (together with alphabetic L2) were significant moderators of the magnitude of the L1–L2 correlation size: samples that were instructed in both languages showed evidence of more transfer than those who were only instructed in L2. Likewise, the decoding skills of samples that had an alphabetic L1 and L2 script had higher L1–L2

correlations than samples with an ideographic L1 and an alphabetic L2. The reasons why instruction in both languages seems to facilitate the transfer of decoding skills between the languages might have to do with the raised level of awareness of both similar language structures (e.g. graphemes and phonemes) and similar procedures (e.g. understanding how phonemes are represented by graphemes). By receiving instruction in both languages, the children may become able to directly compare and recognise both language structures and decoding strategies, which might, in turn, facilitate the L1–L2 transfer. Further, as there are more language structures and procedures that are common for alphabetic languages, transfer seems to play a larger part here than in situations where there is one alphabetic and one ideographic language.

Even if the correlations between L1 and L2 can be interpreted as a support for transfer, and the existence of a common underlying language proficiency, it might also be possible that they reflect, at least partly, underlying cognitive abilities. Thus, cognitive abilities, like nonverbal IQ and working memory, might be a third variable that can explain, at least parts of, the cross-linguistic correlations (Genesee et al., 2006). Unfortunately, only a small subset of the samples included variables like these, so cognitive abilities could not be used as a moderator for the L1–L2 correlations. It can, however, be reasoned that general cognitive ability should affect oral language skills at least as much as it affects decoding and phonological awareness skills and, because the meta-correlation between oral language L1 and L2 was so weak ($r = .16$), it is not likely that such abilities can explain all the cross-linguistic correlations found (e.g. decoding) in the current meta-analysis. Yet, we do urge researchers to include such control variables in future studies of cross-linguistic transfer.

Reading comprehension

There were too few samples to examine the transfer between L1 and L2 reading comprehension skills. However, as reading comprehension can be seen as a function of decoding and oral language skills, it becomes interesting to see whether these two domains in L1 are able to predict reading comprehension at L2. In accordance with the findings from the samples reporting on L1–L2 decoding and L1–L2 oral language correlations, decoding, but not oral language, in L1 correlated reliably with reading comprehension skills at L2. This is to be expected because the correlation between L1 decoding and L2 decoding was moderate to strong and the comparable correlation for L1–L2 oral language was weak. Further, the correlation between L1 decoding and L2 reading comprehension was to a strong degree moderated by the age of the samples: in samples with younger children, the correlation was much stronger then in samples with older children. This is in accordance with theories stating that decoding is a more dominant component of reading comprehension in early years, when children start to read, than later on, when they have acquired basic decoding skills (Hoover & Gough, 1990).

The fact that decoding and oral language skills are important components of reading comprehension was shown by the additional L2 moderator analyses of L2 reading comprehension skills. Both decoding and oral language in L2 predicted reading comprehension in L2. These correlations were also strongly moderated by the age of the children. L2 decoding was more strongly correlated with L2 reading comprehension skills in younger samples than in older samples. For oral language, the pattern was the opposite, in that the samples with the oldest children had the largest correlation between

L2 oral language and L2 reading comprehension. This pattern is very much in accordance with both the simple view of reading (Hoover & Gough, 1990) and the recent longitudinal study of Lervåg and Aukrust (2010): when decoding skills are sufficiently mastered, they become relatively less important, whereas oral language skills became a relatively more important component of reading comprehension skills.

Limitations and recommendations for future studies

In future studies, we recommend authors to also study samples of older children, because our meta-analysis demonstrated that the majority of studies are undertaken on samples that are from 6 to 10 years old. Further, it is also important to study transfer to other languages than English, as this is the case for only four of the studies in this sample. In particular, this can have relevance for the generalisability of the findings concerning decoding and phonological awareness to other languages than English. Because English is less consistent than most alphabetical orthographies, it is possible that the patterns of transfer of decoding and phonological awareness will deviate from other more transparent orthographies. Also, the impact from differences in L1 and L2 oral language skills could not be examined, due to uncertainties regarding whether the L1 and L2 tests were psychometrically equated. As this has been much discussed in the literature (e.g. Alderson, 1984; Cummins, 1991), it could potentially be important to develop measures that allow for comparisons between L1 and L2 skills. Finally, our search revealed few longitudinal studies within this area. Because longitudinal studies make it possible to observe precursors of development, such studies have great methodological benefits compared with concurrent studies. Tracing samples over time will therefore be an important path to follow in future studies.

Summary and conclusion

In this meta-analysis, we have examined the correlational studies that look at cross-linguistic transfer in the area of oral language, decoding, phonological awareness and reading comprehension. Our main finding was that little transfer seemed to occur in the oral language domain. This finding contrasts with the domains of decoding and phonological awareness, where we found moderate to strong cross-linguistic correlations. Further, there was substantial variation between studies that could, to some degree, be explained by moderators. The samples that were instructed in both languages at school showed larger L1–L2 correlations on decoding skills. The same was true for the children where both L1 and L2 were alphabetic scripts. L1 decoding was correlated to L2 reading comprehension and was moderated only by the age of the children, with correlations for younger samples being higher than for older samples, which is all in accordance with the simple view of reading.

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Supporting information

Additional supporting information may be found in the online version of this article:

Appendix S1. Characteristics of Studies of L2 Learners Correlating L1 and L2 on Measures of Oral Language, Phonological Awareness, Decoding and Reading Comprehension.

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