

**The development of antonyms knowledge in American Sign
Language (ASL) and its relationship to reading comprehension in
English**

Rama Novogrodsky, Catherine Caldwell-Harris, Sarah Fish and Robert Hoffmeister

Center for the Study of Communication and the Deaf

Boston University

Key words: ASL, reading comprehension, antonyms, deaf, language delay

Contact information:

Rama Novogrodsky, PhD
Center for the Study of Communication and the Deaf
Programs in Deaf Studies
621 Commonwealth Ave
Boston University
Boston, MA 02215

Email: ramanovo@gmail.com ; ramanovo@bu.edu

Fax: 1-617-353-3292

Acknowledgments

The authors thank Rachel Mayberry for her comments on an earlier version of the manuscript. We would like to thank the students, teachers, and staff at the data collection schools, for without their support and participation, this research would not be possible. This study was supported by grant number R324A100176.

ABSTRACT

It is unknown if the developmental path of antonym knowledge in deaf children increases continuously with age and correlates with reading comprehension, as it does in hearing children. Using a receptive multiple-choice American Sign Language (ASL) antonym test, antonym knowledge depended more strongly on age for deaf children with deaf parents (DCDP) than for deaf children with hearing parents (DCHP). This indicates more developmentally typical acquisition for DCDP, consistent with early natural language exposure. Multiple regressions demonstrated that ASL antonym knowledge eliminated the advantage of deaf parents for reading. This establishes the strong language effect of ASL.

DRAFT: UNDER REVIEW

INTRODUCTION

At an early age, antonyms are part of a child's lexicon. Antonyms represent a strong case of the principle of lexical contrast (Clark, 1987), which proposes that any new word that is acquired must contrast in meaning with other words. The acquisition of antonyms requires knowledge of relationships among words and thus has been fruitfully used as an indicator of both breadth and depth of vocabulary knowledge (Paul & O'Rourke, 1988). Thus, the study of antonyms is a useful tool to learn about aspects of vocabulary knowledge beyond vocabulary size.

Vocabulary knowledge in general positively relates to reading comprehension (Baumann, Edwards, Boland, Olejnik, & Kame'enui, 2003, Davis, 1942, Ouellette, 2006, among others). In recent years it has been shown that vocabulary knowledge in L1 also supports reading comprehension in L2 for spoken languages (de Villiers & Masek, 2013, Lindsey, Manis & Bailey, 2003; Miller, Heilmann, Nockerts, Iglesias, Fabiano, & Francis, 2006; Proctor, August, Carlo, & Snow, 2006, among others). For example, Proctor, et al. (2006) tested 135 bilingual Spanish-English students. They showed that when controlling for language of instruction (English versus Spanish), English decoding skill, and English oral language proficiency (all effects of L2 proficiency), the effect of vocabulary knowledge in Spanish (L1), as measured by the Woodcock Picture Vocabulary test (Woodcock & Muñoz-Sandoval, 1995), was significant. These results are important for the current study as the authors compared vocabulary knowledge with other variables: Spanish language alphabetic knowledge, fluency and listening comprehension on the performance of English reading comprehension. The authors suggest that vocabulary knowledge serves as an adequate proxy for background knowledge, interpretation and comprehension monitoring.

The first goal of present study investigates the developmental trajectory of antonyms in American Sign Language (ASL). For our second goal, we then use antonyms as a measure of ASL proficiency and explore how it supports English reading comprehension.

The development of antonyms

Antonyms constitute a unique class of words as they represent both breadth and depth of vocabulary knowledge. They represent breadth (or size; Ouellette, 2006) of vocabulary knowledge as each antonym is represented by a specific word. Individuals who know more words can make inferences and integrate information into coherent thoughts more easily than those with smaller vocabulary sizes (Sénéchal, Ouellette, & Rodney, 2006). Thus, breadth of vocabulary contributes building blocks for more complex language skills and higher-order thinking skills. A child who knows more antonyms usually knows more words and his vocabulary size is larger (Ouellette, 2006). Depth of vocabulary knowledge refers to the number of meanings, different usages of a word and relationships between words (Johnson, 2001; Paul & O'Rourke, 1988). The knowledge of opposites, presented by the antonymous relationship between two words, elaborates the meaning of each individual word and is thus part of vocabulary depth (Ouellette, 2006).

In production, children use antonyms in robust and creative ways at early ages (Clark 1972; Doherty & Perner, 1998; Jones & Murphy, 2005; among others). In comprehension, children understand antonyms before the age of four years (Doherty & Perner, 1998). Jones and

Murphy (2005) did not find a firm correlation between antonyms children hear in the input¹ and the antonyms they produce. The authors suggested that the process of learning antonyms and how to use them is associated with cognitive development. Thus, knowledge of antonyms provides evidence for cognitive development and the representation of this knowledge in the language. However, little is known about the acquisition of antonyms in sign languages, including ASL.

The acquisition of ASL vocabulary for deaf children is similar to that of vocabulary in spoken languages for hearing children at early ages (Anderson & Reilly, 2002, among others). Anderson and Reilly (2002) described the development of the productive vocabulary size of 110 deaf children between eight months and three years of age. Less is known about the development of ASL vocabulary during school years. However, based on the results from Anderson & Reilly (2002), it is suggested that the development of antonyms in ASL should be similar to that in spoken languages. Some researchers have reported that deaf students are delayed in their knowledge of antonyms (Moeller, Osberger & Eccarius, 1986; Monreal & Hernandez, 2005). For example: 93 Spanish deaf students ages 9-20 achieved scores of only 17% correct on an antonym task in Spanish (Monreal & Hernandez, 2005). In this study, antonym comprehension was tested using written Spanish. Participants had to choose the antonym of the prompt from among four options². One interpretation of these results is not that deaf participants

¹For example, negated antonyms: “That’s not making it clean, that’s making it dirty”, versus coordinated antonyms: “They’re winter shoes that you can wear outside or inside”.

²Similar results are found in production studies. For example, Moeller, Osberger and Eccarius (1986) tested 116 deaf students ages 7;6-20 years old on the Woodcock Johnson Psycho educational test battery (Woodcock &

don't know antonyms, but rather they don't know Spanish. To the best of our knowledge, there is no test or study that has used a sign-to-sign method to evaluate antonym knowledge in a sign language, including ASL. Thus it is unknown if deaf students are delayed in antonym knowledge.

It is important to note that in most receptive tasks that assess a child's vocabulary knowledge the child is provided with a word or a sign and has to select a picture that matches its meaning from a set of pictures (e.g., the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997) for spoken languages; the British Sign Language (BSL) vocabulary test (Mann & Marshall, 2013) and the receptive vocabulary test for German Sign Language (Wildemann, 2008) for signed languages). In contrast, as mentioned above, the task used in the current study is a sign-to-sign matching receptive task assessing both sides of the equation of the antonyms knowledge. The task aims to explore the developmental path of antonyms comprehension in ASL throughout the school years (ages four to 18). This is the first study in which a vocabulary antonym task has been tested on a large age range of deaf children in any signed language.

There are two main reasons for choosing an antonym receptive task as a measurement of antonym knowledge. The first reason relates to the type of task, as receptive vocabularies represent larger knowledge than productive vocabularies across a range of learners, including deaf children (Woolfe, Herman, Roy, & Woll, 2010). Using a receptive task thus maximizes the potential for each child to demonstrate antonym knowledge. The second reason relates to the

Johnson, 1977) which includes antonyms. Oral or signed responses to printed words were measured. The participants in all age groups showed delay in their performance compared to age equivalent scores.

advantage of using depth of vocabulary knowledge as a predictor for reading comprehension. Antonyms represent depth of vocabulary knowledge, a measure found to be a better predictor of reading comprehension in monolinguals compared to breadth of vocabulary knowledge (Ouellette, 2006). The importance of the relationship between vocabulary knowledge and reading comprehension in deaf students is further discussed in the following section.

The relationship between language knowledge in an L1 and reading comprehension in an L2 in deaf children

In the deaf population, the median reading level of young deaf adults graduating from high school is 8 years below the average of their hearing peers (Kelly & Barac-Cikoja, 2007). Part of the explanation for this delay is related to poor proficiency in English for deaf students (Allen et al., 2009; Knoors & Marschark, 2012). However, good sign language skills appear to facilitate English reading (Mayberry, del Giudice, & Lieberman, 2011). In the case of deaf children who use sign language, parental status is a broad measurement of language facility, as deaf children of deaf parents (DCDP) are considered to be native signers of the language. When comparing the sign language skills of DCDP as a group with the sign language of deaf children of hearing parents (DCHP) as a group, it appears that the latter lag far behind the former (Hermans, Knoors, & Verhoeven, 2009; Mayer & Leigh, 2010; Author, 2014, among others). This suggests that the reason DCHP lag behind DCDP in reading comprehension is because they lack strong L1 skills (Dickinson & McCabe, 2001).

Strong language performance mediates proficiency in reading comprehension. This has been shown for both oral deaf children (Waters & Doehring, 1990) and for native signers in L2

reading comprehension (Chamberlain & Mayberry, 2000; Hermans, Ormel & Knoors, 2010; Hoffmeister, 2000; Lichtenstein, 1998; Miller, Kargin, Guldenoglu, Rathmann, Kubus, Hauser, & Spurgeon, 2012; Strong & Prinz, 1997). The relationship between the different language components and reading has been explored in deaf children for vocabulary, syntax and phonology.

Vocabulary knowledge: Research indicates a positive correlation between the knowledge of signed language vocabulary and print vocabulary of a spoken language (Hermans, Knoors, Ormel, & Verhoeven, 2008; Hermans, et al., 2010; Strong & Prinz, 1997). Strong and Prinz (1997) found that deaf children with higher facility in ASL outperformed children in the lowest ASL ability level in English literacy, regardless of age and IQ. Fish, Hoffmeister and Thrasher (2005) found a positive correlation between scores on a test of rare ASL vocabulary and scores on a test of English reading comprehension. In a meta-analysis, Mayberry, Giudice and Lieberman (2011) found that in eight studies where vocabulary was measured, it predicted 35% of the variance in reading ability. These studies suggest that vocabulary knowledge in a sign language can contribute to reading skill in a spoken language, despite the difference in language modality, and can thus serve as an L1 mediator of development in an L2 (here, English reading).

Syntactic knowledge: Syntactic knowledge also predicts reading comprehension (Chamberlain & Mayberry, 2008; Miller, et al., 2012). For example, Chamberlain and Mayberry (2008) found that skilled deaf adult readers of English scored higher on a test of ASL syntax. The authors further demonstrated that ASL syntactic ability contributed unique variance to the English reading performance when the effects of nonverbal IQ, exposure to print, and Manually Coded English comprehension were controlled.

Phonological knowledge: For deaf readers the question of the relationship between phonological awareness and reading needs to be explored from two angles: first, the amount that the hearing threshold of deaf readers mediates phonological awareness, and second, what other language components affect reading for deaf readers if phonological awareness is not a predictor of reading achievement. The first question was tested by Kyle and Harris (2006), who found that phonological awareness in English was significantly correlated with reading ability in deaf students only if hearing loss was not controlled. They suggested that phonological awareness and reading can be mediated by hearing level in deaf children. Studies that tested the second question found that phonological decoding ability³ of the spoken language is not a predictor of reading comprehension for deaf readers (Mayberry, Giudice, & Lieberman, 2011; Miller, et al., 2012). Miller, et al. (2012) found that the variance in reading comprehension of deaf children from four orthographic backgrounds (Hebrew, Arabic, English and German) cannot be related to their phonological decoding skills in the spoken language. Their results showed that the most skilled readers among the 213 tested participants did not perform better on the decoding tasks than did the less skilled readers. In contrast, syntax and semantic knowledge did explain the variance in reading comprehension of the deaf readers in their study. In a meta-analysis study, Mayberry, Giudice and Lieberman (2011) found that phonological coding ability skills and phonological awareness abilities predicted only 11% of the variance in reading ability in deaf participants. These results suggest that phonological knowledge in the spoken language is not a prominent mediator of reading comprehension for deaf readers.

³ For example: lexical decision of words and pseudo words (Miller, et al., 2012; Mayberry, et al., 2011), picture matching of words that match on the level of phoneme and rhyme, word recall of rhyming versus non-rhyming words, manipulating sounds and blending syllabus (Mayberry, et al., 2011).

Evidence for the importance of L1 sign language for deaf students comes also from studies showing that sign language knowledge is activated during the reading process (Morford, Wilkinson, Villwock, Piñar, & Kroll, 2011; Ormel, Hermans, Knoors, & Verhoeven, 2012). Morford, et al. (2011) tested 11 deaf adults who were proficient in ASL on a judgment task of written words. The participants judged word-pairs that were semantically related more quickly when the form of the ASL translation was also similar compared to word-pairs that were semantically unrelated and the form of the ASL translation was similar. The authors suggested that deaf readers activate the ASL translations of written words in English even under conditions in which the ASL translation is neither present perceptually nor required to perform the task. Ormel, et al. (2012) found similar results in 40 deaf children in grades 3-6. Although the task in this study did not involve reading, it supports the assumption of automatic activation of the signed modality in comprehension tasks. In this study children were presented with picture pairs for which the sign translation equivalents varied with respect to overlap of the phonological structure of the sign and sign iconicity. Deaf children showed relatively longer response latencies and more errors to non-matching picture pairs with sign translation that had strong sign phonological structure relations (inhibitory effect) than non-matching picture pairs without sign phonological structure relations. This effect was not found for hearing children, suggesting that the inhibitory effect found for the deaf children can only be attributed to the bilingual activation of their sign language knowledge. These results provide evidence for interactive cross-language processing in deaf children.

To summarize, the results from different tasks and from different sign languages indicate that signs are activated during reading and during comprehension tasks. Thus sign language knowledge contributes to reading comprehension despite the difference in language modality⁴.

There is accumulating evidence that sign language functions as a linguistic basis of reading development for deaf children who use sign language as their dominant language. The current study tested a large number of deaf children on an ASL antonyms task. Because this task represents depth of vocabulary knowledge, it should thus be a good predictor of reading comprehension, following findings with spoken languages (Ouellette, 2006). In addition, three other possible mediators of reading performance were investigated: a) parental hearing status as a mediator of the sign language input that the child receives, DCDP were predicted to outperform DCHP; b) age as a developmental mediator, with age participants were predicted to get higher reading scores; c) gender as a control mediator, no difference was expected to be found between girls and boys on their reading scores (Hogrebe, Nist, & Newman, 1985).

We tested several hypotheses in the present study. The first prediction focused on the development of antonyms. We hypothesized that deaf children (both DCDP and DCHP) would show age-related development on the antonyms task. **The second prediction** focused on the difference between the two parental groups. We hypothesized that DCDP group will outperform

⁴ It is important to note that signs do not prevent auditory speech perception (and related phonological abilities) when this modality is available for deaf readers as in the case of children who successfully use cochlear implants or hearing aids. For these children, the contrary has been shown, that they can benefit from bimodal input (Giezen, 2011; Knoors & Marschark, 2012).

the DCHP on the antonym task. **The third prediction** focused on the relationship between antonyms and reading comprehension. Prior work has found that DCDP have an advantage over DCHP on language tasks (Hermans, Knoors, & Verhoeven, 2008; Author, 2014). Many scholars have attributed this to the cognitive and linguistic benefits of early language exposure. Further, in hearing children, age is a very strong predictor of reading comprehension as it represents language ability (Keenan, Betjemann, & Olson, 2008). We predicted that age will contribute unique variance of reading proficiency consistent with the literature on hearing children. ASL will predict additional unique variance of reading proficiency and once ASL knowledge is statistically equated, parental hearing status will not explain additional unique variance of reading proficiency. Last, based on previous literature, gender will not explain additional unique variance of reading proficiency.

METHOD

Participants

The data were collected from 564 deaf students between the ages of four and 18 years old (see Table 1) from various sites across the US. The participants were grouped by parental hearing status: 122 DCDP were exposed to ASL by at least one deaf adult from birth, and are thus considered to be native signers, and 442 DCHP who were first exposed to ASL-using deaf adults upon entering the education system. It is important to note that although the DCDP group is small in comparison to the DCHP group, it represents 22% of the sample, whereas in the population at large, only 5%-10% of deaf children are born to deaf parents (Mitchell & Karchmer, 2004). Participants were further divided into age groups combining two years together in order to have at least 10 DCDP in each of the age groups (Table 1).

Table 1: Number of Participants by Age, Gender (M and F) and Parental Hearing Status

Age	4-5		6-7		8-9		10-11		12-13		14-15		16-18		Total
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	
DCDP	8	8	16	9	9	13	4	6	12	5	11	11	2	8	
Total	16		25		22		10		17		22		10		122
DCHP	9	13	30	31	35	20	33	30	50	34	36	30	44	47	
Total	22		61		55		63		84		66		91		442

Materials

The antonyms task used in this study is a video-based, receptive multiple-choice subtest of the ASL Assessment Instrument (ASLAI; Hoffmeister, Greenwald, Bahan, & Cole, 1989). The design of the task is briefly reviewed below. The antonym stimuli were chosen by 4 native signers as representing seven easy pairs of antonyms and seven difficult pairs. The judgments were further confirmed by another group of 25 native signers for the antonyms pairs and for the relationship between each prompt and its foils. The 13 antonym pairs included nine pairs of adjective antonyms and five pairs of verb antonyms. Each of the 13 stimulus items consisted of a prompt (1), the target (a), and three possible response options: a semantic foil (b), a phonological foil (c), and an unrelated foil (d). The semantic foils are semantically related to the prompt. For example DARK⁵ (b) is not an antonym of VAGUE (1), but is semantically related to it. The phonological foils differ in 1 to 3 phonological features (hand shape, movement, location, or

⁵ Following convention, all English glosses of ASL signs are written in capital letters.

palm orientation) from the prompt. For example, the signs ATTRACT and WANT used in the test differed only in hand shape. The choice of which features differed was equally distributed across movement, location and palm orientation, while hand shape feature differences only played a role in two foils. The task was piloted on 10 deaf adults with deaf parents. The final task questions were selected from those items which achieved 90% correct or better performance.

Sample test question:

- 1) Prompt: *VAGUE* (See Figure 1).
 - (a) Target: *CLEAR*
 - (b) Semantic foil: *DARK*
 - (c) Phonological foil to the prompt: *MOVIE* (differs in movement and palm orientation from the prompt)
 - (d) Unrelated foil: *LIGHT* (in weight)

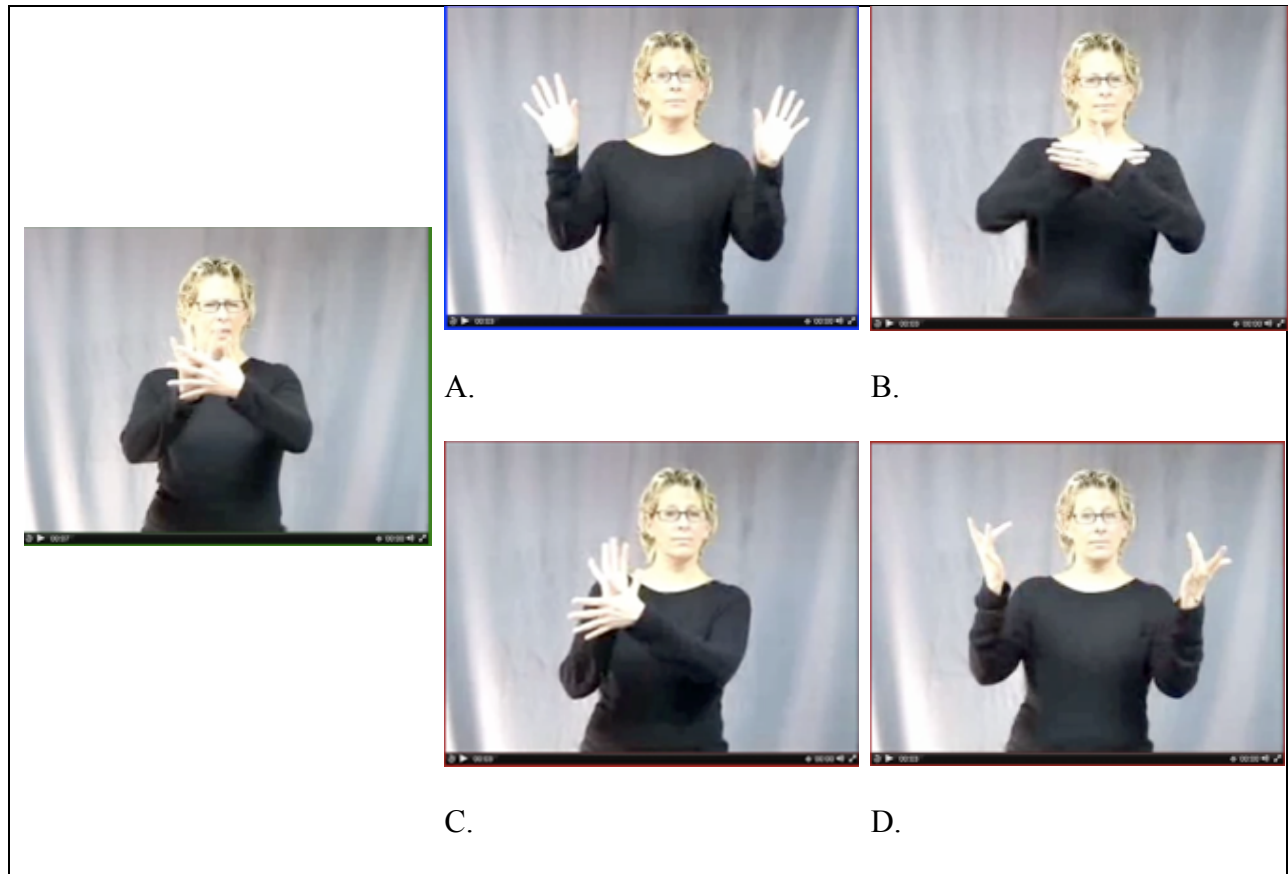


Figure 1: On the left: VAGUE A. CLEAR B. DARK C. MOVIE D. LIGHT (in weight)

Of the 564 participants, a subgroup of 138 students aged 7-18 (37 DCDP and 101 DCHP) took the SAT-RC (Stanford Achievement Test - Reading Comprehension) test (Traxler, 2000) in addition to the antonym task.

Testing procedures

The antonyms task was administered to small groups of participants by deaf researchers, with videotaped instructions and two demonstration items presented by a native signer. Participants then viewed two practice items followed by the 13 test items. For each item, the video presented the stimulus followed by the four response choices. Participants were instructed to select the

response that best reflected the opposite of the prompt. An example of a question from the response booklet is presented in Figure 1.

RESULTS

Hypothesis 1. Knowledge of antonyms will increase with age

Participants performed better on the task with age ($r = 0.34, p < .000$; Figure 2). In the DCDP group, a maximum average correct performance of 81% was achieved at the age of 16-18 years. For the DCHP group, development was more gradual, with a maximum correct performance of 56% at the age of 16-18 years, which is equivalent to the achievement of 6-7 to 8-9 year old DCDP (Figure 2). The correlation between age and performance was strong for the DCDP group ($r = 0.57, p < .0001$) and moderate for the DCHP group ($r = 0.39, p < .0001$).

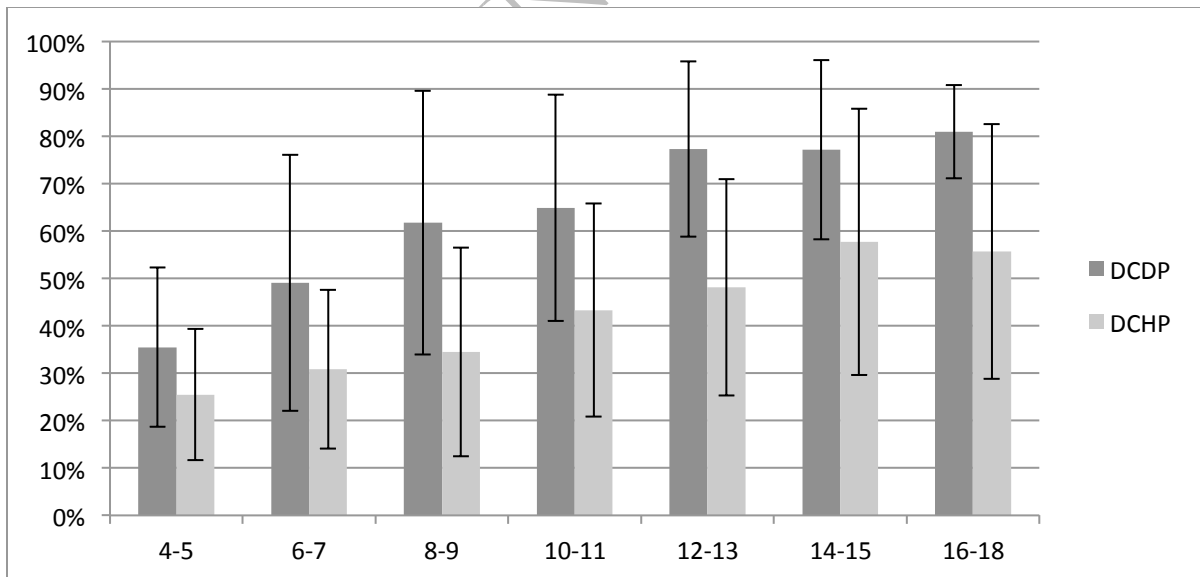


Figure 2. Average correct performance (%) as a function of age and parental hearing status.

Hypothesis 2. The DCDP group will outperform the DCHP on the antonym task

From ages 6-7 and up, the DCDP group performed significantly better than the DCHP group. A t-test with a Bonferroni correction for multiple comparisons was used for this comparison, with seven comparisons, for $p < .01=**$, $p < 0.01 / 7 < .0014$ and for $p < .05=*$, $p < 0.05 / 7 < .007$. The DCHP group performed at chance level at the ages of 4-5 and the DCDP performed above chance level at this age with no significant difference between the two groups ($t(36) = 2.01$, $p = .052$ compare with $p < .007$). At all following ages the DCDP group performed significantly better than the DCHP group with large effect sizes ($>.05$) for all age groups (Table 2).

Table 2. Comparison of average percentage correct on the antonym task between the two parental hearing status groups for each age group

Age	DCDP	DCHP	t-test	Effect size*
6-7	49%	31%	$t(84) = 3.79**$	0.80
8-9	62%	34%	$t(75) = 4.54**$	1.12
10-11	65%	43%	$t(71) = 2.79*$	0.95
12-13	77%	48%	$t(99) = 4.94**$	1.40
14-15	77%	58%	$t(86) = 3.03**$	0.79
16-18	81%	56%	$t(99) = 2.93*$	1.23

*Effect size measured by Cohen's d.

Hypothesis 3. Age and ASL performance will predict reading comprehension

The third hypothesis was confirmed. Age and ASL performance correlated with reading scores and both explained unique variance of the reading comprehension scores. Correlation was calculated between age and reading scores for both DCDP and DCHP groups. As can be seen in

Figure 3, Spearman r correlation between age and reading scores was higher for the DCDP compared to that of the DCHP ($r = 0.67$; $r = 0.37$, $p < .0001$, respectively). Figure 3 illustrates the reason for this: in the DCHP group, the reading scores are highly variable and do not cluster as tightly around the trend line as is the case for DCDP.

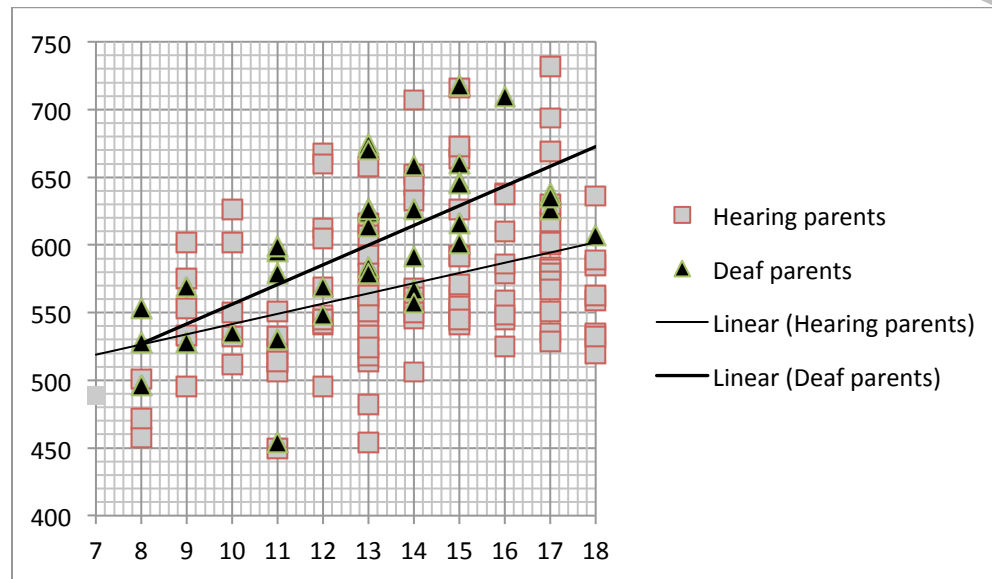


Figure 3. Correlation between age (years) and reading scores (SAT-RC)

In addition, Spearman r correlation between performance on the antonym task and reading scores was high for both DCDP and DCHP groups ($r = 0.65$; $r = 0.55$, $p < .0001$, respectively).

We further compared the four possible mediators of reading performance: age, performance on the antonym task, parental hearing status and gender. Stepwise regression analysis indicated that while ASL knowledge, as represented by scores on the antonyms task, explained unique variance in reading comprehension scores, parental hearing status was not significant (Table 3). In addition, ASL explained more of the variance of the reading comprehension ($R^2 = .35$) than did age ($R^2 = .10$) (Table 3).

Table 3. Antonym, age, parental hearing status and gender as predictors of reading scores

	Zero-order correlation		Multiple regression			
	r	p	b	β	R ²	p
Antonym	.60	< .000	1.21	.54	.35	< .000
Age	.41	< .000	6.64	.37	.10	< .000
Parents	.22	= .01	Parental status excluded during multiple regression			
Gender	.11	= .18	Gender excluded during multiple regression			

DISCUSSION

We investigated how knowledge of antonyms develops across the school years and whether knowledge of antonyms in an L1 (ASL) predicts reading comprehension proficiency in an L2 (English), as is the case for spoken languages.

The development of antonym knowledge

With age deaf children perform better on ASL antonyms, with even the youngest signers performing at above-chance levels on our sign-to-sign task, which is consistent with findings from spoken languages indicating understanding of antonymous relationships at an early age before the beginning of elementary school (Doherty & Perner, 1998). This refutes the claim of prior researchers that deaf children are delayed in antonym development compared to hearing children (Monreal & Hernandez, 2005; Moeller, Osberger, & Eccarius, 1986). Rather, the current results suggest that age-appropriate language development is important to antonym development and that studies finding deaf children to be delayed in this vocabulary domain likely included

children with delayed language. The current results suggest that acquisition of antonyms have similar developmental path regardless of the language modality.

The second characteristic of ASL development relates to the importance of the amount of input at an early age. The current findings showed that DCDP outperformed DCHP at most ages, including the oldest age group. This result extends prior findings that showed delayed acquisition of ASL of DCHP as a group compared to DCDP as a group (Hermans, Knoors, & Verhoeven, 2009; Mayer & Leigh, 2010; Author, 2014)⁶. Luckner & Cooke (2010) explain the differences in vocabulary size among young children as a result of the quantity and quality of language input to which they have been exposed during the first few years of life. What is noteworthy in the current findings is documenting that the gap persists into the beginning of adulthood (ages 16-18).

In spoken languages, antonyms are acquired before synonyms (Charles, Reed, & Derryberry, 1994; Doherty & Perner, 1998), suggesting that the relationship of words with opposite meanings is easier to understand than that of words with similar meanings. To determine if this is true for signers of ASL, the current results were compared with the author's (2014) study of synonym knowledge, which was also an ASL sign-to-sign matching task. At elementary school ages, the native signers (DCDP) performed better on the antonym task than on the synonym task (36% versus 18% at ages 4-5; 49% versus 37% at ages 6-7; 62% versus 54% at ages 8-9). This is what is predicted by the principle of lexical contrast (Clark, 1978), that words contrasting in meaning with other words (e.g. antonyms) are acquired before words that share

⁶It is important to note that many DCHP individuals may overcome this early delay. However, the general finding for the overall DCHP group is consistent.

meaning (e.g. synonyms). Our data thus show that in the case of antonym acquisition, sign languages follow the same principles of language acquisition as spoken languages, despite the modality differences between the two languages.

Language and reading comprehension

The finding of a relationship between vocabulary knowledge and reading comprehension confirms prior findings with deaf readers (Fish, Hoffmeister & Thrasher, 2005; Hermans, Knoors, Ormel, & Verhoeven, 2008; Hermans, et al., 2010; Mayberry, Giudice, & Lieberman, 2011; Strong & Prinz, 1997). The importance of vocabulary knowledge in an L1 for reading comprehension in an L2 has been emphasized by Proctor, et al. (2006). They showed that, controlling for L2-English abilities, the effects of vocabulary knowledge in L1-Spanish was stronger on English reading ability relative to the other L1 variables of alphabetic knowledge, fluency and listening comprehension. The current results are in line with Proctor, et al. (2006) in showing that vocabulary size in a sign language relates to reading comprehension in a second language. This adds evidence to the puzzle of bilingualism and how L1 abilities influence reading in L2: the L1 vocabulary effects on L2 reading comprehension are supra-modal.

Although the current study did not test the effect of the spoken language on reading it is important to understand how this ability relates to reading comprehension in the case of deaf readers who sign. Even when sign language is the dominant communication modality, in many cases, deaf signers use oral language to some degree. Vermeulen, van Bon, Schreuder, Knoors, and Snik (2007) tested the reading comprehension and visual word recognition skills of 50 deaf children who had used a cochlear implant (CI) for at least 3 years. These learners were compared to deaf children without a CI and to hearing children. While the reading comprehension

performance of the CI group was significantly better than that of the no CI group, word recognition scores did not explain the improved reading of the CI group. The authors explained the difference in reading comprehension skills between the deaf children with and without CIs as due to the auditory access to spoken language of the CI group. They mention the contribution of receptive vocabulary knowledge as an important factor in the causal chain. Interestingly, 74% (37/50) participants came from schools for the deaf in the Netherlands. These data suggest another possible factor as a mediator of reading comprehension, Sign Language of the Netherlands (SLN). The contribution of SLN to reading comprehension was not tested in the Vermeulen, et al. (2007) study and is thus a hidden factor in that study. Our results suggest that sign language proficiency of the participants in Vermeulen, et al. (2007) might have explained part of the variance of the reading achievement. This assumption is supported by findings that present benefit from bimodal input (signed and spoken) for deaf children (Giezen, 2011; Knoors & Marschark, 2012). The nature of the relationship between L1 (a sign language), L2 (a spoken language) and reading comprehension requires additional study.

Language and parental hearing status as predictors of reading comprehension

Our findings showed a higher correlation between age and reading scores in the DCDP group compared to the DCHP group. This result suggests that when exposure to L1 is consistent in quantity and quality, as in the case of DCDP, age is a better predictor for reading scores than in the more variable conditions represented by the DCHP group⁷. However, in the correlation between age and reading comprehension one important factor is missing in the equation, the

⁷ It is important to note that the current study sample is not a cross sectional sample of deaf children across the US but rather a unique group of children who are exposed to ASL. The relationship between the language of oral deaf students and reading comprehension is a different question that does not involve the L1-L2 relationship.

language proficiency of each child. When language ability, as measured by antonym test scores, was included in the equation, regression analysis showed no effect for parental hearing status. Strong and Prinz (1997) found that deaf students with deaf mothers outperformed their deaf peers with hearing parents in reading tests. However, in their study, when levels of ASL ability were equivalent across parental hearing status groups, there were no differences in reading ability. Chamberlain and Mayberry (2008) argued that “skilled deaf readers are proficient sign language comprehenders” (Chamberlain & Mayberry, p. 383). The current results support this assumption and confirm that for deaf readers, proficiency in reading comprehension does not depend on parental hearing status, but rather on solid and deep first language proficiency. Similarly to spoken languages, language is the key for reading comprehension achievement.

Language and age as predictors of reading comprehension

For typically developing children, age is a strong predictor of reading ability because language ability develops with age, and language is crucial for reading. In deaf children, language is not as tightly linked to age because deaf children often experience language delays (Vermeulen, et al., 2007; Wauters, Van Bon, & Tellings, 2006). This delay is particularly common for DCHP. Our study established that language remains a good predictor of reading in deaf children, even when age is not (as can be seen in Figure 3 for DCHP). These results add to the literature demonstrating that language ability is important for reading ability, even when the modality is different, as in the case of deaf children acquiring ASL as the L1 and English as the L2. An implication of this variability is that some deaf children have reading delays because of language delays (Marschark, Lang & Albertini, 2002), not because of deafness per se. The

current results suggest that intervention strategies for improving reading comprehension should include enhancement of the L1 (the sign language) in addition to the L2.

CONCLUSION

The acquisition of antonym knowledge in a sign language is another step towards exploring the development of vocabulary knowledge across languages, even those of different modalities. The results of the study reported here indicate that the developmental language path of antonyms and its relationship to reading comprehension holds for signed languages as well as spoken. The importance of a strong L1 for deaf children is true not only for communication but also as a necessary foundation for academic achievement in the L2.

DRAFT: UNDER REVIEW

REFERENCE

- Allen, T. E., Clark, M. D., del Giudice, A., Koo, D., Lieberman, A., Mayberry, R., & Miller, P. (2009). Phonology and reading: A response to Wang, Trezek, Luckner, and Paul. *American Annals of the Deaf*, 145, 338–345.
- Anderson, D. & Reilly, J. (2002). The MacArthur Communicative Development Inventory: Normative Data for American Sign Language. *Journal of Deaf Studies and Deaf Education*, 7, 83-119.
- Baumann, J. F., Edwards, E. C., Boland, E. M., Olejnik, S., & Kame'enui, E. (2003). Vocabulary tricks: Effects of instruction in morphology and context on fifth-grade students' ability to derive and infer word meanings. *American Educational Research Journal*, 40(2), 447-494.
- Chamberlain, C., & Mayberry, R. I. (2000). Theorizing about the relationship between ASL and reading. In C. Chamberlain, J. Morford, & R. I. Mayberry (Eds.), *Language Acquisition by Eye* (pp. 221–260). Mahwah, NJ: LEA.
- Chamberlain, C. & Mayberry, R. I. (2008). American Sign Language syntactic and narrative comprehension in skilled and less skilled readers: Bilingual and bimodal evidence for the linguistic basis of reading. *Applied Psycholinguistics*, 29, 367-388.
- Charles, W., Reed, M., & Derryberry, D. (1994). Conceptual and associative processing of antonymy and synonymy. *Applied psycholinguistics*, 15, 331-356.
- Clark, E. V. (1972). On the child's acquisition of antonyms in two semantic fields. *Journal of Verbal Learning and Verbal Behavior*, 11, 750–58.

- Clark, E. V. (1987). The principle of contrast: a constraint on language acquisition. In B. MacWhinney (Ed.), *Mechanisms of language Acquisition* (pp. 2-29). Lawrence Erlbaum Associates.
- Davis, F. B. (1942). Two new measures of reading ability. *Journal of Educational Psychology*, 33, 365-372.
- de Villiers, P. & Masek, L. (2013). Literate Language: A Predictive Measure of Narrative Language in Low-Income Hispanic Preschoolers. *Proceedings of BUCLD*, 37, 100-109.
- Dickenson, D. K., & McCabe, A. (2001). Bringing it all together: The multiple origins, skills, and environmental supports of early literacy. *Learning Disabilities Research and Practice*, 16, 186–202.
- Doherty, M. & Perner, J. (1998). Metalinguistic awareness and theory of mind: just two words for the same thing? *Cognitive development*, 13, 279-305.
- Dunn, L. M. & Dunn, L. M. (1997). *Peabody Picture Vocabulary Test*. 3rd Edition. Circle Pines, MN: American Guidance Services.
- Fish, S., Hoffmeister, R. H., & Thrasher, M. (2005). Knowledge of rare vocabulary in ASL and its relationship to vocabulary knowledge in English in Deaf children. Paper presented to the IASCL conference, Berlin.
- Giezen, M. R. (2011). *Speech and sign perception in deaf children with cochlear implants*. (PhD dissertation). University of Amsterdam. LOT Dissertational Series 275. Retrieved from <http://www.lotpublications.nl>.
- Hermans, D., Knoors, H., Ormel, E. & Verhoeven, L. (2008). Modeling Reading Vocabulary Learning in Deaf Children in Bilingual Education Programs. *Journal of Deaf Studies and Deaf Education*, 13, 155-174.

- Hermans, D., Knoors, H., & Verhoeven, L. (2009). Assessment of Sign Language development: The case of deaf children in the Netherlands. *Journal of Deaf Studies and Deaf Education*, 15, 107–119.
- Hermans, D., Ormel, E., & Knoors, H. (2010). On the relation between the signing and reading skills of deaf bilinguals. *International Journal of Bilingual Education and Bilingualism*, 13, 187–199.
- Hoffmeister, R. (2000). A piece of the puzzle: ASL and reading comprehension in deaf children. In C. Chamberlain, J.P. Morford, J and R.I. Mayberry (Eds.), *Language acquisition by eye* (pp. 143-163). Mahwah, NJ: Lawrence Erlbaum Associates.
- Hoffmeister, R., Greenwald, J., Bahan, B., & Cole, J. (1989). The American Sign Language Assessment Instrument. Unpub instrument: Boston University Center for the Study of Communication and the Deaf.
- Hogrebe, M. C., Nist, S. L., & Newman, I. (1985). Are there gender differences in reading achievement? An investigation using the high school and beyond data. *Journal of Educational Psychology*, 77(6), 716-724.
- Johnson, D. D. (2001). *Vocabulary in the elementary and middle school*. Boston: Allyn & Bacon.
- Jones, S. & Murphy, M. (2005). Using corpora to investigate antonym acquisition. *International Journal of Corpus Linguistics*, 10, 401-422.
- Keenan, J. M., Betjemann, R. S., & Olson, R. K. (2008). Reading comprehension tests vary in the skills they assess: Differential dependence on decoding and oral comprehension. *Scientific Studies of Reading*, 12(3), 281-300.

- Kelly, L., & Barac-Cikoja, D. (2007). The comprehension of skilled deaf readers: The roles of word recognition and other potentially critical aspects of competence. In K. Cain & J. Oakhill (Eds.), *Children's comprehension problems in oral and written language: A cognitive perspective* (pp. 244–279). New York, NY: Guilford Press.
- Knors, H. & Marschark, M. (2012). Language Planning for the 21st Century: Revisiting Bilingual Language Policy for Deaf Children. *Journal of Deaf Studies and deaf Education*, 17, 291-305.
- Kyle, F. E., & Harris, M. (2006). Concurrent correlates and predictors of reading and spelling achievement in deaf and hearing school children. *Journal of Deaf Studies and Deaf Education*, 11(3), 273-288.
- Lichtenstein, E. (1998). The relationships between reading processes and English skills of deaf college students. *Journal of Deaf Studies and Deaf Education*, 3, 80–134.
- Lindsey, K. A., Manis, F. R., & Bailey, C. E. (2003). Prediction of first-grade reading in Spanish-speaking English-language learners. *Journal of Educational Psychology*, 95(3), 482-494.
- Luckner, L. J & Cooke, C. (2010). A Summary of the vocabulary research with students who are deaf or hard of hearing. *American Annals of the Deaf*, 155, 38-67.
- Mann, W. & Marshall, C. R. (2013). Investigating Deaf children's vocabulary knowledge in British Sign Language. *Language Learning*, 62(4), 1024-1051.
- Marschark, M., Lang, H. G., & Albertini, J. A. (2002). *Educating deaf students: From research to practice*. New York: Oxford University Press.

- Mayberry, R. I., del Giudice, A. A., & Lieberman, A. M. (2011). Reading achievement in relation to phonological coding and awareness in deaf readers: A meta-analysis. *Journal of Deaf Studies and Deaf Education*, 16(2), 164-188.
- Mayer, C., & Leigh, G. (2010). The changing context for sign bilingual education programs: Issues in language and the development of literacy. *International Journal of Bilingual Education and Bilingualism*, 13, 175–186.
- Miller, J. F., Heilmann, J., Nockerts, A., Iglesias, A., Fabiano, L., & Francis, D. J. (2006). Oral language and reading in bilingual children. *Learning Disabilities Research & Practice*, 21(1), 30-43.
- Miller, P., Kargin, T., Guldenoglu, B., Rathmann, C., Kubus, O., Hauser, P., & Spurgeon, E. (2012). Factors distinguishing skilled and less skilled deaf readers: evidence from four orthographies. *Journal of Deaf Studies and Deaf Education*, 17(4), 439-462.
- Moeller, M. P., Osberger, M. J., & Eccarius, M. (1986). Language and learning skills of hearing-impaired students. Receptive language skills. *ASHA monographs*, 23, 41- 53.
- Monreal, S. T., & Hernandez, R. S. (2005). Reading levels of Spanish deaf students. *American Annals of the Deaf*, 150(4), 379-387.
- Morford, J. P., Wilkinson, E., Villwock, A. Piñar, P, & Kroll, J.F. (2011). When deaf signers read English: Do written words activate their sign translations? *Cognition*, 18, 286–292.
- Mitchell, R.E., & Karchmer, M.A. (2004). Chasing the mythical ten percent: parental hearing status of deaf and hard of hearing students in the United States. *Sign Language Studies*, 4(2), 138-163.

- Author. (2014). The acquisition of synonyms in American Sign Language (ASL): Towards a further understanding of the components of ASL vocabulary knowledge. *Sign Language Studies, 14* (2).
- Ormel, E., Hermans, D., Knoors, H., & Verhoeven, L. (2012). Cross-language effects in written word recognition: The case of bilingual deaf children. *Bilingualism: Language and Cognition, 15*(02), 288-303.
- Ouellette, G. P. (2006). What's meaning got to do with it: The role of vocabulary in word reading and reading comprehension. *Journal of Educational Psychology, 98*(3), 554.
- Paul, P. & O'Rourke, J. (1988). Multimeaning words and reading comprehension: implications for special education students. *Remedial and special education, 9*, 42-52.
- Proctor, C. P., August, D., Carlo, M. S., & Snow, C. (2006). The intriguing role of Spanish language vocabulary knowledge in predicting English reading comprehension. *Journal of Educational Psychology, 98*(1), 159-169.
- Sénéchal, M., Ouellette, G., & Rodney, D. (2006). The misunderstood giant: On the predictive role of early vocabulary to future reading. In D. Dickinson & S. Neuman (Eds.), *Handbook of early literacy research* (pp. 173–182). New York: Guilford Press.
- Strong, M. & Prinz, P. (1997). A study of the relationship between American Sign Language and English literacy. *Journal of Deaf Studies and Deaf Education, 2*, 37-46.
- Traxler, C. B. (2000). The Stanford Achievement Test: National norming and performance standards for deaf and hard-of-hearing students. *Journal of deaf studies and deaf education, 5*(4), 337-348.

- Vermeulen, A. M., van Bon, W., Schreuder, R., Knoors, H., & Snik, A. (2007). Reading comprehension of deaf children with cochlear implants. *Journal of Deaf Studies and Deaf Education*, 12(3), 283-302.
- Waters, G. S., & Doehring, D. G. (1990). Reading acquisition in congenitally deaf children who communicate orally: Insights from an analysis of component reading, language, and memory skills. In T. H. Carr & B. A. Levy (Eds.), *Reading and its development* (pp. 323–373). San Diego, CA: Academic Press.
- Wauters, L. N., Van Bon, W. H., & Tellings, A. E. (2006). Reading comprehension of Dutch deaf children. *Reading and Writing*, 19(1), 49-76.
- Wildemann, A. (2008). Perlesko – ein Testinstrument zur Überprüfung sprachlicher Kompetenz. Ein Erfahrungsbericht. *Das Zeichen*, 78, 96-101.
- Woodcock, R. & Johnson, M.B. (1977). *Woodcock-Johnson Psycho-educational test battery*. Boston: Teaching Resources.
- Woodcock, R. W., & Muñoz-Sandoval, A. F. (1995). *Woodcock Language Proficiency Battery-revised: English and Spanish Forms*. Riverside Publishing Company.
- Woolfe, T., Herman, R., Roy, P., & Woll, B. (2010). Early vocabulary development in deaf native signers: a British Sign Language adaptation of the communicative Vocabulary development in sign language 37 development inventories. *Journal of Child Psychology and Psychiatry*, 51, 322 – 331.