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Sentence comprehension in post-institutionalized school-aged children

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Abstract

Purpose—This study investigated sentence comprehension and spatial working memory abilities in a sample of internationally adopted, post-institutionalized (PI) children. We compared the performance of these PI children to an age-matched group of children living with their birth families. We hypothesized that PI children would perform below clinical threshold on tasks of sentence comprehension and that poor sentence comprehension would be associated with poor performance in working memory.

Method—Twenty-three PI children and 36 comparison children were administered sentence comprehension and spatial memory tasks from standardized assessments.

Results—Some oral sentence comprehension skills and the spatial working memory skills were weaker in the school-aged PI children than in the age-matched comparison children. A mediational analysis demonstrated that poor spatial working memory performance partially explains the sentence comprehension differences between the two groups.

Conclusion—These findings provide valuable information to better plan early intervention and special education for PI children.

Keywords

children; international adoption; post-institutionalized; sentence comprehension; spatial working memory

Introduction

Children who were adopted internationally and who also spent some of their pre-adopted life in orphanage care are known as post-institutionalized children (PI). There is much evidence that institutionalization has adverse effects on child development across a wide range of skills (e.g., Rutter et al., 2010). Although there is a corpora of research on language development and international adoption, not all studies have specifically documented post-institutionalization. In addition, extant research reports inconsistent findings in this area.

Whereas some studies indicate that PI children's language development is comparable to that of their peers (Dalen & Rygvold, 2006; Scott et al., 2008), other studies suggest that PI children present with notable language deficits (Croft et al., 2007; Groze & Ileana, 1996; Judge, 2004; Tirella, Chan, & Miller, 2006). Here, we examine the sentence comprehension abilities of school-aged PI children, and test the relationship between sentence comprehension and spatial working memory skills. The literature linking sentence comprehension and working memory in school-aged children provides the basis for this examination and may help explain why these children perform differentially on various measures of language functioning (Marton & Schwartz, 2003; Montgomery, 2003; Montgomery, Magimairaj, & O'Malley, 2008; Roberts, Marinis, Felser, & Clahsen, 2007).

Language Development of Post-Institutionalized Children

When children are raised in orphanage settings, they are often deprived of the positive input that is more prevalent in family environments. While there are differences within countries and across countries, many orphanages around the world provide less than optimal conditions for human development. These conditions are characterized by unfavorable caregiver to child ratios; highly regimented routines with all children eating, sleeping, and toileting at the same time; impoverished sensory, cognitive, and linguistic stimulation; and unresponsive care-giving practices (Daunhauer, Bolton, & Cermak, 2005; Johnson, 2000; Nelson et al., 2007).

Investigations into how these negative conditions in orphanage settings affect a child's language development after adoption into an enriched environment have produced inconsistent results. One reason for this inconsistency may be that different types of instruments tap into different components of language (Roberts & Scott, 2009). One group of studies relied on answers to questionnaires or surveys completed by parents, teachers, or by the children themselves once they had reached adulthood. These questionnaires and surveys include unpublished inventories and surveys created by the investigators, as well as published measures including the Revised Denver Pre-screening Developmental Questionnaire and the Children's Communication Checklist-2. Results from some of these studies suggest that the language performance of PI children is comparable to that of children being raised in their birth families (Dalen & Rygvold, 2006); whereas other studies indicate that language abilities of PI children are weaker than those of their peers (Groze & Ileana, 1996; Judge, 2004; Tirella, Chan, & Miller, 2006). Another group of studies used instruments that directly assess language skills in PI children, perhaps a better measure of language performance than questionnaires and surveys. Yet, these studies also report mixed results. For example, Croft et al. (2007) investigated a cohort of 132 PI children adopted from Romanian orphanages and compared their results to those of 49 children adopted domestically without orphanage experience. They measured sentence comprehension, vocabulary, and narrative discourse when the children were 6 and then 11 years old. They found that the children who had experienced less than 6 months of orphanage care performed as well as the children adopted domestically, but the children with more than 6 months of orphanage care evidenced considerable and statistically significant deficits. On the other hand, Scott et al. (2008) examined a group of 24 PI girls between 7 and 9 years of age who were adopted from China. They administered an in-depth battery of standardized tests measuring comprehension and expression abilities as well as academic achievement and reading skills. These researchers found that most participants exhibited scores in the average to above average range for all standardized measures administered. Therefore, while there is data suggesting that PI children may be at risk of ongoing language difficulties, it is not clear precisely what aspects of language are most vulnerable in the children's development.

Sentence Comprehension and Working Memory Research

One way to resolve the conflicting results in the research investigating PI language development is to focus on specific dimensions of language. To that effect, a recent systematic review recommended further investigation of sentence comprehension (Scott, 2009). Comprehension of sentences that are complex because of grammatical elements of difficulty (e.g., passive, pronominal, or reflexive) has been an area of interest in studies with children who present with language impairment (Montgomery & Evans, 2009). In these studies, performance on the comprehension of simple sentences (e.g., The mouse is eating the yellow cheese.) is compared to the comprehension of sentences that require the interpretation of complex syntactic features. These complex sentences contain elements such as semantically reversible passives (e.g., The baby is kissed by the woman.), pronouns that could be assigned to more than one person (e.g., Peter Pan says Captain Hook is kicking him.), or reflexive pronouns (e.g., The mother washes herself.). Children with language impairment consistently obtain poorer scores than their typically developing peers on such sentence comprehension tasks (Marton & Schwartz, 2003; Montgomery & Evans, 2009). These studies highlight the important role of sentence comprehension in school-aged children where, in classroom settings, this ability is necessary to understand instructions presented orally as well as in written text (Wallach, 2008; Westby, 2005). Comprehension of complex sentences is therefore clearly linked to academic success and probably comprised within the notion of academic language proposed by Cummins (1984), and later applied by Rygvold (1999) and Dalen (2001). Yet, little is known about sentence comprehension in PI children (Scott, 2009).

To shed light on the process of sentence comprehension, we focused on working memory. In sentence comprehension, it is necessary to hold chunks of information in working memory in order to be able to make sense of the message conveyed by a set of words. With both typically developing children and with children who have language impairments, it has been demonstrated that working memory is an important correlate of sentence comprehension. Results from Montgomery and colleagues (Montgomery et al., 2008; Montgomery & Evans, 2009) confirm that complex sentence comprehension is significantly associated with verbal working memory. That is, understanding complex sentences requires important mental resources as well as mental effort.

Investigating the link between language abilities and working memory, most studies have focussed on verbal working memory using non-word repetition or competing language processing tasks (Archibald and Gathercole, 2006a; Archibald and Gathercole, 2006b; Montgomery et al., 2008; Montgomery & Evans, 2009). In the latter, children are asked to listen to a series of short sentences and to judge the veracity of each sentence by responding “yes” or “no”. The child is then asked to recall the final word of each of the sentences after a set of four items. One study suggests that, in children with language impairments, verbal working memory is impaired while visuospatial working memory is preserved (Archibald and Gathercole, 2006b). Yet, another study reports very low scores on a task of visuospatial working memory in children with language impairment (Archibald and Gathercole, 2006a). In this study, 50% of the participants obtained a score more than one standard deviation below the mean on a composite visuospatial short term memory index. The index included three tasks: block recall and mazes memory (Working Memory Test Battery for Children/ WMTB-C; Pickering and Gathercole, 2001), and a visual patterns test (Della Sala et al., 1997). These results taken together suggest that verbal working memory is impaired in children with language impairment and that visuospatial working memory may also be compromised for a large proportion of these children. It is therefore reasonable to propose that weak performance on tasks of sentence comprehension may be associated not only with weak performance on verbal working memory but also with weak performance on visuospatial working memory.

Given the well-documented link between sentence comprehension and working memory, we investigated these abilities in school-aged PI children. This population of children has known delays in working memory (Pollak et al., 2010). Therefore, the main purpose of this study was to investigate whether these children would perform below clinical threshold on tasks of sentence comprehension. It was further hypothesized that poor performance in sentence comprehension would be associated with poor performance in spatial working memory.

Methods

Participants

Fifty-nine children participated in this study (see Table 1 for details). Our PI group consisted of 23 children (15 females; Age $M=8$ years, 7 months; $SD=9$ months). The age-matched comparison group consisted of 36 children (19 females; Age $M=8$ years, 4 months; $SD=6$ months). Before adoption, the PI children were raised in orphanages in Bulgaria ($N=5$), Romania ($N=3$), Russia ($N=6$), China ($N=8$), and India ($N=1$). The average age at adoption was 27.2 months (range 12 months–78 months; $SD=15.37$). Table 1 reports the time of exposure to a second language and highlights the fact that PI children were more likely to have received speech/language services in the past or currently. The PI children were recruited from the Wisconsin International Adoption Project consisting of families created through international adoption who expressed interest in being contacted about research participation. Control families were recruited through community advertisements and flyers. As suggested by other researchers (Rutter, Dunn, Plomin, & Simonoff, 1997; Roberts & Scott, 2009), we recruited control families who were similar to the adoptive families in maternal level of education and median family income to ensure similar current family environments. All participants had IQs screened in the normal range (>78). Children were not included if they met the following criteria: facial phenotype of fetal alcohol exposure, diagnosis of neurologic disease, significant developmental challenge (e.g., autism), history of abuse or neglect in state or county registries, or domestic adoption. All parents provided informed consent and the procedures were approved by the University of Wisconsin Social Science Institutional Review Board.

Procedures

Hearing was screened at 20 dB HL at 500 Hz, 1000Hz, 2000 HZ, and 4000Hz in each ear using a Maico MA 39 audiometer. Vision was screened at 20/40 and better in each eye using the Graham Field Kindergarten 20 Foot Eye Chart and the Child's Recognition and Near Point Test. One parent of each participant completed a survey about the child. The survey included questions about pre-adoption and school history. Participants were individually administered all measures by one of three trained examiners with advanced degrees.

Instruments

The Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk, 1999) is a norm-referenced oral language instrument for children and young adults, ages 3–21. Data from one subtest of the CASL, the Paragraph Comprehension subtest, was analyzed in this study. The Paragraph Comprehension subtest measures auditory comprehension of syntax in spoken narratives. Items in this subtest are paragraphs having successive levels of syntactic difficulty such as complex clauses, embeddedness, and passive voice. The child is asked to listen to a story that is told in one paragraph. She then answers questions about the story by pointing to an answer offered on a page containing four pictures. Subtest scores are reported as standard scores with a mean of 100 and a standard deviation of 15. It is important to mention that comprehension of sentences in this subtest is measured using meaningful

contextual materials and that it therefore depends on the examinee's deriving the meaning of what is said, not on her memory of the specific words in the sentences themselves.

The Clinical Evaluation of Language Fundamentals – Fourth Edition (CELF-4; Semel, Wiig, & Secord, 2003) is a clinical tool for the identification, diagnosis, and follow-up evaluation of language and communication disorders in children and young adults, ages 5–21. Data from one subtest of the CELF, the Concepts and Following Directions subtest, was analyzed in this study. The Concepts and Following Directions subtest evaluates the ability to interpret spoken directions containing concepts that require logical operations, and to remember the names, characteristics, and order of mentioned objects. This subtest requires a child to listen to an oral directive of one sentence and then respond by pointing to pictured objects. Subtest scores can be reported as scaled scores with a mean of 10 and a standard deviation of 3. Unlike the CASL Paragraph Comprehension subtest, there is no story providing a context to support comprehension. The child must understand each word in relation to the others in the sentence in a de-contextualized fashion.

The Cambridge Neuropsychological Test Automated Battery (CANTAB; Cambridge Cognition Limited, Cambridge, United Kingdom, 2004) is a non-verbal cognitive assessment administered using a touch-screen computer. The full assessment contains 15 subtests in 5 main categories. Data from the Spatial Working Memory subtest was analyzed for this study. The Spatial Working Memory subtest assesses the subject's ability to retain spatial information and to manipulate remembered items in working memory. This subtest is not confounded with a child's verbal skills, but rather, provides a non-verbal measure of working memory. To perform this subtest, the child employs a process of elimination to seek blue tokens hidden in boxes on the computer screen. She then moves the tokens to fill up a column, also on the screen, while striving not to look in a box where a token has already been found. The number of boxes increases until the search for tokens involves 8 boxes. The color and position of the boxes changes across trials. Results can be reported as total errors, between errors, within errors, and/or use of strategy (Owen, Downes, Sahakian, Polkey, & Robbins, 1990). Total errors refers to the number of times a box is selected that is certain not to contain a blue token and therefore should not have been visited by the child. Between errors are those that occur when the child returns to a box where a token has already been found. Within errors occur when the child returns to a box that has already been shown to be empty earlier in the same search sequence. A measure of strategy produces a score related to the number of times a child returns to a particular box to begin each new search sequence after a token has been found. High strategy scores indicate many sequences beginning with a different box and low scores indicate many sequences starting with the same box, the latter being the more efficient strategy.

Data Analyses

We first used t-tests to compare PI and control children's results on the measures administered (Table 2). An analysis of the items on the CELF-4 on which the PI children had the worst performance was then completed (Table 3). Next, as part of an approach to testing the mediational effect of working memory, ANCOVA was used to examine the relationship between sentence comprehension and working memory.

Results

Sentence Comprehension

Two tasks of sentence comprehension were administered, the CELF-4 Concepts and Following Directions subtest and the CASL Paragraph Comprehension subtest. PI children obtained significantly lower scores than the control children on the CELF-4. While there

was trend to a lower score for the PI children on the CASL task, both groups achieved similar scores on the CASL (see Table 2). On the CELF-4, 26.1% of the PI children scored more than one standard deviation below the mean compared to 0% of the control children. On the CASL, 13.0% of the PI children scored more than one standard deviation below the mean compared to 5.6% of the control children.

To verify that errors were occurring on the difficult items of the CELF-4 Concepts and Following Directions subtest, an item analysis was completed. As can be seen in Table 3, nearly one-third of the items were failed by more than 40% of the PI children and there was a significant difference in performance between the two groups on these items. The failed items are characterized by a high number of complexity elements and a higher word count.

Spatial Working Memory

As can be seen in Table 2, results on the Spatial Working Memory subtest of the CANTAB were significantly different between the two groups. The PI children demonstrated worse performance by committing more total errors than the control children. The PI children also committed more between errors ($M=53.35$) and more within errors ($M=2.52$) than the control children ($M=37.56$; $M=1.25$) in a similar pattern as their total errors. Use of a strategy was poor in each of the groups with a mean of 34.47 for control children and a mean of 38.26 for the PI children. This indicates that both groups of children were often starting their searches with a different box, an inefficient strategy for this task.

Relationship Between Sentence Comprehension and Spatial Working Memory

A significant correlation was found between sentence comprehension as measured by the CELF-4 and spatial working memory ($r=.5$, $p<.01$). There were also significant correlations between group and sentence comprehension ($r=.543$, $p<.001$), as well as group and spatial working memory ($r=-.432$, $p=.001$) which raise important questions as to how these abilities relate to each other. To explore this further, we used a mediational model examining the relationship between spatial working memory and sentence comprehension, controlling for group. The ANCOVA confirmed a significant effect from spatial working memory to sentence comprehension ($r=-.35$, $p<.01$), which combined with a significant effect from group to spatial working memory ($r=-.43$, $p<.01$), supports a mediational hypothesis according to the joint significance test (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). It is important to note however, that the mediational effect should be viewed as only partial given that a significant residual correlation exists between group and sentence comprehension when controlling for spatial working memory ($r=.42$, $p<.01$). This means that poor spatial working memory ability only explains some of the difficulty that PI children have with sentence comprehension and that there remain other factors about this group of children that relate to poor sentence comprehension.

Discussion

The first aim of this study was to verify whether school-aged PI children's sentence comprehension abilities were weaker than those of their peers. Results on one of the two sentence comprehension tasks, the CELF-4 Concepts and Following Directions subtest, confirmed a lower performance by PI children when compared to the control group while there was trend to a lower score for the PI children on the CASL task. This is noteworthy given that the children had spent an average of six years in an enriched environment. The second aim was to find out if spatial working memory would be associated with performance in sentence comprehension. In that regard, a strong correlation was present between results on the CELF-4 Concepts and Following Directions subtest and the CANTAB Spatial Working Memory subtest, and a mediational analysis revealed that spatial

working memory results partially mediated sentence comprehension results. Taken together, these results suggest that sentence comprehension and spatial working memory may be areas of vulnerability in PI children's development.

It is noteworthy that the pattern of results differed between the two comprehension tasks. The PI children obtained significantly lower scores on the CELF-4 task. On the CASL task, the difference was observable but did not reach significance. Hence, the difference in performance between the PI children and the control group was more marked on the CELF-4 than on the CASL. This is interesting given that both are receptive language tasks that do not require verbal responses. Looking more closely at these two tests, we see that the CASL subtest uses sentences of increasing morphosyntactic complexity combined into a paragraph while the CELF-4 subtest uses single sentences that require some conceptual capacity and an ability to interpret and follow increasingly long directions. To succeed on the CELF-4 task, it is necessary to retain the verbal instructions, to map them onto visual stimuli, and to execute a sequential motor response. In this task, the child must scan the pictures to respond correctly, an effort that requires spatial abilities. It is possible that, to correctly respond to the CELF-4 task, participants must rely upon spatial working memory. This task would therefore require an underlying process that is different in nature from the process underlying the response to the CASL subtest. In the CASL Paragraph Comprehension subtest, the child does not have to retain information and map it onto visual stimuli because this task provides a context for comprehension (i.e., a story for which the child is expected to construct her own representation) that supports the child's response. It is possible that our results reflect the fact that the abilities required to succeed on these two tasks may be distinct, i.e the CELF-4 task relying more on working memory abilities than the CASL task. It could also be argued that understanding a story and answering questions about it can be conceived as an everyday language task (Rygvoid, 1999; Dalen, 2001). In their studies, Rygvoid and Dalen suggested that this type of language was a relative strength of children adopted internationally. In contrast, the CELF-4 Concepts and Following Directions subtest does not provide contextual support for comprehension. This lack of contextual support is one feature of school-related language as referred to by Rygvoid (1999) and Dalen (2001). Indeed, other authors have argued that the language used in schools tends to be more de-contextualized than the language used in everyday situations (Paul, 2007; Wallach, 2008; Westby, 2005).

Comprehension of de-contextualized language is precisely the challenge that the CELF-4 Concepts and Following Directions subtest represents. The PI children not only obtained significantly lower scores than the control children on that task, but greater than one quarter of the PI children scored more than one standard deviation below the mean. An in-depth analysis of the CELF-4 subtest items failed more frequently by the PI children revealed that some elements of complexity in the sentences were more challenging than others for this group, those being sequence, temporality, higher level command (i.e., requiring more operations), serial orientation, and modifiers. The PI children obtained the poorest results on the more difficult items, those that included an increasing number of these complex elements as well as a higher word count (e.g., *Point to the two cars that are to the right of a house, then point to the last house*). On this subtest, it is reasonable to assume that as the number of words and complex elements increases in the items the demand on working memory also increases. Given that our PI children demonstrated weaker spatial working memory abilities than the control children, this suggests a possible explanation for the disparate results seen in our two groups.

Poor performance on following complex oral directions is of great concern because this skill is clearly associated with academic success (Cain & Oakhill, 2007; Semel et al., 2003; Walters & Chapman, 2000). In a school setting, children must follow orally presented

directions for classroom assignments and homework, as well as for behavior in the classroom. Furthermore, the ability to follow oral directions is an important skill for developing positive family and peer relationships. Taken together, our results regarding the sentence comprehension abilities of PI children lend support to the idea that PI children have particular difficulty with school-related language as previously discussed by Rygvold (1999) and Dalen (2001). Our results lend support to the idea put forward by these authors that the shift to using language for academic purposes during school-aged years may be a challenge for PI children. We believe that the CASL subtest has more similarities with children's everyday language and the CELF-4 subtest has more similarities with children's school-related language, according to the descriptions provided by Rygvold and Dalen. This difference in language types in these two subtests provides another possible explanation for the disparate results seen in our two groups.

Now let us turn to the spatial working memory task. The PI children in our sample obtained results that were significantly weaker than those of the comparison group, which is consistent with previous data from our lab (Pollak et al., 2010). On the CANTAB Spatial Working Memory subtest the PI group committed more total errors, as well as more between errors and more within errors, than the control group. They also were somewhat less likely than the control group to employ an effective strategy, although neither group was particularly efficient in this regard. In addition, our data showed a strong correlation between results obtained on the sentence comprehension task and on the spatial working memory task. Finally, spatial working memory was found to partially mediate the sentence comprehension results.

The correlation found between the CELF subtest and the CANTAB subtest further supports the idea that working memory is indeed an underlying mechanism of sentence comprehension and add to a body of knowledge on that topic (Montgomery et al., 2008; Roberts, et al., 2007). To date, most of the studies with children that investigate the link between working memory and sentence comprehension have been carried out with children who present with identified language impairment. In that context, results similar to ours have previously been reported (Marton & Schwartz, 2003; Montgomery & Evans, 2009). These authors maintain that an efficient working memory is probably an underlying mechanism for optimal sentence comprehension. In the CELF-4 comprehension task used in our study, upon hearing a long sentence, a child must simultaneously retrieve the semantic information about the words, assign syntactic functions to the words, *e.g. agent, action, object*, and take into account sequential information about the sentence heard. This requires holding information in working memory while simultaneously processing other parts of the information. Our results, therefore, are consistent with the finding that the processing of more complex sentences requires more working memory capacity (Marton & Schwartz, 2003). They also are consistent with the work of Owen et al. (1990) where working memory is essential for the storage of a correct sequence.

It is noteworthy that the measure of working memory used in this study is designed to assess the integrity of the visuospatial working memory. It has been argued that the two slave systems of the central executive in working memory (i.e., verbal and visuospatial) are relatively separate (Gathercole, Pickering, Ambridge, & Wearing, 2004). Yet, in our study using a spatial working memory task, we obtained results confirming an association between working memory and sentence comprehension. While the task used differs from those reported in other studies, the results nevertheless support the idea that there is a link between sentence comprehension and working memory. As noted earlier, it is also intriguing that while verbal working memory may be more closely associated with sentence comprehension than visuospatial working memory, some previous results also suggested that children with language impairment are at risk of having weak visuospatial working memory skills

(Archibald and Gathercole, 2006a). Furthermore, the results of the analysis of covariance done in this study lend support to the idea that working memory, even spatial working memory, at least partially mediates sentence comprehension. This means that, in order to correctly understand complex directions, children must rely on short term memory, storing some elements of the sentence in working memory, and then process the sentence in order to correctly carry out the direction. It also suggests that working memory abilities as a whole may serve as a foundation for sentence comprehension and that, when measuring spatial working memory, we tap into a mechanism that may adequately reflect the integrity of working memory as a whole.

Strengths and Limitations of the Study

A first strength of our study was in examining a sample of children who shared the characteristics of having been internationally adopted as well as having spent their early life in an institution prior to the adoption. While our sample remains heterogeneous in nature, the fact that these two variables were documented for all of our PI participants contributes to clarifying the future applications of these results. Second, we followed the advice of Rutter et al. (1997) as well as Roberts & Scott (2009) who suggest that comparison groups for PI children be matched in terms of parental education and socioeconomic levels since adoptive parents generally have high levels of education and financial security. It is possible that, had we not done this, our PI group would have performed better in comparison with their peers. Our point, however, is this: it is critical to use control children from similar family environments as the PI children. This is because normed tests include a full range of children from impoverished to enriched family environments, but PI children tend to be attending school in the more affluent and educated neighborhoods. As discussed by Lahey (1990), this puts PI children at great risk of social and academic failure in communities where a large percentage of children perform above average. While it does not necessarily follow that we should designate low-performing PI children as language disordered, it certainly means that they are at risk for language-related problems.

It is important to keep in mind that there is enormous individual variability among children who join their families through international adoption (Glennen, 2007). Our sample of PI children was no exception as can be seen in Table 1 where we report wide ranges in time in institution, age at adoption, and exposure to a second language. This could be seen as a limitation of this study. However, we also made great effort to keep our PI sample similar in respect to our control sample as was reported in our methods section and this can be seen as a strength of this study as discussed above.

Two limitations of the present study also warrant discussion. First, it must be acknowledged that this sample is relatively small and heterogeneous, and that our results must therefore be interpreted with caution. Second, as was previously mentioned, we report on data from an extant database which means that neither the participants nor the tasks available were selected *a priori*. In examining this existing dataset, the initial objective was to describe and explain sentence comprehension abilities in this sample of PI children. This interest was prompted by observations of the examiners regarding the differences in performance of PI children on the CELF and the CASL subtests. In reviewing the literature, the importance of the relationship between sentence comprehension and working memory was striking, leading to analysis of the existing spatial working memory data. On one hand, it may be argued that using a measure of phonological loop integrity would have strengthened the design of this study. On the other hand, the fact that the visuospatial working memory measure was associated with sentence comprehension scores could also be considered to be a novel finding that strengthens the argument that working memory is one of the underlying mechanisms for sentence comprehension. This being said, given the current results, the strongest design may well be to use both types of measures of working memory, that of the

phonological loop and of the visuospatial sketchpad, in a future study in order to further describe the link between working memory and sentence comprehension. We must also keep in mind that the task used in our study to examine working memory may also tap into other elements of executive functioning subserved by the prefrontal cortex and that working memory did not account for all of the difficulty with sentence comprehension.

Conclusion and Future Directions

Our results show that PI children have more difficulty with comprehension of de-contextualized sentences and spatial working memory than peers who live in their birth families. This is in line with previous suggestions that everyday language is preserved while school-related language is impaired in PI children. This information suggests that in planning special educational services for PI children, sentence comprehension and working memory abilities should be directly assessed and targeted for intervention, as needed. This would facilitate intervention decisions as early as possible to prevent learning difficulties. It further invites professionals working with young or recently adopted children and their families to employ a preventive approach with regards to learning, thereby encouraging planners of early intervention services to consider international adoption as a risk factor for requiring services. Future studies might also address the question of whether the language vulnerabilities described for school-aged PI children resolve as they mature and whether there is a link between sentence comprehension and future reading abilities.

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Table 1

Sample Characteristics

	Post-institutionalized (N=23)	Control (N=36)	Statistics	p value
Age (Mean (SD), range)	8 y. 7 mos (0.77), 8 – 11;5	8 y. 4 mos (0.49), 8 – 9;9	t= 1.61	0.11
Gender (% male)	35	47	$\chi^2 = 0.346$	0.25
Maternal education	Associate degree or college academia program	Bachelor's degree		
Median family income	\$50–75,000	\$50–75,000		
Time in institution (mos), range	26.09 (14.96), 11–77	N.A.		
Exposure to 2 nd language (mos), range	81.37 (20.84), 19–114	N.A.		
Speech/language services (%)				
Past	30.4	11.1	$\chi^2 = 3.46$	0.06
Current	34.8	0	$\chi^2 = 14.49$	< 0.001

Table 2

Descriptive Data on Assessment Results

	Post-institutionalized	Control	<i>t</i> value	<i>p</i> value	Cohen's <i>d</i>
	Mean (SD) Range				
Sentence comprehension					
CASL Paragraph comprehension ¹	105.61 (17.29) 76–135	116.19 (14.93) 64–136	–2.50	0.15	0.71
CELF-4 Concepts & following directions ²	8.44 (3.79) 1–13	12.28 (2.28) 7–16	–4.39	<0.001	1.69
Spatial working memory					
CANTAB ³	54.39 (18.06) 17–89	37.92 (16.40) 4–64	3.62	0.001	–1.00
¹ standard score					
² scaled score					
³ total errors					

Table 3

Results on items from the CELF-4

Item	Post-institutionalized (N=23) % who failed	Control (N=36) % who failed	χ^2	p value
42	43.5	5.6	12.46	0.001
46	43.1	8.3	10.09	0.002
47	47.8	16.7	6.64	0.01
48	52.2	13.9	10.03	0.002
49	43.5	22.2	2.99	0.007
50	60.9	25.0	7.59	0.007
51	69.6	27.8	9.94	0.002
53	65.2	36.1	4.77	0.03
54	82.6	44.4	8.8	0.003