Sentence Comprehension in Postinstitutionalized School-Age Children

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Purpose: In this study, the authors investigated sentence comprehension and spatial working memory abilities in a sample of internationally adopted, postinstitutionalized (PI) children. The authors compared the performance of these PI children with that of an age-matched group of children living with their birth families. They 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-age 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 2 groups.

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

Key Words: children, international adoption, postinstitutionalized, sentence comprehension, spatial working memory

Children who were adopted internationally and who also spent some of their preadopted life in orphanage care are known as postinstitutionalized (PI) children. 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 corpus of research on language development and international adoption, not all studies have specifically documented postinstitutionalization effects. In addition, the 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, Roberts, & Krakow, 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). In this study, we examined the sentence comprehension abilities of school-age PI children and tested the relationship between sentence comprehension and spatial working memory skills. The literature linking sentence comprehension and working memory in school-age children provides the basis for this examination and may help explain why these children perform differently on various measures of language functioning (Marton & Schwartz, 2003; Montgomery, 2003; Montgomery, Magimairaj, & O’Malley, 2008; L. Roberts, Marinis, Felser, & Clahsen, 2007).

Language Development of PI Children

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

Investigations into how the negative conditions in orphanage settings affect a child’s language development
after adoption into a more enriched environment have produced inconsistent results. One reason for this inconsistency may be that different types of instruments tap into different components of language (J. A. Roberts & Scott, 2009). One group of studies relied on answers to questionnaires or surveys completed by parents, by 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 Prescreening Developmental Questionnaire (Frankenburg, Fandal, & Thornton, 1987) and the Children’s Communication Checklist—2 (Bishop, 2006). 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 have indicated that language abilities of PI children are weaker than those of their peers (Groze & Ileana, 1996; Judge, 2004; Tirella et al., 2006). Another group of studies has used instruments that directly assess language skills in PI children, which perhaps are better measures of language performance than questionnaires and surveys; however, these studies also have reported mixed results. For example, Croft et al. (2007) investigated a cohort of 132 PI children adopted from Romanian orphanages and compared their results with those of 49 children adopted domestically, without orphanage experience. They measured sentence comprehension, vocabulary, and narrative discourse when the children were 6 years old and then 11 years old. Croft et al. found that the children who had experienced fewer 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 ages 7 and 9 years who were adopted from China. The authors administered an in-depth battery of standardized tests that measured comprehension and expression abilities as well as academic achievement and reading skills and found that most of the girls exhibited scores in the average to above-average range for all standardized measures administered. Therefore, although some data suggest 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 of 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 with the comprehension of sentences that require the interpretation of complex syntactic features. These complex sentences contain elements such as semantically reversible passive verbs (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-age children for whom, 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 included 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, researchers have demonstrated that working memory is an important correlate of sentence comprehension. Results from studies conducted by 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.

Most studies that have investigated the link between language abilities and working memory have focused on verbal working memory, using nonword repetition or competing language-processing tasks (Archibald & Gathercole, 2006a, 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.” After responding to four items, the children are then asked to recall the final word of each of the sentences.
One study suggested that, in children with language impairment, verbal working memory is impaired but visuospatial working memory is preserved (Archibald & Gathercole, 2006b); however, another study reported very low scores on a task of visuospatial working memory in children with language impairment (Archibald & Gathercole, 2006a). In the latter study, 50% of the participants obtained a score more than 1 SD below the mean on a composite visuospatial short-term memory index. The index included three tasks: (a) block recall, (b) mazes memory (from the Working Memory Test Battery for Children; Pickering & Gathercole, 2001), and (c) a visual patterns test (Della Sala, Gray, Baddeley, & Wilson, 1997). Taken together, these results 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 with weak performance not only on verbal working memory but also on visuospatial working memory.

Given the well-documented link between sentence comprehension and working memory, we investigated these abilities in school-age 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 a clinical threshold on tasks of sentence comprehension. We further hypothesized that poor performance in sentence comprehension would be associated with poor performance in spatial working memory.

## Method

### Participants

Fifty-nine children participated in this study that examined an extant database (see Table 1 for details). Our PI group consisted of 23 children (15 females: M age = 8;7 [years; months], SD = 0.77). The age-matched comparison group consisted of 36 children (19 females: M age = 8;4, SD = 0.49). 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). Average age at adoption was 27.2 months (range: 12–78, SD = 15.37). In Table 1, we report the time of exposure to a second language and highlight the fact that PI children were more likely to have received speech/language services in the past or currently. PI children were recruited from the Wisconsin International Adoption Project, which consists of families created through international adoption who have expressed an interest in being contacted about research participation (see www.waisman.wisc.edu/childemotion/wiap.html). Control families were recruited through community advertisements and flyers. As suggested by other researchers (J. A. Roberts & Scott, 2009; Rutter, Dunn, Plomin, & Simonoff, 1997), we recruited control families who were

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>PI (n = 23)</th>
<th>Control (n = 36)</th>
<th>Statistic</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>t(57) = 1.61.11</td>
<td></td>
<td></td>
<td>.11</td>
</tr>
<tr>
<td>M (years;months)</td>
<td>8;7</td>
<td>8;4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD (months)</td>
<td>0.77</td>
<td>0.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range (years;months)</td>
<td>8;0–11;5</td>
<td>8;0–9;9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (% male)</td>
<td>35</td>
<td>47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal education</td>
<td>Associate degree or college academic program</td>
<td>Bachelor’s degree</td>
<td></td>
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<tr>
<td>Median family income</td>
<td>$50,000–$75,000</td>
<td>$50,000–$75,000</td>
<td></td>
<td></td>
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<tr>
<td>Time in institution (months)</td>
<td>26.09</td>
<td>14.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>11–77</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Exposure to second language (months)</td>
<td>81.37</td>
<td>20.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>19–114</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speech-language services (%)</td>
<td>30.4</td>
<td>11.1</td>
<td></td>
<td>.06</td>
</tr>
<tr>
<td>Past</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>34.8</td>
<td>0</td>
<td></td>
<td>.001</td>
</tr>
<tr>
<td>Note. PI = postinstitutionalized.</td>
<td></td>
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</tr>
</tbody>
</table>
similar to the adoptive families in regard to maternal level of education and median family income, to ensure similar current family environments. All participants had screened IQs 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.

**Procedure**

Hearing was screened at 20 dB HL at 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz in each ear using a Maico MA 39 audiometer. Vision was screened at 20/40 and better in each eye using the Kindergarten 20 Foot Eye Chart (TechMed Services, 2000) and the Child’s Recognition and Near Point Test (Western Optical, 2011). One parent of each participant completed a survey about the child. The survey included questions about preadoption 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 through 21. Data from one subtest of the CASL, Paragraph Comprehension, were analyzed in this study. This subtest measures auditory comprehension of syntax in spoken narratives. Items on it are paragraphs with 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. He or 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 \( M = 100 \) and \( SD = 15 \). It is important to mention that comprehension of sentences in this subtest is measured using meaningful contextual materials and that therefore the respondent’s score depends on the examinee’s derivation of the meaning of what is said, not on his or 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 used for the identification, diagnosis, and follow-up evaluation of language and communication disorders in children and young adults, ages 5 through 21. Data from one subtest of the CELF, Concepts and Following Directions, were analyzed in this study. This subtest evaluates the respondent’s ability to interpret spoken directions containing concepts that require logical operations and to remember the names, characteristics, and order of mentioned objects. It 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 \( M = 10 \) and \( SD = 3 \). 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 decontextualized fashion.

The Cambridge Neuropsychological Test Automated Battery (CANTAB; Cambridge Cognition Limited, 2004) is a nonverbal cognitive assessment administered using a touch-screen computer. The full assessment contains 15 subtests in five main categories. Data from the Spatial Working Memory subtest were analyzed for this study. This subtest assesses the respondent’s ability to retain spatial information and to manipulate remembered items in working memory. The subtest is not confounded with a child’s verbal skills but instead provides a nonverbal measure of working memory. To perform this subtest, the child uses a process of elimination to seek blue tokens hidden in boxes on the computer screen. He or she then moves the tokens to fill 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 eight boxes. The color and position of the boxes change across trials. The results can be reported as total errors, between errors, within errors, and/or use of strategy (Owen, Downes, Sahakian, Polkey, & Robbins, 1990). The term *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 in which 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 (see Table 2). We then conducted an analysis of the items on the CELF–4 on which the PI children had the worst
performance (see Table 3). Next, as part of an approach to testing the mediational effect of working memory, we used an analysis of covariance (ANCOVA) to examine the relationship between sentence comprehension and working memory.

Results

Sentence Comprehension

Two tasks of sentence comprehension were administered: (a) the CELF–4 Concepts and Following Directions subtest and (b) the CASL Paragraph Comprehension subtest. PI children obtained significantly lower scores than the control children on the CELF–4. Although there was trend toward 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 1 SD below the mean, compared with 0% of the control children. On the CASL, 13.0% of the PI children scored more than 1 SD below the mean, compared with 5.6% of the control children.

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 = 37.56 and 1.25, respectively), in a pattern similar to that of their total errors. Use of a strategy was poor in each of the groups, with a mean of 34.47 for the 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 = .50, p < .01). There were also significant correlations between group and sentence comprehension (r = .54, p < .001), as well as between group and spatial working memory (r = -.43, p = .001), that raised important questions as to how these abilities relate to each other. To explore this further, we used a

To verify that errors were occurring on the difficult items of the CELF–4 Concepts and Following Directions subtest, we performed an item analysis. 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 complex elements and a higher word count.

Table 3. Results on items from the CELF–4.

<table>
<thead>
<tr>
<th>Item</th>
<th>PI (n = 23)</th>
<th>Control (n = 36)</th>
<th>χ²[1, N = 59]</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>43.5</td>
<td>5.6</td>
<td>12.46</td>
<td>.001</td>
</tr>
<tr>
<td>46</td>
<td>43.1</td>
<td>8.3</td>
<td>10.09</td>
<td>.002</td>
</tr>
<tr>
<td>47</td>
<td>47.8</td>
<td>16.7</td>
<td>6.64</td>
<td>.01</td>
</tr>
<tr>
<td>48</td>
<td>52.2</td>
<td>13.9</td>
<td>10.03</td>
<td>.002</td>
</tr>
<tr>
<td>49</td>
<td>43.5</td>
<td>22.2</td>
<td>2.99</td>
<td>.007</td>
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<tr>
<td>50</td>
<td>60.9</td>
<td>25.0</td>
<td>7.59</td>
<td>.007</td>
</tr>
<tr>
<td>51</td>
<td>69.6</td>
<td>27.8</td>
<td>9.94</td>
<td>.002</td>
</tr>
<tr>
<td>53</td>
<td>65.2</td>
<td>36.1</td>
<td>4.77</td>
<td>.03</td>
</tr>
<tr>
<td>54</td>
<td>82.6</td>
<td>44.4</td>
<td>8.8</td>
<td>.003</td>
</tr>
</tbody>
</table>

Note. CASL = Comprehensive Assessment of Spoken Language; CELF–4 = Clinical Evaluation of Language Fundamentals, Fourth Edition; CANTAB = Cambridge Neuropsychological Test Automated Battery.

*Standard score. †Scaled score. ‡Total errors.
mediational model to examine 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 \( (r = -0.35, p < 0.01) \), which, combined with a significant effect from group to spatial working memory \( (r = -0.43, p < 0.01) \), 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 \( (r = 0.42, p < 0.01) \). This means that poor spatial working memory ability explains only 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-age 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 with the control group, and there was a trend toward a lower score for the PI children on the CASL task. This is noteworthy given that the children had spent an average of 6 years in an enriched environment. The second aim was to determine whether 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 than the control group 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. If one looks more closely at these two tests, one can see that the CASL subtest uses sentences of increasing morphosyntactic complexity combined into a paragraph, whereas 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, map them onto visual stimuli, and 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 on 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 his or 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., that the CELF-4 task relies more on working memory abilities than the CASL task does). One could also argue that understanding a story and answering questions about it can be conceived as an everyday language task (Dalen, 2001; Rygvold, 1999). In their studies, Rygvold (1999) and Dalen (2001) 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 Rygvold and Dalen; indeed, other authors have argued that the language used in schools tends to be more decontextualized than the language used in everyday situations (Paul, 2007; Wallach, 2008; Westby, 2005).

Comprehension of decontextualized language is precisely the challenge that the CELF-4 Concepts and Following Directions subtest represents. Not only did the PI children obtain significantly lower scores than the control children on that task, but also more than one quarter of the PI children scored more than 1 SD 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 elements 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 the two groups.

Poor performance on tasks that require one to follow 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 the school-age years may be a challenge for PI children. We believe that the CASL Paragraph Comprehension subtest has more similarities with children’s everyday language and that the CELF–4 Concepts and Following Directions subtest has more similarities with children’s school-related language, according to the descriptions provided by Rygvold (1999) and Dalen (2001). This difference in language types in these two subtests provides another possible explanation for the disparate results seen in our two groups.

Now, we 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 laboratory (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 use 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–4 Concepts and Following Directions subtest and the CANTAB Spatial Working Memory subtest further supports the idea that working memory is indeed an underlying mechanism of sentence comprehension and adds to a body of knowledge on that topic (Montgomery et al., 2008; L. Roberts et al., 2007). To date, most of the studies of children that have investigated the link between working memory and sentence comprehension have examined children who present with identified language impairment. In that context, results similar to ours have previously been reported (Marton & Schwartz, 2003; Montgomery & Evans, 2009). Montgomey and Schwartz (2003) and Montgomery and Evans (2009) have maintained 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 are therefore 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), who found that working memory is essential for the storage of a correct sequence.

It is noteworthy that the measure of working memory used in this study was designed to assess the integrity of the visuospatial working memory. Researchers have 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. Although 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 although verbal working memory may be more closely associated with sentence comprehension than is visuospatial working memory, some previous results also suggest that children with language impairment are at risk of having weak visuospatial working memory skills (Archibald & Gathercole, 2006a). Furthermore, the results of the ANCOVA performed 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, one taps into a mechanism that may adequately reflect the integrity of working memory as a whole.
**Strengths and Limitations of This Study**

A first strength of our study was that we examined a sample of children who shared the characteristics of having been internationally adopted and had spent their early lives in an institution prior to the adoption. Although our sample remains heterogeneous in nature, the fact that these two variables were documented for all of our PI participants contributes to researchers’ ability to clarify the future applications of these results. Second, we followed the advice of Rutter et al. (1997) as well as that of J. A. Roberts and Scott (2009), who suggested that comparison groups for PI children be matched in terms of parental education and socioeconomic levels, because adoptive parents generally have high levels of education and financial security. It is possible that, had we not done this, the children in 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 family environments that are similar to those of 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 more affluent and educated neighborhoods. As Lahey (1990) discussed, this puts PI children at great risk of social and academic failure in communities where a large percentage of children perform above average. Although it does not necessarily follow that we should designate low-performing PI children as having a language disorder, 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 spent in an institution, age at adoption, and exposure to a second language. This could be seen as a limitation of this study. However, we also made a concerted effort to keep our PI sample similar in respect to our control sample, as we reported in the Method section; this can be seen as a strength of this study, as discussed above.

Two limitations of the present study also warrant discussion. First, we acknowledge that this sample was relatively small and heterogeneous and that our results must therefore be interpreted with caution. Second, as 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 data set, 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—4 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 the one hand, one could argue 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 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 that of the visuospatial sketch pad—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 the possibility 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 decontextualized sentences and spatial working memory than do peers who live with their birth families. This is in line with previous suggestions that everyday language is preserved, whereas 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 who work with young or recently adopted children and their families to use a preventive approach with regard 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-age PI children resolve as they mature and whether there is a link between sentence comprehension and future reading abilities.

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