# Verbal Working Memory in Bilingual Children

**Vera F. Gutiérrez-Clellen**
**Janet Calderón**
San Diego State University,
San Diego, CA

**Susan Ellis Weismer**
University of Wisconsin–
Madison

The present study compared the performance of 44 Latino children on the Competing Language Processing Task (CLPT; C. Gaulin & T. Campbell, 1994) and the Dual Processing Comprehension Task (DPCT; S. Ellis Weismer, 1996). First, it was of interest to know if there were significant differences between children with and without bilingual proficiency on processing tasks that were assumed to require limited vocabulary knowledge. The second goal of this research was to determine whether there were cross-linguistic differences in verbal working memory by examining performance within bilinguals and between children with limited proficiency in a second language. The performance of the participating children was also examined in the context of research with other English-speaking groups. Finally, given that the CLPT and the DPCT may differ in their processing demands (from a relative focus on storage to one of attention inhibition or resistance to interference), it was important to know the extent to which these tasks were related or involved similar cognitive–linguistic operations. Results revealed shared processing skills as well as differences related to individual attainments in bilingual acquisition.

**KEY WORDS: verbal, working, memory, bilingual, children**

Current demographic trends in the United States indicate a significant increase in the number of children who are bilingual and, in particular, who speak Spanish as their first language (L1). Yet, available assessment tools are not normed for this population (for a review, see Gutiérrez-Clellen, 1996). In addition, typical language assessments rely heavily on previous language experience, which may vary depending on the child's exposure to the languages before the assessment (Umbel, Pearson, Fernandez, & Oller, 1992) and may not clearly differentiate language disorders from language differences (e.g., Paradis & Crago, 2000). Recent studies with culturally and dialectally diverse groups indicate that processing measures may be less biased than traditional language-assessment tasks because they are assumed to rely less on previous language experience (Campbell, Dollaghan, Needleham, & Janosky, 1997; Ellis Weismer & Evans, 2002; Ellis Weismer, Tomblin, Zhang, Chynoweth, & Jones, 2000). Thus, from a clinical perspective, it would be important to know how these tasks could be applied to the assessment of bilingual children. However, before one can evaluate the sensitivity of these measures for the identification of bilingual children with language disorders, we need a better understanding of normal individual differences within bilingual groups. Specifically, we will focus on verbal working memory (VWM) tasks in children with limited second-language (L2) abilities and in children with high L1 and L2 proficiency. These tasks have been used previously in research with children with various language skills and have been found to differentiate groups with different levels of language ability.

## Verbal Working Memory in Monolinguals

VWM is a dynamic part of the memory system that is responsible for maintaining temporary information during mental operations. The specific processes involved in VWM may vary across tasks (Adams, Bourke, & Willis, 1999; Gathercole & Pickering, 2000; Swanson, Howell Ashbaker, & Lee, 1996), and there is no clear consensus as to whether working memory reflects the capacity to allocate resources to processing and storage activities (Hitch, Towse, & Hutton, 2001) or a capacity for controlled, sustained attention in the presence of interference or distraction (Conway & Engle, 1994; Engle, Conway, Tuholski, & Shisler, 1995; Engle, Kane, & Tuholski, 1999; Rosen & Engle, 1997). Several models have been proposed to describe VWM in monolinguals. For example, in Baddeley's (1986) model, there is an attentional control mechanism, or central executive, and two modality-specific storage buffers, the visuospatial and phonological loop components. In contrast, unitary models such as that of Daneman and Carpenter (1980) and Just and Carpenter (1992) focus on the VWM role of the central executive without fractionating the system into modality-specific components.

While the processes involved continue to be investigated, several tasks have been applied in research on VWM with children. In the present study, we focus on the Competing Language Processing Task (CLPT), adapted by Gaulin and Campbell (1994) from the original task developed by Daneman and Carpenter (1980). In this task, participants are asked to listen to sets of unrelated sentences while simultaneously attempting to retain the last word of each sentence. In addition, we will examine an alternative task, the Dual Processing Comprehension Task (DPCT), in which participants are asked to reenact each of two sentences presented at the same time (Ellis Weismer, 1996). Both tasks require the simultaneous storage and processing of information as central functions of VWM. However, these tasks may vary in their processing demands, and therefore, they may reveal differences in control of processing or ability to sustain attention under conditions of interference or distraction, such as when participants need to suppress sentence information and just remember the last word or when they need to attend to two sentences at the same time.

Early studies with monolingual adults indicated that performance on VWM tasks relates to reading and listening comprehension (Daneman & Carpenter, 1980; Just & Carpenter, 1992). Adults with smaller reading or listening spans had difficulty maintaining information under attention while processing new information and, as a result, made more errors on comprehension tasks than adults with larger spans. These relationships have been corroborated in research with children as well. The comprehension problems of monolingual children with accurate word-reading ability have been attributed in part to limited VWM skills (Yuill, Oakhill, & Parkin, 1989). Word recall appears to contribute to variance in reading comprehension independently of word-recognition abilities (Gottardo, Stanovich, & Siegel, 1996; Leather & Henry, 1994; Swanson & Berninger, 1995).

Research on VWM in monolingual children has found that these measures may reveal differences in language ability. Gaulin and Campbell (1994) developed the CLPT, a listening span measure for children that was based on an adult measure of VWM (Daneman & Carpenter, 1980). Gaulin and Campbell examined the CLPT performance of 68 monolingual children, ages 6, 8, and 10 years, and found a developmental trend across age groups and a high significant correlation between CLPT scores and children's receptive vocabulary skills. Compared to these developmental norms, children with specific language impairment (SLI) demonstrated word recall that was 2 *SD*s below the mean for their age (Ellis Weismer, 1996) and significantly poorer than that of controls with normal language (NL), even when differences in nonverbal cognitive scores were used as a covariate (Ellis Weismer, Evans, & Hesketh, 1999).

Children with SLI also have specific difficulties on dual-processing tasks such as the DPCT (Ellis Weismer, 1996). While their ability to process individual sentences may not differ from that of controls, they show disproportionate decrements in processing sentences presented at the same time (Ellis Weismer, 1996; Ellis Weismer & Thordardottir, 2002). Ellis Weismer and Thordardottir found that the CLPT, the DPCT, and a nonword repetition task accounted for significant variance in children's language abilities beyond that attributable to differences in nonverbal cognition for a sample of 134 monolingual school-age children with a wide range of language and cognitive abilities (Ellis Weismer & Thordardottir, 2002). These results support associations between control of processing in VWM and language skills in monolingual children with varying levels of language proficiency.

## Verbal Working Memory in Bilinguals

To our knowledge, no published studies have examined the performance of bilingual children on either the CLPT or the DPCT. Although bilingual studies from a cognitive–linguistic perspective have emphasized the role of the central executive and the presence of significant associations between language processing and fluency in a second language, these studies have used different tasks and have produced inconclusive evidence for a processing advantage or disadvantage for bilingual children (Bialystok, 1992, 2001). Research with bilingual adults has shown that performance may be affected by the speakers' proficiency, language preference, and the nature of the task. Harris, Cullum, and Puente (1995) compared 44 bilingual adults and 22 English monolinguals on their memory rates and found that the bilingual speakers had lower English scores. Yet, there were no group differences when bilinguals were compared on their dominant languages. Research suggests that cross-language differences in VWM within bilingual speakers may also be revealed depending on the listening conditions (e.g., Daro & Fabbro, 1994) and tasks used (Ardila et al., 2000). For example, the bilinguals studied by Ardila and colleagues performed better in L1 (Spanish) than in L2 (English) for some tasks, in spite of the fact that over half of them reported better proficiency in L2 and were considered highly fluent in the two languages.

Research with L2 learners suggests that VWM tasks may be useful to assess their proficiency. Harrington and Sawyer (1992) examined the English performance of 34 Japanese adult English language learners by means of three memory tasks (digit span, word span, and reading span). The digit span consisted of eight sets of three strings of random digits. The word span was a simple VWM task with five sets of three strings of unrelated words. The reading span was based on the task developed by Daneman and Carpenter (1980). It consisted of 42 sentences (half were selected to be ungrammatical by reversing the last four to six preterminal words) presented in sets of increasing size (from 2 to 5 sentences per set). Participants had to read each sentence and then write down the final word of each sentence in the set. Digit span, word span, and reading span scores were then correlated to English reading using a cloze passage and the Grammar and Reading sections of the Test of English as a Foreign Language (TOEFL). The reading span task was significantly correlated to the TOEFL measures but not the digit span or word span tasks. The findings suggest that a complex VWM measure such as reading span can help predict differences in L2 proficiency. Although there is no research available using the CLPT or the DPCT with bilingual children, there is indication that VWM tasks can help predict L2 proficiency in young children (e.g., Masoura & Gathercole, 1999; Service, 1992). Service (1992) examined the relationship between VWM and L2 learning in a school setting. Children were administered measures of working memory and 2½ years later were assessed in their L2 abilities. The VWM measures were found to be good predictors of L2 acquisition. The tasks accounted for 47% of the variance in L2 learning.

Bilingual studies also have shown that the ability to attend and recall elements in a sentence is not language-specific. Osaka and Osaka (1992) administered Daneman and Carpenter's (1980) reading span task in English and a similar reading span task in Japanese to 30 Japanese–English bilingual adults. They found that within highly proficient speakers, the two languages were highly correlated. L1 reading span may be useful to predict L2 reading span. These cross-linguistic correlations within bilinguals were later replicated with an older group of 15 Swiss German–French bilinguals (Osaka, Osaka, & Groner, 1993) and were also reported for French–English bilinguals (Hummel, 2000). The correlations indicated a general (rather than language-specific) capacity to simultaneously store and process incoming information in spite of differences between the languages.

The present study compared the performance of bilingual children and language controls on two VWM tasks: the CLPT and the DPCT. First, it was of interest to determine if there were significant differences on these measures between fluent bilingual Spanish–English children and children who were proficient in only one of these languages. If L2 learning provided any significant control-of-processing advantage on these tasks, the fluent bilingual children would demonstrate higher VWM performance than the children who were proficient in one language. On the other hand, if L2 learning had a negative effect on processing performance related to an increase in cognitive load, the performance of the bilingual group would be expected to be lower than that of the groups with single-language proficiency.

The second aspect of this research examined the cross-language performance within fluent bilinguals. It was expected that the VWM tasks would reveal within-group differences given the fact that children who were highly fluent and proficient in two languages may not show equivalent performance in the L1 and L2, in particular when given tasks that were highly demanding on control of processing (Gutiérrez-Clellen, 2002).

The third goal of this study was to evaluate the adequacy of the Spanish version of the CLPT and the DPCT. Given that neither the CLPT nor the DPCT has been tested in Spanish (a language with different characteristics from English), it was necessary to determine whether language-specific differences had any effect on processing performance by comparing the performance of Spanish-speaking children with limited English proficiency with that of English-speaking children with limited Spanish proficiency.

Finally, we hypothesized that the CLPT and the DPCT may vary in their processing demands (from a relative focus on storage to one of greater attention inhibition or resistance to interference). As was described earlier, the CLPT requires the listener to attend to a sequence of unrelated sentences (one at a time), judge each sentence for its truthfulness, and retain the last word for later recall. In contrast, in the DPCT, the listener hears two sentences at the same time. Sufficient control of processing is required so that processing one sentence does not interfere with processing the other. Thus, it was important to know the extent to which these tasks were related or involved similar cognitive–linguistic operations within individuals.

# Method

## Participants

Forty-four typically developing children and their families were sampled from second-grade classes of a large school district serving predominantly low-income families in Southern California. Parent education levels varied across families, but they were well distributed across groups. Within families of children with limited L2 proficiency, 5 families reported primary education, 15 reported secondary education, and 2 reported college education. Of the 22 bilingual families, 3 had primary education, 18 had secondary education, and 1 had a college education. Except for one child of Puerto Rican descent, all children were of Mexican American descent. The children ranged in age from 7.3 to 8.7 years, with a mean of 8.1 years. There were 26 boys and 18 girls. None of the participating children had a history of hearing loss, developmental delays, language delays, and/or significant health problems, based on school records. They had all passed recent hearing screenings at their schools and were reading at grade level in the target language of instruction based on teacher reports. That is, children who were receiving primarily English instruction were achieving at grade level in English. Children who were attending primarily Spanish-speaking classrooms were achieving at grade level in Spanish.

Given that current language-proficiency tests have limited validity (Valdés & Figueroa, 1994), the bilingual status of the participants was determined based on data derived from parent interviews, teacher questionnaires, and spoken narrative samples (for details on the validation of parent and teacher questionnaires for establishing bilingual status, see Gutiérrez-Clellen & Kreiter, 2003). Parent interviews were used to obtain estimates of amount of exposure to the languages at home and ratings of use and proficiency. Teacher questionnaires provided an estimate of the amount of exposure to the languages at school, as well as ratings of use and proficiency based on teacher observations (see Appendix A). The proportion of grammatical utterances from the child's spontaneous narrative samples was used as an external measure of proficiency in each language based on recommendations provided by Gutiérrez-Clellen, Restrepo, Bedore, Peña, and Anderson (2000). For each child, narratives were obtained using a wordless picture book. The storybooks selected were *Frog, Where Are You?* (Mayer, 1969; for English) and *Frog Goes to Dinner* (Mayer, 1974; for Spanish). The narratives were audiotaped, transcribed word for word, and coded for the presence of grammatical errors in each language using the Systematic Analysis of Language Transcripts (SALT) computer program (Miller & Chapman, 2000) by a bilingual research assistant. Lexical errors, phonological errors, or cohesion errors were not counted as grammatical errors. Spanish–English mixed utterances and utterances with unintelligible words were excluded from the analysis.

Transcription reliability was obtained with two bilingual transcribers, who independently transcribed and coded 20% of the audiotapes in each language. Word transcription reliability was 93% for English and 90% for Spanish. Grammatical code reliability was 92% for English and 90% for Spanish. Any discrepancies were resolved by consensus with a third bilingual transcriber. Bilingual status was determined according to the following criteria:

1. A minimum of 3 years of exposure to each language since birth.
2. A minimum of 20% of time exposed to each language.
3. A minimum parent rating of 3 for language use in each language (on a scale ranging from 0 [*no use*] to 4 [*use all the time*]).
4. A minimum parent rating of 3 for language proficiency in each language (on a scale ranging from 0 [*no proficiency*] to 4 [*nativelike proficiency*]).
5. A minimum of 2.5 hr reading a week in each language at home.
6. A minimum teacher rating of 3 for language use in each language (on a scale ranging from 0 [*no use*] to 4 [*use all the time*]).
7. A minimum teacher rating of 3 for language proficiency in each language (on a scale ranging from 0 [*no proficiency*] to 4 [*nativelike proficiency*]).
8. A minimum of 80% grammatical utterances in each language.

Of the 44 participants, 22 were identified as "both proficient–bilingual" because they met criteria in the two languages. Eleven children were identified as "English proficient–limited Spanish" because they met all criteria only for English and not Spanish. Eleven children were identified as "Spanish proficient–limited English" because they met all criteria only for Spanish and not English. These two groups had some L2 exposure but were not able to speak it. For example, the "English proficient–limited Spanish" group had some

**Table 1.** Profile of bilingual participants ($n$ = 22).

| Characteristic | English *M* | English *SD* | Spanish *M* | Spanish *SD* |
|---|---|---|---|---|
| Years of exposure | 2.50 | 1.23 | 5.00 | 1.34 |
| Proportion of input at home | .30 | .17 | .70 | .17 |
| Hours of reading and other literacy activities | 14.70 | 5.91 | 6.20 | 5.83 |
| Parents' rating of use | 3.10 | 1.13 | 4.00 | 0 |
| Teachers' rating of use | 3.00 | 0.91 | 3.10 | 1.52 |
| Teachers' rating of proficiency | 3.00 | 0.93 | 3.10 | 1.58 |
| Proportion of input at school | .47 | .31 | .53 | .31 |

initial exposure to Spanish (less than 2 years since birth) and then more than 5 years of primarily English at school with minimal exposure to Spanish at home. These children could not produce narrative samples in Spanish and could not answer questions in that language. The "Spanish proficient–limited English" group had more than 5 years of exposure to Spanish and, on average, had been exposed to English for less than 2 years before the time of testing. Although teacher and parent reports indicated that these children had some exposure to English, they could not produce a narrative in English. Tables 1 and 2 contain the profiles of the participants for each language based on the parent reports and teacher questionnaires. Table 3 contains the percentage of grammatical sentences for the target languages across groups.

The language histories of the groups obtained from the parent questionnaires indicated significant differences between the "English proficient–limited Spanish" group and the "both proficient" group on their reported years of Spanish exposure, $t(31) = 6.01$, $p = .0001$; amount of Spanish input, $t(31) = 5.61$, $p = .0001$; reported hours of Spanish reading, $t(31) = 3.29$, $p = .002$; ratings of use, $t(31) = 10.66$, $p = .0001$; and ratings of proficiency in Spanish, $t(31) = 4.37$, $p = .0005$. Even after we used a conservative alpha of .007, the "English proficient" group showed Spanish-language experiences that were significantly low compared to the "both proficient–bilingual" group in that language. For the "Spanish proficient–limited English" children, both parent and teacher ratings of use indicated significant limitations in English, $t(31) = 5.28$, $p = .0001$; $t(31) = 5.28$, $p = .0001$, compared to their "both proficient–bilingual" peers. These children also received significantly lower ratings of proficiency by their teachers, $t(31) = 2.66$, $p = .01$.

The majority of children (i.e., 27) were attending bilingual classrooms with various levels of use for the two languages; 13 children were attending nine English-only classrooms; and 4 children were in primarily Spanish-speaking classrooms. The English-only classrooms had Spanish-speaking aides and Spanish resources available to them, depending on individual needs. The children in the primarily Spanish-speaking classrooms received English-language-development instruction and had Spanish-speaking teachers, aides, and materials. There were 8 "English proficient–limited Spanish" speakers in English-only classrooms and 3 in bilingual classrooms. Six of the "Spanish proficient–limited English" speakers were in bilingual classrooms, 4 were in primarily Spanish-speaking classrooms, and 1 was in an English-only class. Most "both proficient" speakers

**Table 2.** Profile of "Spanish proficient–limited English" (SPLE; $n$ = 11) and "English proficient–limited Spanish" (EPLS; $n$ = 11) groups.

| Characteristic | SPLE *M* | SPLE *SD* | EPLS *M* | EPLS *SD* |
|---|---|---|---|---|
| Years of exposure to English | 1.80 | 0.90 | 5.50 | 1.49 |
| Years of exposure to Spanish | 5.50 | 1.00 | 2.10 | 1.32 |
| Proportion of English input at home | .20 | .10 | .70 | .24 |
| Proportion of Spanish input at home | .80 | .10 | .30 | .24 |
| Hours of English reading and other literacy activities | 9.50 | 5.70 | 29.30 | 16.47 |
| Hours of Spanish reading and other literacy activities | 7.40 | 4.90 | 0.30 | 0.68 |
| Parents' rating of English use | 1.71 | 1.10 | 3.80 | 0.60 |
| Parents' rating of Spanish use | 4.00 | 0 | 2.00 | 0.89 |
| Teachers' rating of English use | 1.30 | 0.80 | 3.90 | 0.19 |
| Teachers' rating of Spanish use | 3.90 | 0.30 | 0.60 | 0.96 |
| Teachers' rating of English proficiency | 2.00 | 1.20 | 3.80 | 0.40 |
| Teachers' rating of Spanish proficiency | 3.60 | 0.50 | 0.50 | 1.21 |
| Proportion of English input at school | .40 | .30 | .90 | .24 |
| Proportion of Spanish input at school | .56 | .28 | .10 | .24 |

**Table 3.** Percentage of grammatical sentences across groups and languages.

| Group | n | M | SD |
|---|---|---|---|
| English | | | |
| English proficient | 11 | 96.0 | 5.7 |
| Both proficient–bilingual | 22 | 90.7 | 6.4 |
| Spanish | | | |
| Spanish proficient | 11 | 92.3 | 4.6 |
| Both proficient–bilingual | 22 | 89.9 | 5.3 |

(i.e., 18) were attending bilingual classrooms, and only 4 of them were in English-only classrooms.

## Procedure

### Competing Language Processing Task

The English CLPT included the stimuli sentences developed by Gaulin and Campbell (1994) for children as young as 5 years of age. It consisted of 42 English sentences, three words in length, ranging from 3 to 6 syllables. The Spanish CLPT was constructed to have the same number of sentences as the English CLPT. They were not direct translations from the English CLPT, and as with the English CLPT, they were constructed to contain concrete nouns and verbs comprehensible to young school-age children based on the more than 25 years of experience of the first author as a Spanish-speaking speech-language pathologist working with children of Argentine, Spanish, Puerto Rican, Mexican, and Central American backgrounds; her previous research with Spanish-speaking Puerto Rican and Mexican American children (e.g., Gutiérrez-Clellen, 1998); and her expertise in the area of cross-cultural and dialectal differences in child language development (e.g., Gutiérrez-Clellen & DeCurtis, 1999; Gutiérrez-Clellen & Quinn, 1993). Many of the vocabulary words are included in Spanish-language inventories (e.g., Jackson-Maldonado, Thal, Marchman, Bates, & Gutiérrez-Clellen, 1993) and in tests normed on Spanish speakers, such as the Preschool Language Scale–3, Spanish Edition (Zimmerman, Steiner, & Pond, 1993).

It is important to note that word and syllable number could not be equated to the English CLPT due to the obligatory use of articles in Spanish. Since the goal was to provide syntactically well formed sentences in both languages and to ensure that the stimuli preserved the integrity of the language, the inclusion of articles increased the length of the sentences from three to four words, with a range of four to seven syllables in length. There is evidence that word-length differences between the two languages do not necessarily result in differences in word duration (Miranda & Valencia, 1997) because English is a “stress-timed” language and Spanish is a “syllable-timed” language (Dauer, 1983; Hoequist, 1983; Imazu, 1973). Thus, although the sentences were recorded at the same rates, they were equivalent in duration across the two language versions in spite of word-length differences. Examples are included in Appendix B.

A bilingual female speaker recorded the two language versions of the stimulus sentences. Recordings were made in a sound-attenuated booth onto a DAT recorder. The stimuli were subsequently input into a PowerPC computer via a DAT recorder and Sound Designer®. The sentences were equated for speech rate and amplitude with Sound Edit®. After stimuli selection was made, sentences were output onto analog tapes through Psyscope®.

The English CLPT and Spanish CLPT stimuli were presented in groups of two to six short sentences over headphones. Participants were instructed to demonstrate comprehension by responding “true” or “false” to each sentence and to recall the last word of each sentence after all the sentences in the group had been presented. There were four practice sentences before the administration of the task.

### Dual Processing Comprehension Task

The English DPCT included the stimuli developed by Ellis Weismer (1996), adapted from a task used by Campbell and McNeil (1985). It consisted of 20 commands to manipulate tokens (circles and squares) or objects (toy house, truck, shoe, star, and boat). The commands contained 8–9 words with a range of 9 to 10 syllables per sentence. For the Spanish DPCT, similar but not identical commands were constructed. The Spanish commands preserved syntactic structure and were 8–10 words long, with a range of 15 to 18 syllables per sentence. Examples are found in Appendix B. Two bilingual speakers (one male, one female) recorded the two language versions of the task. Psyscope was used to combine the sentences and to create the competing condition (i.e., 2 sentences presented at the same time) for both the English and the Spanish tasks.

Participants manipulated the items in response to taped instructions. The children either heard both sentences simultaneously (competing condition) or heard only one sentence (noncompeting condition) and were asked to manipulate the tokens or objects. The sentences were presented binaurally through headphones. Both noncompeting conditions were followed by the competing condition across all children. The female’s voice was always presented with the tokens, and the male’s voice was always presented with the objects. The order of presentation of the female noncompeting sentences and the male noncompeting sentences was counterbalanced across participants in all groups. In the first 5 trials of the competing condition, the children were instructed to do what the female said first then do what the male said. This was reversed in the remaining 5 trials. Each condition consisted of 10 trials.

Both the CLPT and the DPCT were administered by two bilingual examiners, one for each language, on different days within 1 week of initial testing. During testing, the child was addressed in only one language, either Spanish or English. Order of task presentation was counterbalanced across participants. Order of language tested also was counterbalanced for the bilingual group.

Gaulin and Campbell's (1994) procedure resulted in two possible scores for the CLPT, a comprehension and a word-recall score. Both scores were reported as percentages for all participants. The score for comprehension was determined by the number of true/false sentences answered correctly. Word recall was credited if the word contained the correct stem of the target word (e.g., *leaf* for *leaves*) and if it was the same part of speech, regardless of whether they were recalled in the same order as in the original order of presentation.

For the DPCT, there were two conditions, a noncompeting condition and a competing condition, which were used to generate a difference score between the two. The noncompeting condition score reflected the percentage of words in each trial that were accurately comprehended regardless of whether the order of the actions reenacted matched the order of the elements in the original instructions. The difference score was calculated in two ways. We calculated the percentage change in performance between the competing and noncompeting conditions relative to the noncompeting condition based on the following formula (adapted from Duff & Logie, 2001):

$$\text{Difference score} = \frac{(\text{noncompeting condition} - \text{competing condition})}{\text{noncompeting condition} \times 100}.$$

The difference between the two conditions was also established by means of a formula previously used with monolingual children (Ellis Weismer, 1996), to make direct comparisons with data collected in those studies (difference score = noncompeting condition – competing condition).

Twenty percent of the children's responses to both CLPT and DPCT tasks in English and Spanish were independently rescored by a bilingual research assistant. Interjudge agreement for the scoring of the CLPT was 100% and for the DPCT was above 90% based on a point-by-point percentage of agreement formula.

All children were able to complete the tasks given appropriate demonstration and practice. An error analysis of their comprehension responses on the CLPT indicated that 7 stimulus sentences (4 in English and 3 in Spanish) were consistently missed by the majority of the children, probably due to vocabulary difficulties or differences in conceptual or cultural experience. Thus, the percentage word-recall scores was calculated over 38 English sentences and 39 Spanish sentences to obtain a more accurate estimate of children's processing performance. The analyses were run on arcsine transformations of the percentage scores. Because of the number of tests involved, all comparisons were conducted using one-way analysis of variance (ANOVA) tests with an alpha level of .01.

Paired $t$ tests were used to compare the languages of the bilinguals, and unpaired $t$ tests were used to compare the monolingual groups. Comparisons between the performance of the participants in this study and that of children from other studies were made by converting the participants' scores into standard scores using the sample means and standard deviations (peer reference) and by deriving z distributions based on the means and standard deviations obtained in previous research with non-Latino groups. Pearson product–moment correlations were used to determine the extent to which the CLPT and DPCT shared similar cognitive–linguistic operations.

## Results

The first analysis was to compare the performance of the "Spanish proficient–limited English" and the "English proficient–limited Spanish" speakers with that of bilinguals who met criteria for the target language. Table 4 contains the means and standard deviations of the "Spanish proficient–limited English" and the "both proficient–bilingual" groups on the Spanish CLPT and DPCT. The ANOVA tests revealed no significant group differences in comprehension, $F(31, 1) = 0.03$, $p = .85$, or word recall, $F(31, 1) = 0.07$, $p = .78$, for the Spanish CLPT. For the Spanish DPCT, there were no significant group differences for either the noncompeting score, $F(31, 1) = 1.10$, $p = .30$, or the percentage change score, $F(31, 1) = 0.13$, $p = .72$.

Table 5 contains the means and standard deviations of the "English proficient–limited Spanish" and the "both proficient–bilingual" groups on the English CLPT and DPCT. Group differences in comprehension on the English CLPT did not reach statistical significance at the $p < .01$ level, $F(31, 1) = 4.22$, $p = .04$. There were no statistically significant differences for English CLPT word recall, $F(31, 1) = 0.71$, $p = .40$. Similarly, there were no significant group differences for the English DPCT for the noncompeting condition, $F(31, 1) = 1.92$, $p = .17$, or the percentage change score, $F(31, 1) = 1.62$, $p = .21$.

The second analysis compared cross-language performance within the 22 bilingual children and between the other two groups that were proficient in only one

**Table 4.** Mean percentages and standard deviations of SPLE and "both proficient–bilingual" groups on the Spanish Competing Language Processing Task (SCLPT) and the Spanish Dual Processing Comprehension Task (SDPCT).

| Task | SPLE (*n* = 11) *M* | *SD* | Both proficient–bilingual (*n* = 22) *M* | *SD* | *F* | *p* |
|---|---|---|---|---|---|---|
| SCLPT | | | | | | |
| Comprehension | 98.60 | 1.30 | 97.90 | 2.90 | 0.03 | .85 |
| Word Recall | 49.90 | 7.20 | 48.80 | 9.60 | 0.07 | .78 |
| SDPCT | | | | | | |
| Noncompeting | 97.50 | 1.2 | 97.40 | 3.40 | 1.10 | .30 |
| Competing | 58.70 | 20.1 | 56.0 | 14.7 | | |
| Difference score | 39.70 | 20.7 | 42.60 | 14.80 | 0.13 | .72 |

*Note.* Difference score = percentage of change difference score (adapted from Duff & Logie, 2001): noncompeting condition – competing condition/noncompeting condition × 100. Only the noncompeting condition and the difference score were evaluated, so *F* and *p* values are not reported for the competing condition.

language (i.e., "Spanish proficient–limited English" and "English proficient–limited Spanish"). Paired *t* tests indicated no significant cross-language differences within the bilingual children for either word recall, $t(21) = 0.31$, $p = .75$, or percentage change scores, $t(21) = 0.21$, $p = .83$. Unpaired *t* tests between the Spanish-proficient and the English-proficient groups showed no cross-language differences for either word recall, $t(20) = 0.35$, $p = .72$, or percentage change scores, $t(20) = 0.47$, $p = .63$.

**Table 5.** Means percentages and standard deviations of EPLS and "both proficient–bilingual" groups on the English Competing Language Processing Task (ECLPT) and the English Dual Processing Comprehension Task (EDPCT).

| Task | EPLS (*n* = 11) *M* | *SD* | Both proficient–bilingual (*n* = 22) *M* | *SD* | *F* | *p* |
|---|---|---|---|---|---|---|
| ECLPT | | | | | | |
| Comprehension | 98.80 | 1.80 | 94.97 | 6.20 | 4.22 | .04 |
| Word Recall | 50.96 | 6.80 | 48.20 | 9.10 | 0.71 | .40 |
| EDPCT | | | | | | |
| Noncompeting | 97.50 | 2.40 | 96.50 | 2.60 | 1.92 | .17 |
| Competing | 61.40 | 12.1 | 54.80 | 14.6 | | |
| Difference score | 36.90 | 12.90 | 43.30 | 14.40 | 1.62 | .21 |

*Note.* Difference score = percentage of change difference score (adapted from Duff & Logie, 2001): noncompeting condition – competing condition /noncompeting condition × 100. Only the noncompeting condition and the difference score were evaluated, so *F* and *p* values are not reported for the competing condition.

Finally, correlations between the CLPT and the DPCT for the 22 bilinguals were conducted to determine the extent to which these tasks were related or involved similar cognitive–linguistic operations (see Table 6). The distributions of scores were sufficiently normally distributed to warrant use of the Pearson product–moment statistic. As expected, the two languages were intercorrelated for the same task. The Spanish CLPT had a significant moderate correlation with the English CLPT ($r = .44$, $p = .03$), and the Spanish DCPT was also significantly correlated with the English DPCT ($r = .48$, $p = .02$). However, when the association between the different tasks was examined, the patterns were different across languages. The DPCT was highly correlated to the CLPT ($r = –.70$, $p < .0001$) for Spanish, but not for English ($r = –.31$, $p > .05$). The negative correlation reflects the fact that greater word recall was associated with a smaller score difference between competing and noncompeting conditions, or, in other words, with less interference during the competing condition.

## Discussion

The present study was designed to investigate VWM in children with varying degrees of bilingual development on processing tasks that had been used with monolingual children. Previous studies using processing tasks had found differences between monolinguals and bilinguals, but our results revealed no significant differences between fluent bilingual children and those with proficiency in only one language on either the CLPT or the DPCT. These results do not support the idea that bilinguals exhibit enhanced (or reduced) control of processing. To evaluate the processing skills of bilingual children, their proficiency in the languages should be carefully evaluated based on language histories and spontaneous language measures. Bilinguals do not constitute a homogeneous group. In the present study, bilingual children were identified based on stringent criteria that included detailed information about the acquisition of the

**Table 6.** Correlations Between the CLPT and the DPCT in Spanish and English for the "both proficient–bilingual" group.

| | VWM task 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1. SCLPT | — | .44* | –.70** | –.23 |
| 2. ECLPT | | — | –.17 | –.31 |
| 3. SDPCT | | | — | .48* |
| 4. EDPCT | | | | — |

*Note.* VWM = verbal working memory.

*$p < .05$. **$p < .0001$.

Table 7. Comparisons with data from Gaulin and Campbell (1994) and Ellis Weismer, Evans, and Hesketh (1999) for the ECLPT.

| ECLPT | EPLS | | Both proficient–bilingual | | Gaulin & Campbell | | Ellis Weismer et al. | |
|---|---|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Comprehension | 98.80 | 1.80 | 94.97 | 6.18 | 99.25 | 1.39 | 97.50 | 2.8 |
| Word Recall | 50.96 | 6.78 | 48.20 | 9.09 | 60.40 | 8.70 | 60.20 | 13.0 |

two languages and spontaneous language measures. Future research examining the performance of bilingual children learning different language pairs under different language-learning conditions will be needed to further understand whether bilingualism has an effect on language processing. This research should also compare the task performance of bilinguals with that of children raised in monolingual environments.

The second analysis investigated whether language-processing tasks revealed bilingual proficiency differences. Because the ability to focus on aspects of the input for later recall may reveal subtle differences in proficiency within fluent bilinguals, we expected differences in cross-language performance. The results indicated no significant processing differences between the two languages of proficient bilinguals for either the CLPT or the DPCT. These children were highly proficient in the two languages, and the tasks may not have stressed their attentional resources sufficiently to reveal any differences. Future research under conditions of language competition (e.g., tasks in which children are required to process two languages simultaneously or where they need to switch from one language to the other within a task) may provide further insights about the processes of bilingual acquisition, as the contexts of use and exposure to the languages may change over time (Kohnert, Bates, & Hernandez, 1999). Research with adult bilinguals using tasks in which they are required to suppress or deactivate one language to perform a given task in another has shown that performance may vary depending on the level of proficiency or exposure to the languages. Less proficiency will require less inhibition, whereas more proficiency will require more inhibition to deactivate (Green, 1998). Control of processing may also be affected in bilingual contexts in which both languages are activated (Grosjean, 1997, 1998).

Since the different characteristics of the languages could have an effect on performance across the two language versions of the task, we also compared two groups who were proficient in only one language; however, they did not differ significantly on either the CLPT or the DPCT. Language-specific differences between these two languages (such as differences in word length or grammatical morphology) had no effect on processing performance based on these tasks. The findings support previous research with bilingual adults that indicates that VWM performance is not language-specific but reflects a more general ability to process information (Osaka & Osaka, 1992; Osaka et al., 1993). In addition, the correlational data suggest that the Spanish versions of these tasks may be useful in future research with Spanish-speaking children.

Further, it was important to see the extent to which the participants' performance differed from groups from other backgrounds. Table 7 contains the English CLPT means and standard deviations of the groups and the published means obtained with other English-speaking (monolingual) groups of comparable ages: Gaulin and Campbell (1994) and Ellis Weismer et al. (1999). Table 8 shows the English DPCT scores for the participants compared with the means reported by Ellis Weismer and Thordardottir (2002). The standardized score distributions of the 44 participants (including the best language scores of the bilinguals) across studies for the CLPT indicate that about 65% of the 44 participants fall within 1 *SD* from the mean of the Ellis Weismer et al. (1999) group and of their peer reference group. About 52% of the participants fall within 1 *SD* from the mean based on Gaulin and Campbell's sample. For the DPCT, about 72% of the children fell within 1 *SD* from Ellis Weismer et al.'s sample mean, and 68% fell within 1 *SD* of the group mean for the present sample. The similarities across distributions suggest that the performance of the participants was similar to that described in previous research.

Finally, we hypothesized that the CLPT and the DPCT may vary in their processing demands, from a

Table 8. Comparisons with data from Ellis Weismer and Thordardottir (2002) for the EDPCT.

| EDPCT | Ellis Weismer & Thordardottir (2002) | | EPLS | | Both proficient–bilingual | |
|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Difference score | 39.37 | 17.8 | 43.27 | 15.54 | 50.00 | 16.38 |

*Note.* Difference score = noncompeting – competing condition, based on formula used by Ellis Weismer and Thordardottir (2002).

relative focus on storage to one of greater attention inhibition or resistance to interference when the task presented two sentences simultaneously. The findings of the correlational analysis should be interpreted with caution given the small size of the sample (22 participants). The between-task correlations indicated that the CLPT and the DPCT were highly related for Spanish. Children with high Spanish word recall were less susceptible to interference during Spanish dual processing. This finding suggests that differences in working memory capacity may relate to differences in capability for controlled attention, or the notion that working memory may be constrained by one's ability to use controlled processing (Tuholski, Engle, & Baylis, 2001). Yet, this relationship was not replicated for English. Although there were no significant score differences between the two languages, an inspection of the two frequency distributions for these children (one per language) suggested some differences. There were fewer children who had achieved high word recall in English compared with the number of children who had high recall in Spanish. For these children, the competing condition did not affect Spanish as much as it affected English. It is possible that the DPCT unveiled individual differences within bilinguals that were not evidenced when children were compared as a group.

The correlation results may be also interpreted based on recent reports with monolinguals that show differences between individuals with high and low word recall. Engle (2002) showed that participants with high word recall exhibited decreased performance levels when they were asked to perform a secondary task at the same time. This was consistent with the observed correlations between the Spanish CLPT and the Spanish DPCT in the present study. In contrast, Engle reported that the performance of participants with low word recall was unaffected by cognitive load because they did not normally allocate attention to resist interference. This may explain why there was not a significant correlation between the English versions of these tasks. There were relatively fewer children who performed at the high end of the word-recall distribution in English. For this sample of bilinguals, English was less well represented and activated. If we had had a greater number of highly performing children in English, we may have seen similar patterns of correlations.

The lack of correlation between the two tasks for English also suggests that performance on VWM tasks is not independent of language skill. As was discussed earlier, vocabulary familiarity may affect performance on word-recall tasks. Indeed, Thorn and Gathercole (1999) have argued that VWM functions in a "highly language-specific way" because it relies on lexical knowledge (p. 322). MacDonald and Christiansen (2002) have claimed that a substantial amount of individual differences in VWM task performance is due to variation in language experience. Experience has a significant impact on processing efficiency. In their view, greater language experience is assumed to have effects not only on vocabulary but also on the ability to form critical expertise in syntactic structures and in probabilistic constraints that govern language comprehension. The notion that processing-based measures may be useful for reducing bias in assessment (Campbell et al., 1997) needs to be further evaluated using additional measures of language proficiency as well as other processing tasks, including nonwords. Such studies should include valid external measures of language production and comprehension and should have larger samples of proficient bilinguals.

The present study represents a first attempt to examine individual differences in VWM in bilingual children. By examining bilingual performance using appropriate control groups, we were able to identify shared processing skills as well as differences related to individual children's attainments in bilingual acquisition. Further research is needed to examine bilingual working memory at different stages of bilingual development, in particular, at points in which the L2 learner may shift dominance from one language to the other. Although this research is preliminary and requires replication with different age groups in different language-learning environments, it provides a step toward examining the use of language-processing measures in future clinical studies with this population.

## Acknowledgments

This project was partially supported by National Institute on Deafness and Other Communication Disorders Grant 1-DC-8-2100 and by National Institute of General Medical Sciences Grant 1 R25 GM58906-04 to San Diego State University's Minority Biomedical Research Support Program.

## References

**Adams, A. M., Bourke, L., & Willis, C.** (1999). Working memory and spoken language comprehension in young children. *International Journal of Psychology, 34*, 364–373.

**Ardila, A., Rosselli, M., Ostrosky-Solis, F., Marcos, J. Granda, G., & Soto, M.** (2000). Syntactic comprehension, verbal memory, and calculation abilities in Spanish-English bilinguals. *Applied Neuropsychology, 7*(1), 3–16.

**Baddeley, A. D.** (1986). *Working memory*. Oxford, England: Clarendon Press.

**Bialystok, E.** (1992). Selective attention in cognitive processing: The bilingual edge. In R. J. Harris (Ed.), *Cognitive processing in bilinguals* (pp. 501–513). Amsterdam, The Netherlands: Elsevier Science.

**Bialystok, E.** (2001). *Bilingualism in development: Language, literacy, and cognition* (pp. 134–151). Cambridge, England: Cambridge University Press.

**Campbell, T., Dollaghan, C., Needleman, H., & Janosky, J.** (1997). Reducing bias in language assessment: Processing-dependent measures. *Journal of Speech, Language, and Hearing Research, 40*, 519–525.

**Campbell, T., & McNeil, M.** (1985). Effects of presentation rate and divided attention on auditory comprehension in children with an acquired language disorder. *Journal of Speech and Hearing Research, 28*, 513–520.

**Conway, A. R. A., & Engle, R. W.** (1994). Working memory and retrieval: A resource-dependent inhibition model. *Journal of Experimental Psychology: General, 123*, 354–373.

**Daneman, M., & Carpenter, P. A.** (1980). Individual differences in working memory and reading. *Journal of Verbal Learning Behavior, 19*, 450–466.

**Daro, V., & Fabbro, F.** (1994). Verbal memory during simultaneous interpretation: Effects of phonological interference. *Applied Linguistics 15,* 365–381.

**Dauer, R. M.** (1983). Stress-timing and syllable-timing reanalyzed. *Journal of Phonetics, 11*, 51–62.

**Duff, S. C., & Logie, R. H.** (2001). Processing and storage in working memory span. *The Quarterly Journal of Experimental Psychology, 54*, 31–48.

**Ellis Weismer, S.** (1996). Capacity limitations in working memory: The impact on lexical and morphological learning by children with language impairment. *Topics in Language Disorders, 17*, 33–44.

**Ellis Weismer, S., & Evans, J.** (2002). The role of processing limitations in early identification of specific language impairment. *Topics in Language Disorders, 22*, 15–29.

**Ellis Weismer, S., Evans, J., & Hesketh, L. J.** (1999). An examination of verbal working memory capacity in children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 42*, 1249–1260.

**Ellis Weismer, S., & Thordardottir, E. T.** (2002). Cognition and language. In P. Accardo, A. Capute, & B. Rogers (Eds.), *Disorders of language development* (pp. 21–37). Timonium, MD: York Press.

**Ellis Weismer, S., Tomblin, J. B., Zhang, X., Chynoweth, J. G., & Jones, M.** (2000). Nonword repetition performance in school-age children with and without language impairment. *Journal of Speech, Language, and Hearing Research, 43*, 865–878.

**Engle, R. W.** (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science, 11*, 19–23.

**Engle, R. W., Conway, A. R. A., Tuholski, S. W., & Shisler, R. J.** (1995). A resource account of inhibition. *Psychological Science, 6*, 122–125.

**Engle, R. W., Kane, M. J., & Tuholski, S. W.** (1999). Individual differences in working memory capacity and what they tell us about controlled attention, general fluid intelligence, and functions of the prefrontal cortex. In A. Miyake & P. Shah (Eds.), *Models of working memory: Mechanisms of active maintenance and executive control* (pp. 102–134). New York: Cambridge University Press.

**Gathercole, S. E., & Pickering, S. J.** (2000). Assessment of working memory in six- and seven-year-old children. *Journal of Educational Psychology, 92*, 377–390.

**Gaulin, C., & Campbell, T.** (1994). Procedure for assessing verbal working memory in normal school-age children: Some preliminary data. *Perceptual and Motor Skills, 79*, 55–64.

**Gottardo, A., Stanovich, K. E., & Siegel, L. S.** (1996). The relationships between phonological sensitivity, syntactic processing, and verbal working memory in the reading performance of third-grade children. *Journal of Experimental Child Psychology, 63*, 563–582.

**Green, D. W.** (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism, Language, and Cognition, 1*, 67–81.

**Grosjean, F.** (1997). Processing mixed language: Issues, findings, and models. In A. M. B. de Groot & J. F. Kroll (Eds.), *Tutorials in bilingualism: Psycholinguistic perspectives* (pp. 225–254). Mahwah, NJ: Erlbaum.

**Grosjean, F.** (1998). Studying bilinguals: Methodological and conceptual issues. *Bilingualism, Language, and Cognition, 1*, 131–149.

**Gutiérrez-Clellen, V. F.** (1996). Language diversity: Implications for assessment. In K. Cole, P. Dale, & D. Thal (Eds.), *Advances in assessment of communication and language* (pp. 29–56). Baltimore: Brookes.

**Gutiérrez-Clellen, V. F.** (1998). Syntactic skills of Spanish-speaking children at risk for academic underachievement. *Language, Speech, and Hearing Services in Schools, 29,* 207–215.

**Gutiérrez-Clellen, V. F.** (2002). Narratives in two languages: Assessing performance of bilingual children. *Linguistics & Education, 13*(2), 175–197.

**Gutiérrez-Clellen, V. F., & DeCurtis, L.** (1999). Word definition skills in Spanish-speaking children with language impairment. *Communication Disorders Quarterly, 21*(1), 23–31.

**Gutiérrez-Clellen, V. F., & Kreiter, J.** (2003). Understanding child bilingual acquisition using parent and teacher reports. *Applied Psycholinguistics, 24*, 267–288.

**Gutiérrez-Clellen, V. F., & Quinn, R.** (1993). Assessing narratives in diverse cultural/linguistic populations: Clinical implications. *Language, Speech, and Hearing Services in Schools, 24,* 2–9.

**Gutiérrez-Clellen, V. F., Restrepo, M. A., Bedore, L., Peña, E., & Anderson, R.** (2000). Language sample analysis in Spanish-speaking children: Methodological considerations. *Language, Speech, and Hearing Services in Schools, 31*, 88–98.

**Harrington, M., & Sawyer, M.** (1992). L2 working memory capacity and L2 reading skill. *Studies in Second Language Acquisition, 14*, 25–38.

**Harris, J. G, Cullum, C. M., & Puente, A. E.** (1995). Effects of bilingualism on verbal learning and memory in Hispanic adults. *Journal of the International Neuropsychological Society, 1*, 10–16.

**Hitch, G. J., Towse, J. N., & Hutton, U.** (2001). What limits children's working memory span? Theoretical accounts and applications for scholastic development. *Journal of Experimental Psychology: General, 130*, 184–198.

**Hoequist, C.** (1983). Syllable duration in stress-, syllable-, and mora-timed languages. *Phonetica, 40*, 203–237.

**Hummel, K. M.** (2000). Second language acquisition and verbal working memory. In F. Fabbro (Ed.), *Advances in the neurolinguistics of bilingualism: Essays in honor of Michel Paradis* (pp. 95–118). Udine, Italy: Forum, Editrice Universitaria Udinese.

**Imazu, T.** (1973). A comparative study of stress-tone contours in Spanish, English, and Russian. *Study of Sounds, 16*, 169–180.

**Jackson-Maldonado, D., Thal, D., Marchman, V., Bates, E., & Guitiérrez-Clellen, V.** (1993). Early lexical development of Spanish-speaking infants and toddlers. *Journal of Child Language, 20*, 523–549.

**Just, M., & Carpenter, P.** (1992). A capacity theory of comprehension: Individual differences in working memory. *Psychological Review, 99*, 122–149.

**Kohnert, K., Bates, E., & Hernandez, A. E.** (1999). Balancing bilinguals: Lexical–semantic production and cognitive processing in children learning Spanish and English. *Journal of Speech, Language, and Hearing Research, 42*, 1400–1413.

**Leather, C. V., & Henry, L. A.** (1994). Working memory span and phonological awareness tasks as predictors of early reading ability. *Journal of Experimental Child Psychology, 58*, 88–111.

**MacDonald, M. C., & Christiansen, M. H.** (2002). Reassessing working memory: Comment on Just and Carpenter (1992) and Waters and Caplan (1996). *Psychological Review, 109*, 35–54.

**Masoura, E. V., & Gathercole, S. E.** (1999). Phonological short-term memory and foreign language learning. *International Journal of Psychology, 34*, 383–388.

**Mayer, M.** (1969). *Frog, where are you?* New York: Puffin Pied Piper.

**Mayer, M.** (1974). *Frog goes to dinner*. New York: Puffin Pied Piper.

**Miller, J. F., & Chapman, R.** (2000). Systematic analysis of language transcripts (Version 6.1) [Computer software]. Madison, WI: Language Analysis Laboratory, Waisman Center.

**Miranda, J. P., & Valencia, R. R.** (1997). English and Spanish versions of a memory test: Word-length effects versus spoken-duration effects. *Hispanic Journal of Behavioral Sciences, 19*, 171–181.

**Osaka, M., & Osaka, N.** (1992). Language-independent working memory as measured by Japanese and English reading span tests. *Bulletin of the Psychonomic Society, 30*, 287–289.

**Osaka, M., Osaka, N., & Groner, R.** (1993). Language-independent working memory: Evidence from German and French reading span tests. *Bulletin of the Psychonomic Society, 31*, 117–118.

**Paradis, J., & Crago, M.** (2000). Tense and temporality: A comparison between children learning a second language and children with SLI. *Journal of Speech, Language, and Hearing Research, 43*, 834–847.

**Rosen, V. M., & Engle, R. W.** (1997). The role of working memory capacity in retrieval. *Journal of Experimental Psychology: General, 126*, 211–227.

**Service, E.** (1992). Phonology, working memory, and foreign language learning. *The Quarterly Journal of Experimental Psychology, 45A*, 21–50.

**Swanson, H. L., & Berninger, V.** (1995). The role of working memory in skilled and less skilled readers' comprehension. *Intelligence, 21*, 83–108.

**Swanson, H. L., Howell Ashbaker, M., & Lee, C.** (1996). Learning-disabled readers' working memory as a function of processing demands. *Journal of Experimental Child Psychology, 61*, 242–275.

**Thorn, A. S. C., & Gathercole, S. E.** (1999). Language-specific knowledge and short-term memory in bilingual and non-bilingual children. *The Quarterly Journal of Experimental Psychology, 52A*, 303–324.

**Tuholski, S. W., Engle, R. W., & Baylis, G. C.** (2001). Individual differences in working memory capacity and enumeration. *Memory & Cognition, 29*, 484–492.

**Umbel, V. M., Pearson, B. Z., Fernandez, M. C., & Oller, D. K.** (1992). Measuring bilingual children's receptive vocabularies. *Child Development, 63*, 1012–1020.

**Valdés, G., & Figueroa, R. A.** (1994). *Bilingualism and testing: A special case of bias.* Norwood, NJ: Ablex.

**Yuill, N., Oakhill, J., & Parkin, A.** (1989). Working memory, comprehension ability and the resolution of text anomaly. *British Journal of Psychology, 80*, 351–361.

**Zimmerman, I. L., Steiner, V. G., & Pond, R. E.** (1993). *Preschool Language Scale–3: Spanish edition.* San Antonio, TX: Psychological Corporation.

Received October 8, 2002

Revision received March 3, 2003

Accepted December 3, 2003

DOI: 10.1044/1092/4388(2004/064)

Contact author: Vera F. Gutiérrez-Clellen, PhD, School of Speech, Language, and Hearing Sciences, San Diego State University, San Diego, California 92182-1518. E-mail: vclellen@mail.sdsu.edu

## *Appendix A.* Parents' and teachers' ratings of proficiency and use.

**Proficiency**

0 Cannot speak the indicated language, knows a few words or phrases, cannot produce sentences (Expressive Language), only understands a few words (Receptive Language).

1 Cannot speak the indicated language, knows a few words or phrases (Expressive Language), understands the general idea of what is being said (Receptive Language).

2 Limited proficiency with grammatical errors, limited vocabulary (Expressive Language), understands the general idea of what is being said (Receptive Language).

3 Good proficiency with some grammatical errors, some social and academic vocabulary (Expressive Language), understands most of what is said (Receptive Language).

4 Nativelike proficiency with few grammatical errors, good vocabulary (Expressive Language), understands most of what is said (Receptive Language).

**Use**

0 Never speaks the indicated language (Expressive Language), never hears it (Receptive Language).

1 Never speaks the indicated language (Expressive Language), hears it very little (Receptive Language).

2 Speaks the indicated language a little (Expressive Language), hears it sometimes (Receptive Language).

3 Speaks the indicated language sometimes (Expressive Language), hears it most of the time (Receptive Language).

4 Speaks the indicated language all of the time (Expressive Language), hears it all of the time (Receptive Language).

*Note.* Abstracted from Parent Questionnaire and Teacher Questionnaire (Vera F. Gutiérrez-Clellen, copyright holder). Copies are available from Vera F. Gutiérrez-Clellen at San Diego State University.

## *Appendix B* (p. 1 of 2). Examples of stimuli.

Examples of sentence stimuli adapted from the Competing Language Processing Task. Reproduced with permission of authors and publisher from: Gaulin, C. A., & Campbell, T. F. Procedure for assessing verbal working memory in normal school-age children: Some preliminary data. *Perceptual and Motor Skills*, 1994, *79*, 55–64. © Perceptual and Motor Skills 1994.

| Sentence stimulus | True/false comprehension | Word recall |
|---|---|---|
| Level 1 (Group 1) | | |
| Trees have *leaves*. | Y/N | ________ |
| Level 3 (Group 1) | | |
| Carrots can *dance*. | Y/N | ________ |
| Water is *dry*. | Y/N | ________ |
| Sugar is *sweet*. | Y/N | ________ |
| Level 6 (Group 1) | | |
| Apples are *square*. | Y/N | ________ |
| Rabbits read *books*. | Y/N | ________ |
| Houses can *jump*. | Y/N | ________ |
| Pencils eat *candy*. | Y/N | ________ |
| Airplanes can *fly*. | Y/N | ________ |
| Balls are *round*. | Y/N | ________ |

Examples of sentence stimuli created for the Spanish Competing Language Processing Task.

| Sentence stimulus | True/false comprehension | Word recall |
|---|---|---|
| Level 1 (Group 1) | | |
| Las mesas tienen *pelo*. [Tables have hair.] | Y/N | ________ |
| Level 3 (Group 1) | | |
| Las ballenas *nadan*. [Whales swim.] | Y/N | ________ |
| Las uvas son *pequeñas*. [Grapes are small.] | Y/N | ________ |
| Los leones son *fuertes*. [Lions are strong.] | Y/N | ________ |
| Level 6 (Group 1) | | |
| Los lapices *manejan*. [Pencils can drive.] | Y/N | ________ |
| Las camas *caminan*. [Beds can walk.] | Y/N | ________ |
| La gente lee *libros*. [People read books.] | Y/N | ________ |
| Las niñas son *azules*. [Girls are blue.] | Y/N | ________ |
| Los gatos son *suaves*. [Cats are soft.] | Y/N | ________ |
| Las arañas *leen*. [Spiders can read.] | Y/N | ________ |

***Appendix B*** (p. 2 of 2). Examples of stimuli.

Examples of sentence stimuli used for the competing condition of the Dual Processing Comprehension Task (adapted from Ellis Weismer, 1996).

Touch the blue circle and the red square.
Touch the little star and the big truck.
Put the white circle on the blue square.
Put the little star on the big house.

Examples of sentence stimuli used for the competing condition of the Spanish Dual Processing Comprehension Task.

Toca el círculo amarillo y el cuadrado rojo.
[Touch the yellow circle and the red square.]
Toca el camión pequeño y la estrella grande.
[Touch the small truck and the big star.]
Pon el cuadrado verde al lado del cuadrado amarillo.
[Put the green square beside the yellow square.]
Pon la casa grande al lado del zapato grande.
[Put the big house beside the big shoe.]