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The role of verbal and nonverbal memory in the Family Pictures Subtest: Data from children with specific language impairment

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This study examined the contribution of verbal and visual memory to performance on the Family Pictures subtest of the Children's Memory Scale. This subtest purports to assess declarative memory functioning in the visual/nonverbal domain. A total of 115 nine-year-old children participated in this study. Fifty-eight had specific language impairment (SLI), whilst the remaining 57 were typically developing (TD), with no history of language difficulties. Results showed that the children with SLI, who had intact declarative memory for visual but not verbal information, obtained significantly lower scores on the Family Pictures subtest when compared to the TD group. Regression analyses revealed that across the entire sample, individual differences on the Family Pictures subtest was best predicted by a measure of verbal working memory. These results question whether the Family Pictures subtest can be considered a measure of visual memory in pediatric populations. These results have implications for the interpretation of scores on this subtest regarding the nature of the types of neurocognitive difficulties children may exhibit.

Keywords: Family Pictures; Children's Memory Scale; Declarative memory; Specific language impairment; Verbal working memory.

The assessment of learning and memory in pediatric populations is routinely undertaken to identify cognitive problems, to develop remediation programs, or to evaluate treatment outcomes. In these contexts, it is important that inferences made from neuropsychological tests accurately assess targeted cognitive skills and brain functions. In meeting this goal, neuropsychological tests should measure their intended constructs so that cognitive problems are correctly identified, remediation for an intended impairment have an accurate basis, and appropriate clinical endpoints are assessed following treatment. This study examines the contribution of verbal and visual memory skills to performance on the Family Pictures subtest of the Children's Memory Scale (CMS; M. J. Cohen, 1997), which was designed to test visual/nonverbal declarative memory. In the adult neuropsychological literature, there has been debate about the actual cognitive and neurological correlates of this

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subtest (e.g., Chapin, Busch, Naugle, & Najm, 2009; Millis, Malina, Bowers, & Ricker, 1999), but less is known about the relevance of these issues to pediatric populations. The current study addressed this gap in the literature.

The Children's Memory Scale

The CMS is a widely used instrument for assessing memory in children aged between 5 and 16 years (for reviews, see Baron, 2004; Vaupel, 2001). The instrument is primarily designed to assess the learning and memory functions of the declarative memory system. This system is involved in the learning, consolidation, and long-term storage and retrieval of information and is supported by the medial temporal lobes, in particular the hippocampus (Squire, Stark, & Clark, 2004). According to the CMS manual, learning and memory in the auditory/verbal domain is assessed by three subtests: Stories (Core subtest), Word Pairs (Core subtest), and Word Lists (Supplemental subtest). Learning and memory in the visual/nonverbal domain is assessed by the Dot Locations (Core subtest), Faces (Core subtest), and Family Pictures (Supplemental test) subtests. This study investigates the extent the Family Pictures subtest can be considered a test of declarative memory for visual information.

The CMS subtests are similar in format and use comparable stimuli, to those from the Wechsler Memory Scale-III (WMS-III) for adolescents and adults (Wechsler, 1997). For example, the Stories, Word Pairs, Faces, and Family Pictures subtests from the CMS are, respectively, very similar to the Logical Memory, Paired Associates, Faces, and Family Pictures subtests from the WMS-III. Analogous subtests from the WMS-III and CMS are designed to assess similar constructs in learning and memory. In both instruments, subtests that are intended to assess verbal memory target left temporal lobe functioning, while subtests assessing nonverbal/visual memory target the right temporal lobe (M. J. Cohen, 1997; Wechsler, 1997). Given the similarities between the two instruments, the CMS is often considered to be a downward age extension of the WMS-III (e.g., Baron, 2004). This has led to concerns about the appropriateness using subtests developed from adult neuropsychological models to understand cognitive functioning in children (e.g., Gonzalez, Anderson, Wood, Mitchell, & Harvey, 2007).

The Family Pictures Subtest

There is little published data on the performance of pediatric samples on the CMS Family Pictures subtest. This is of some concern because in the adult neuropsychological literature there has been debate about the validity of this subtest (Chapin et al., 2009; Millis et al., 1999). In the WMS-III, the Family Pictures subtest purports to measure declarative memory for visual information (Wechsler, 1997). However, in studies conducted by Dulay et al. (2002) and Chapin et al. (2009), performance on the Family Pictures subtest was best predicted by the Logical Memory subtest that measures verbal memory. The Logical Memory subtest, which is similar to the Stories subtest in the CMS, requires participants to recall and recognize an auditorily presented story. A measure of verbal working memory and a task measuring learning and memory for unknown faces were also found to be significant predictors of scores from the Family Pictures subtest. Interestingly, the contribution of the memory for faces and verbal working memory subtests to performance on the Family Pictures subtest was much smaller than the Logical Memory subtest. For example, in one analysis Dulay et al. found that Logical Memory accounted for 26.9% of variance in scores from the Family Pictures subtest, a measure of verbal working memory accounted for 5.2%, and recognition of visual information accounted for 2.4%. Thus, in adult samples, the Family Pictures subtest was best predicted by tasks assessing declarative memory for verbal information.

In the CMS manual (M. J. Cohen, 1997, pp. 2–3), the Family Pictures subtest is initially described as a subtest assessing declarative memory functioning in the visual/nonverbal domain. However, the test manual does caution that because visual stimuli used in the subtest can be processed verbally, poor scores could potentially reflect problems with the right or left temporal lobe (M. J. Cohen, 1997, p. 153). Because there is little pediatric research, it is unclear which aspects of memory are being assessed by this subtest.

Riccio, Cash, and Cohen (2007) investigated the profile of children with specific language impairment (SLI) on the CMS. Children with SLI present with clinically significant language impairments despite at least average nonverbal intelligence and non-impaired sensory functioning (American Psychiatric Association, 2000; World Health Organization, 1993). Riccio et al. found that the children with SLI obtained significantly lower scores than controls on the Stories subtest (comparable to Logical Memory in the WMS-III; see above) and subtests assessing verbal working memory. No significant differences were found between the groups on subtests assessing declarative memory for visual information. Based on adult findings (e.g., Dulay et al., 2002), one would expect children with SLI to perform more poorly on the Family Pictures subtest given their poorer verbal memory skills. But this was not the case. Riccio et al. found that the difference between groups on the Family Pictures subtest was not significant. Thus, unlike the adult literature, these results suggest that in children, performance on the Family Pictures subtest may be more aligned with learning and memory for visual information.

The aim of the present study is to investigate the contribution of visual and verbal memory to performance on the Family Pictures subtest. In order to afford direct comparisons with existing pediatric literature on the Family Pictures subtest in this clinical group, we presented children with SLI and a control group with the CMS core and Family Picture subtests, along with a test of verbal working memory. This study extends the research of Riccio et al. (2007) by investigating the contribution of memory for verbal and visual information to performance on the Family Pictures subtest. Based on the claim that the Family Pictures subtest assesses declarative memory for visual information (e.g., M. J. Cohen, 1997), two hypotheses were forwarded. First, since previous research demonstrated intact visual memory in SLI (e.g., Riccio et al., 2007), no significant differences between the SLI and control groups on the Family Pictures subtest were expected. Second, across both groups, performance on the Family Pictures subtest was hypothesized to be best predicted by performance on CMS core subtests that assess memory for visual but not verbal information.

METHOD

Participants

The study group comprised 58 (42 male, 16 female) children with SLI and the control group comprised 57 (39 male, 18 female) nonlanguage-impaired children. Data on a subset of these children on working, declarative, and procedural memory tasks (not including the

Family Pictures subtest) were reported in Lum, Conti-Ramsden, Page, and Ullman (2012). All children were recruited from primary schools located in the North East of England. Children in the control group were recruited from the same schools and communities as those with SLI. The children in the control group were individually matched to the children with SLI on the basis of gender and nonverbal IQ scores as measured by the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999).

Inclusionary criteria for the SLI group were below-average language skills as identified by a standardized language test (described below) and recognition of language/learning problems in the form of in-school support. Inclusionary criteria for the control group were language skills within the average range. Children with SLI and controls were excluded if they came from homes where English was not the first language, had been diagnosed with a sensory impairments or medical problems or had below average intelligence.

Language skills were assessed using the Clinical Evaluation of Language Fundamentals-4^{UK} (CELF-4^{UK}; Semel, Wiig, & Secord, 2003). All children with SLI obtained a Core Language Score (CLS) that was -1 standard deviation or lower from the mean. The CLS provides an overall measure of children's ability to produce and understand language. This criterion has been demonstrated to have sensitivity and specificity rates of 1.00 and 0.82, respectively (Semel et al., 2003). Children participating in the control group obtained a CLS within +/- 1 standard deviation from the mean.

All children in the study were administered the Block Design and Matrix Reasoning subtests from the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999), allowing Performance IQ (PIQ) to be computed. In the pediatric speech and communication field, nonverbal tasks that place minimal demands on verbal skills are commonly used to evaluate intellectual abilities in children with language impairments (Plante, 1998). Summary statistics of the SLI and Control Groups' scores on the CELF-4^{UK} and WASI are presented in Table 1.

Table 1 shows results from independent samples *t*-tests comparing the groups on age and scores from the language and intelligence tests. Statistically significant differences and large effect sizes[1] between the groups were observed only on the CLS. Nonsignificant

Table 1 Summary Statistics for Participant's Age and Standard Scores from the CELF-4 and WASI.

	SLI Group ($n = 58$)			Control Group ($n = 57$)			Comparison of Means	
Variable	*M*	*SD*	Range	*M*	*SD*	Range	*t*	Cohen's *d*
Age (Years)	9.8	0.7	8.58 – 11.42	9.8	0.7	8.92 – 11.42	0.029	0.01
WASI PIQ	98.1	7.6	85 – 115	99.5	8.0	85 – 115	0.997	0.18
CLS	72.9	9.3	48 – 85	99.2	5.9	90 – 114	18.130**[a]	3.39

Note. Abbreviations: CLS = Core Language Score; WASI PIQ = Wechsler Abbreviated Scale of Intelligence, Performance Intelligence Quotient. CLS and WASI PIQ standardized to a mean of 100 and a standard deviation of 15.

[a]Adjusted for unequal variances.

$^{*}p < .05$. $^{**}p < .001$.

[1]As a generic interpretative framework J. Cohen (1988) suggested that a standardized mean difference of 0.8 is large, 0.5 is medium, and 0.2 is small.

differences and small effect sizes between the groups were observed on age and PIQ scores. Thus, the two groups differed only with respect to language functioning.

Materials

Verbal working memory subtests from the Working Memory Test Battery for Children (WMTB-C; Pickering & Gathercole, 2001) and core and Family Pictures subtests from the Children's Memory Scale (CMS; M. J. Cohen, 1997) were presented to all children. A brief summary of the test battery presented to the children is provided below (for a detailed description and review of the WMTB-C, see Dehn, 2008; for a detailed description and review of the CMS, see Vaupel, 2001).

Measure of Verbal Working Memory. The Central Executive Component score from the WMTB-C (Pickering & Gathercole, 2001) was used to measure verbal working memory (for a summary of the WMTB-C validity and reliability, see Dehn, 2008; Gathercole, Pickering, Ambridge, & Wearing, 2004). This is a composite score summarizing performance on three subtests: Listening Recall, Backward Digits, and Counting Recall subtests. The Central Executive Component score is standardized to a mean of 100 and standard deviation of 15.

On the Listening Recall subtest children are presented with an increasing number of sentences (e.g., "Scissors cut paper") and asked (a) to provide a true/false judgment concerning the sentence's semantic accuracy (e.g., true) and then (b) to recall the sentence-final word (e.g., "paper"). In the Counting Recall subtest, children are shown an array of randomly presented dots, which they are asked to count and then recall. As children progress through the subtest, they are asked to recall an increasing number of arrays. For example, on one item, children are asked to count two arrays of dots. After both arrays have been counted, children are prompted to recall the number of dots on the first array and then the number of dots on the second. It should be noted that, even though the Counting Recall subtest involves presentation of visual stimuli, psychometric evidence indicates the task assesses verbal working skills (Gathercole, Pickering, Ambridge, & Wearing, 2004). This is most likely because verbal skills are required to encode the stimuli (e.g., counting numbers) and then to recall the number of dots. Finally, for the Backward Digit Recall subtest, children are verbally presented with an increasingly longer string of digits, which they are asked to repeat in reverse order.

Family Pictures Subtest from the Children's Memory Scale. The Family Pictures subtest is similar in content and structure to the Family Picture subtest from the Wechsler Memory Scale, 3rd edition (WMS-III; Wechsler, 1997). Children are shown pictures one at a time that depict four different scenes. In each scene, characters appear in four spatial locations engaging in a specific action (e.g., cooking, looking at clothing). In the immediate and delayed recall conditions children are asked which characters were present, their locations, and actions. Performance on the subtest is measured by the Immediate Recall and Delayed Recall subscales. Both are standardized to a mean of 10 and standard deviation of 3.

Verbal Memory Subtests from the Children's Memory Scale. Learning and memory for verbal information was assessed by the Stories and Word Pairs subtests. In the Stories subtest, children are auditorily presented with short stories that they are asked to recall verbatim in immediate and delayed conditions. An additional component of the subtest assesses delayed recognition. Performance on the Stories subtest is measured by Immediate Recall, Delayed Recall, and Delayed Recognition subscales. On the Word Pairs subtest, children are assessed on their ability to learn and retrieve an auditorily presented list comprising semantically unrelated word pairs in immediate and delayed conditions. Performance learning and recalling the word-pairs list in an immediate condition is measured by the "Immediate Total Score" subscale. Children's ability to recognize and recall the word-pairs list following a delay is measured by the Delayed Recognition and Delayed Recall subscales, respectively. All subscales from the Stories and Word Pairs subtests are standardized to have a mean of 10 and standard deviation of 3.

Visual Memory Subtests from the Children's Memory Scale. Learning and memory for visual/nonverbal information was assessed using the Dot Locations and Faces subtests. In the Dot Locations subtest, children are assessed on their ability to learn and recall an array of nine randomly positioned dots in immediate and delayed conditions. Performance learning and recalling the array in an immediate recall condition is measured by the "Immediate Total Score" subscale. Children's ability to recall the array of dots following a delay is measured by the Delayed Recall subscale. In the Faces subtest, children are shown and then asked to recognize a series of unknown faces. The Immediate Recognition and Delayed Recognition subscales measure children's performance in immediate and delayed conditions, respectively. Scores from all Dot Location and Faces subscales have a mean of 10 and standard deviation of 3.

Procedure

Subtests from the WMTB-C and CMS were presented to the children along with other tests assessing language functioning in different sessions. Presentation of the memory tests was counterbalanced so that half of the sample was presented with the WMTB-C in one session before the CMS. Ethical approval for the study was obtained from The University of Manchester, and informed written consent was obtained from the children's parents.

RESULTS

Preliminary Analyses: Investigating Differences between Children with SLI and Controls on Central Executive Component Score and CMS Core Subtests

The first set of analyses examined differences between the SLI and TD groups on the measures of verbal working memory (measured using the Central Executive Component Score) and core CMS subtests. Descriptive statistics reported by group for all studied subtests and effect sizes for pairwise comparisons (SLI vs. TD) are presented in Table 2.

A one-way analysis of variance (ANOVA) indicated that the children with SLI obtained a significantly lower score on verbal working memory as indexed by the Central Executive Component score, $F(1, 113) = 54.026$, $p < .001$, partial $\eta^2 = .323$. Multivariate analyses of variance (MANOVAs) were then used to examine differences between the groups on the CMS core subtests. The first MANOVA examined differences on the core CMS subtests that assess memory for verbal information. The dependent variables in

Table 2 Summary Statistics for Family Pictures, Central Executive Component Score, and CMS Core Subtests Reported by Group.

	SLI Group			Control Group			Effect Size	
Domain/Subtest	*M*	*SD*	Range	*M*	*SD*	Range	(Cohen's *d*)	*p* value[c]
Verbal Working Memory								
Central Executive Component Score[a]	80.5	15.9	55 – 118	101.2	14.3	73 – 139	1.37	<.001**
Family Pictures Subtests								
Family Pictures Immediate Recall[b]	8.8	2.3	4 – 13	10.0	2.3	4 – 14	0.51	.002*
Family Pictures Delayed Recall[b]	8.4	2.1	2 – 12	10.0	2.7	4 – 16	0.63	.008*
Declarative Memory for Verbal Information								
Stories								
Immediate Recall[b]	6.2	3.1	1 – 16	9.2	3.2	2 – 16	0.97	<.001**
Delayed Recall[b]	6.3	3.0	1 – 16	9.7	3.4	2 – 17	1.05	<.001**
Delayed Recognition[b]	6.6	2.6	1 – 12	8.6	2.8	1 – 14	0.75	<.001**
Word Pairs								
Immediate Total Score [b]	7.3	2.8	1 – 14	9.5	2.7	4 – 17	0.80	<.001**
Delayed Recall[b]	7.5	2.9	1 – 14	9.4	2.6	3 – 16	0.69	<.001**
Delayed Recognition[b]	7.0	3.9	2 – 12	9.7	3.1	2 – 12	0.76	<.001**
Declarative Memory for Visual/Nonverbal Information								
Dot Locations								
Immediate Total Score [b]	10.1	3.6	1 – 16	10.8	2.9	4 – 16	0.22	.668
Delayed Recall[b]	8.6	3.5	1 – 14	9.5	3.1	3 – 14	0.28	.575
Faces								
Immediate Recognition[b]	9.6	3.1	2 – 17	9.1	2.4	2 – 15	0.18	.704
Delayed Recognition[b]	9.5	3.3	2 – 19	8.7	2.3	4 – 16	0.28	.575

[a]Score standardized to a mean of 100 and a standard deviation of 15.
[b]Score standardized to a mean of 10 and a standard deviation of 3.
[c]Corrected for multiple comparisons using the Holm's (1979) Procedure.
$^{*}p < .05$. $^{**}p < .001$.

this analysis were scores from the immediate and delayed components from the Stories and Word Pairs subtests. The overall multivariate effect size for group was statistically significant, Pillai's Trace = .282, $F(6, 108) = 5.763$, $p < .001$, partial $\eta^2 = .282$. Univariate post hoc tests using the Holm's Procedure (Aicken & Gensler, 1996; Holm, 1979) were used to control for an inflated Type I error arising from multiple comparisons. The Holm's procedure was used for all post hoc tests. Results from these analyses revealed that the SLI group obtained significantly lower scores on the Stories and Word Pairs subtests ($p < .001$ for all comparisons, see Table 2). The second MANOVA examined differences between the groups on the immediate and delayed components of the visual/nonverbal subtests. The overall multivariate effect for group was not statistically significant, Pillai's Trace = .039, $F(4, 110) = 1.128$, $p = .347$, partial $\eta^2 = .039$. All univariate comparisons were nonsignificant (see Table 2).

Differences between Children with SLI and Controls on the Family Pictures Subtest

A one-way MANOVA was used to investigate whether children with SLI obtained significantly lower scores than the control group on the Family Pictures subtest. The dependent variables in the analysis were immediate and delayed recall components of this subtest. The multivariate effect for group was significant, Pillai's Trace = .093, $F(2, 112) = 5.763$, $p = .004$, partial $\eta^2 = .093$, indicating that, overall, the SLI group obtained significantly lower scores on the Family Pictures subtest compared to the control group. Post hoc tests revealed the SLI group obtained significantly lower scores than the controls on the immediate and delayed components (see Table 2).

Predictors of Family Pictures Scores

Regression analysis was used to investigate the contribution of the CMS verbal and visual declarative memory core subtests, verbal working memory, and general language skills to Family Pictures scores. In the first regression analysis, the outcome variable was the Family Pictures scores from the immediate recall condition. The predictor variables were the CMS core subtests (i.e., Stories, Word Pairs, Dot Locations, and Faces), verbal working memory (measured by the Central Executive Component Score), and general language skills (measured by the CLS, from the CELF-4^{UK}). Including a measure of language in the model allowed us to investigate the influence of the memory variables on Family Pictures scores whilst holding language skills constant. The outcome variable in the second regression analysis was the Family Pictures scores from the delayed recall condition. Predictor variables were CMS core subtests assessing verbal and visual declarative memory in the delayed recall and recognition conditions, verbal working memory, and general language skills. To preserve statistical, power the CMS subtests that assessed recall for verbal information (i.e., Stories Delayed Recall & Word Pairs Delayed Recall) were combined to create a "Delayed Verbal Recall" composite. Similarly, CMS subtests assessing recognition for verbal information (i.e., Stored Delayed Recognition & Word Pairs Delayed Recognition) were combined to create a "Delayed Verbal Recognition" composite. Variables were combined by summing z-score transformed scaled scores. WASI Performance IQ scores were not found to be linearly related to either the immediate ($r = .139$, $p = .138$) or delayed ($r = .169$, $p = .072$) Family Pictures scores and were not included as a predictor variable in either of the regression analyses.

Finally, preliminary analyses revealed that the correlations between the variables used in the regression analyses were not significantly different between SLI and TD groups (Correlation matrices for each group and results from Box's M test that compared equality of the matrices between the two groups are presented in the appendix). Subsequently, data from the SLI and TD groups were collapsed to further improve statistical power. Results from regression analyses are summarized in Table 3.

The model examining the immediate recall component of the Family Pictures subtest was found to significantly predict scores and accounted for 11.2% of variance, $F(6, 108) = 2.265$, $p = .043$, $R^2 = .112$. The only significant predictor of Family Pictures in the immediate recall condition was the Central Executive Component, which measured verbal working memory. Inspection of zero-order correlations, also shown in Table 3, shows that, relative to other predictor variables, Central Executive Component Score had the highest correlation with the Family Pictures subtest. Subtests measuring visual/nonverbal declarative memory (i.e., Dot Locations nor Faces) were not significant predictors and had low zero-order correlations with the immediate recall Family Pictures component.

The model examining performance on the delayed recall component of the Family Pictures was also significant and accounted for 20.8% of variance, $F(6, 108) = 4.119$, $p < .001$, $R^2 = .208$. In this analysis, both the Central Executive Component Score (verbal working memory) and Delayed Verbal Recognition variables were found to be significant predictors. Both variables also had the largest zero-order correlations with the outcome variable. Again, neither Dot Locations nor Faces predicted scores from this component of the Family Pictures subtests and both had low zero-order correlations.

DISCUSSION

This study examined the extent performance on the CMS Family Pictures subtest is related to declarative memory for verbal information, visual information, and working memory. According to the CMS manual, the Family Pictures subtest measures declarative memory in the visual domain. Overall, the results of this study do not support this view. The first hypothesis that children with SLI would perform at levels comparable to controls on the Family Pictures subtest was not supported. Preliminary analyses showed that children with SLI had intact visual/nonverbal memory skills. However, as a group, they obtained significantly lower scores than controls on the Family Pictures subtest. The second hypothesis that performance on the Family Pictures subtest would be predicted by measures of visual/nonverbal memory was also not supported. Scores on the Family Pictures subtest in immediate and delayed recall conditions were consistently predicted by a measure of verbal working memory. Also, a composite variable measuring delayed recognition for verbal information was found to predict scores from the delayed recall component of the Family Pictures subtest. Scores from the CMS core subtests measuring memory for visual/nonverbal information were not found to be related to Family Pictures scores. Overall, the results suggest that individual differences on the Family Pictures subtest are related to verbal working memory and recognition for verbal information.

Our findings that children with SLI obtained significantly lower scores than controls on the Family Pictures subtest are not in line with results reported by Riccio et al. (2007). However, close inspection of the data from both studies reveals similarities across the overall profile of the children with SLI across subtests. In the current study, the average Cohen's d values for verbal declarative memory (Stores, Word Pairs), visual declarative memory

Table 3 Summary of Regression Analyses Investigating Predictors of Family Pictures Scores.

Dependent Variable/Predictor Variables in the Model	*b*	*SE b*	β	% of unique variance explained[c]	Zero-order correlations
Family Pictures Immediate Recall[a]					
CLS (Core Language Score; General Language)	−.004	0.021	−0.028	0.04%	.187
Central Executive Component Score (Verbal Working Memory)	.034	0.016	0.262*	3.57%	.296
Stories (Immediate Recall)	−.041	0.083	−0.061	0.20%	.080
Word Pairs (Immediate Total Score)	.119	0.097	0.149	1.25%	.221
Dot Locations (Immediate Total Score)	.061	0.066	0.085	0.71%	.120
Faces (Immediate Recall)	−.056	0.081	−0.066	0.40%	−.020
Family Pictures Delayed Recall[b]					
CLS (Core Language Score)	−.015	0.022	−0.090	0.35%	.272
Central Executive Component Score	.034	0.016	0.250*	3.61%	.336
Delayed Verbal Recall (Delayed Recall from Word Pairs & Stories)	−.043	0.217	−0.027	0.03%	.316
Delayed Verbal Recognition (Delayed Recognition from Word Pairs & Stories)	.598	0.207	0.374*	6.15%	.409
Dot Locations (Delayed Recall)	.016	0.066	0.021	0.04%	.083
Faces (Delayed Recognition)	.026	0.077	0.030	0.08%	.066

[a]Constant = 5.881; $SE = 1.621$.
[b]Constant = 6.959, $SE = 2.054$.
[c]Value obtained by squaring part correlation.
$^{*}p < .05$. $^{**}p < .001$.

(Dot Locations, Faces), and Family Pictures subtests were .84, .20, and .57, respectively. In the study by Riccio et al., the average effect sizes for the same subtests were .64, .20, and .39. Taken together, these results suggest that the performance of children with SLI on the Family Pictures subtest is worse when compared to other CMS subtests that measure memory for visual information. Furthermore, Riccio et al. had a smaller sample ($n = 30$) in each group. Thus, we may have had more power in this study to detect differences between the SLI and control groups. These findings can be interpreted to suggest that as a group, children with SLI experience more difficulty with the Family Pictures subtest compared to other core subtests assessing memory functioning for visual/nonverbal information.

Contrary to the claims published in the CMS test manual (M. J. Cohen, 1997), Family Pictures was not found to be associated with declarative memory for visual/nonverbal information (Table 3). In the adult literature, several studies show this lack of association as well. For example, the WMS-III version of the Family Pictures subtest has been found to be strongly related to declarative memory functions for verbal information but not visual/nonverbal information (Chapin et al., 2009; Dulay et al., 2002).

However, not all findings in the current study are comparable to those from the adult literature. In the studies by Dulay et al. (2002) and Chapin et al. (2009), the Logical Memory subtest, a measure of declarative memory for verbal information, was found to be the best predictor of Family Pictures scores in immediate and delayed conditions. In the current study, CMS subtests assessing delayed recognition of verbal information was only found to be related to performance on the delayed recall component of the Family Pictures subtest. The relative contribution of verbal working memory and declarative memory for verbal information on the Family Pictures subtests also appears to differ between adult and pediatric samples. In the adult literature, verbal working memory has been found to play a small role in predicting performance in the Family Pictures subtest (e.g., Dulay et al., 2002). In the current study, verbal working memory was found to be one of the best predictors of performance. Specifically, the measure of verbal working memory significantly predicted performance on the Family Pictures subtest, for both the immediate and delayed components, even after measures of language and other core CMS subtests were included in the model. Thus, at least in samples comprising children with and without SLI, the Family Pictures subtest appears to place demands on verbal working memory. This result might suggest that in completing the subtest, most effort is assigned to temporarily storing and manipulating the visually presented pictures into a verbal code. However, additional experimental work will be required to clarify this finding.

It is important to note that the measure of verbal working memory used in this study may also tap declarative memory skills. The subtests from the WMTB-C measuring verbal working memory use words and sentences as stimuli. The learning and retrieval of this knowledge is likely to be dependent upon processes supported by the declarative memory system (e.g., Ullman, 2004). From this perspective it is acknowledged that associations observed between the WMTB-C and Family Pictures subtest also implicate declarative memory. Thus, overall, the results indicate roles for both verbal working memory and declarative memory for verbal information.

The results of this study have implications for the interpretation of poor performance on the Family Pictures subtest. Low test scores on this subtest may reflect problems with verbal working memory, as well as verbal declarative memory, especially in the delayed component of the subtest, and not the visual/nonverbal domain. This suggestion is consistent with a growing literature indicating that children with working memory problems struggle considerably with learning especially in classroom settings (Gathercole, Pickering, Knight, & Stegmann, 2004).

This study is one of the first to examine the correlates of the Family Pictures subtest in a pediatric population. The findings show that the core subtests of the CMS subtest appear to be sensitive to the presence of verbal problems. However, the supplemental Family Pictures subtests, despite being presented as a test of visual memory, appear to be related to verbal working memory. Consequently, caution is required when interpreting results from this subtest about the nature of cognitive and neurological problems in both clinical and research contexts.

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Appendix Correlations between Memory Subtests Reported by Group.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
							SLI Group						
1. Central Executive Component Score (Verbal Working Memory)	–												
2. Family Pictures Immediate Recall	.322*	–											
3. Family Pictures Delayed Recall	.405*	.659*	–										
4. Stories: Immediate Recall	.089	−.102	.074	–									
5. Stories: Delayed Recall	.269	.106	.234	.780**	–								
6. Stories: Delayed Recognition	.162	−.104	.123	.583**	.616**	–							
7. Word Pairs: Total Score (Learning & Immediate Recall)	.380*	.089	.311*	.470**	.492**	.309*	–						
8. Word Pairs: Delayed Recall	.364*	.124	.173	.125	.170	.143	.472	–					
9. Word Pairs: Delayed Recognition	.305*	.136	.340*	.118	.206	.103	.552	.552**	–				
10. Dot Locations: Total Score (Learning & Immediate Recall)	−.017	.157	.060	.020	.053	.035	.080	−.042	−.019	–			
11. Dot Locations: Delayed Recall	−.043	.247	.103	.056	.018	−.002	.078	.000	−.063	.615**	–		
12. Faces: Immediate Recognition	.301*	−.061	.079	.260*	.245	.270*	.272*	.097	.344*	−.057	.049	–	
13. Faces: Delayed Recognition	.229	.072	.162	.104	.079	.004	.187	.273*	.263*	.073	.135	.627**	–
							Control Group						
1. Central Executive Component Score (Verbal Working Memory)	–												
2. Family Pictures Immediate Recall	.056	–											
3. Family Pictures Delayed Recall	.038	.873**	–										
4. Stories: Immediate Recall	−.021	.032	.082	–									
5. Stories: Delayed Recall	−.028	.058	.119	.928**	–								
6. Stories: Delayed Recognition	.041	.212	.284*	.728**	.676**	–							
7. Word Pairs: Total Score (Learning & Immediate Recall)	.289*	.196	.178	.494**	.392*	.415**	–						
8. Word Pairs: Delayed Recall	.216	.105	.107	.201	.117	.166	.547**	–					
9. Word Pairs: Delayed Recognition	.080	.172	.204	.086	.178	.174	.414**	.414**	–				
10. Dot Locations: Total Score (Learning & Immediate Recall)	.111	.023	−.092	.099	.122	.026	.043	.203	.057	–			
11. Dot Locations: Delayed Recall	.211	.111	−.011	.097	.079	.108	.074	.268*	.134	.572**	–		
12. Faces: Immediate Recognition	.096	.082	.207	.146	.161	.208	.194	−.011	.117	−.073	.031	–	
13. Faces: Delayed Recognition	−.093	−.130	.073	.187	.244	.143	.123	.009	.080	−.265*	−.185	.427**	–

Note: Differences in correlation matrices investigated by using the Box's M statistic. Data submitted for this analysis were z-transformed variables. Results revealed differences in matrices were not statistically significant (Box's M = 117.371), $F(1.134, 91) = 1.134$, $p = .181$.

$^{*}p < .05$; $^{**}p < .001$.