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List Recall Performance in Adults with Language Learning Disability

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List Recall Performance in Adults with Language Learning Disability

by

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Abstract

List Recall Performance in Adults with Language Learning Disability

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This thesis is a pilot study of ongoing research concerning the nature of impairments in adults with language learning disorders. The current study assessed lexical-semantic organization in14 adults with language learning disorders (LLD), ages 18;9 to 24;3 and 14 adults with no history of language impairment (TD) matched for age, gender, and education with a list recall task adapted from Watson, Balota, and Roediger (2001). All adults were enrolled in a four-year university. No significant differences were found on accuracy of list recall in LLD and TD. Similar to previous research, list recall for semantically- related words was higher in accuracy than for phonologically- related words for both LLD and TD participants. All participants were more likely to accurately recall the words at the beginning and at end of the lists. The LLD group showed a

positive correlation between oral language and phonological processing performance with accuracy of recall. These results suggest that adults with language learning disorders who are enrolled in a four-year university are able to implement strategies that compensate for any language difference that may exist. Also, the similarities in patterns and accuracy of list recall suggest similar lexical-semantic organization in adults with LLD and TD.

Table of Contents

List of Tables x

List of Figures xi

Introduction 1

Learning Disability 2

Specific Languge Impairment (SLI) and Language Learning Disability……3

Dyslexia……...5

Verbal Memory in LLD…….7

The List RecallParadigm…….8

Present Study……..…10

Methods 12

Participants 12

Stimuli 14

Procedures……15

Coding……...16

Results 17

List Type Effect 17

List Position Effect 18

Group by List Position Interaction 19

List Type by List Position Interaction .....….20

Relationship Between Standardized Test Performance and Recall Accuracy ..

…….....21

Discussion 23

Recall Accuracy 23

List Type Effect 25

List Position Effect 26

Conclusion 26

Appendix 28

Bibliography 30

List of Tables

Table 1: Participant data and mean standardized test scores 14

List of Figures

Figure 1: Recall accuracy by list type. 18

Figure 2: Recall accuracy by list position. 19

Figure 3: Recall accuracy by group and list position 20

Figure 4: Recall accuracy by list type and list position 21

Introduction

Language learning disorder (LLD) or primary language impairment (also known as specific language impairment, or SLI) is a condition affecting approximately 7% of the United States children (Tomblin, Records, Buckwalter, Zhang, Smith, & O Brien, 1997). For the purposes of the current thesis LLD will be used. Individuals with LLD have intact nonverbal intelligence, but considerable difficulties in acquiring language (Leonard, 1998). Children can be diagnosed with LLD as early as 3 years of age, and even with intervention, these difficulties can persist into adulthood (Poll, Betz & Miller, 2010). Among other things, small vocabulary and poor phonological working memory have been identified as behavioral markers of LLD in child populations (Dollaghan and Campbell, 1998; McGregor, Newman, Reilly, & Capone, 2002). It is still unclear to what extent these deficits persist into adulthood and how they interact with language processing. The purpose of this study is to further our understanding of the nature of LLD in adulthood by comparing performance on a list recall experiment between young adults with LLD and typical controls. In addition, the relationship among extant vocabulary, phonological working memory capacity, oral language proficiency and list recall performance was explored among these two groups. In the following sections of the introduction the definitions of a few common terms used to label LLD in children and adults are provided, the behavioral symptoms of these various disorders are described, the experimental paradigm is explained, and the research questions and hypotheses of the current study are presented.

Learning Disability (LD)

Learning disability (LD) is a generic term frequently used to refer to individuals with LLD. Although not all LDs are language-based, a considerable proportion of the individuals with LD have primary deficits in the areas of reading, writing, and spelling, all of which draw on a foundation of oral language skills (Gibbs & Cooper, 1989; Paul, 2007). Sparks and Lovett (2009) reviewed the literature concerning classification criteria for adults with LD enrolled in postsecondary programs. The learning disabled population is underrepresented in institutions of higher learning, which can result from a multitude of factors including insufficient instruction curricula in high school, the inconsistency for diagnostic criteria between high school and college, and the limited skill training providing strategies for this population to succeed in institutions (Sparks & Lovett, 2009). Twenty-three different combinations of inclusion criteria for a diagnosis of LD were found among the 108 reviewed studies. Achievement discrepancy, defined as a significant difference between IQ and standardized test scores, was frequently used for inclusion. However, most studies did not include the specific degree of discrepancy used, although standard deviations of 1.0, 1.3, and 1.5 were most commonly used to qualify individuals for an LD diagnosis (Sparks & Lovett, 2009). The tests commonly administered for diagnosis included the *Woodcock-Johnson Proficiency Battery (WJPB, WJ-R, WJ-III),* the *Wide Range Achievement Test (WRAT, WRAT-R, WRAT-3),* the *Nelson-Denny Reading Test,* and the *Peabody Picture Vocabulary Test (PPVT).* Individuals with a learning disability who were pursuing a college degree frequently scored within and/or above the average range of test scores on the oral language,

language comprehension and mathematic standardized tests (Sparks & Lovett, 2009). The results of this study indicate more controversy than consistency when determining diagnosis criteria for individuals with LD pursuing a college degree. The authors noted their attempt to assess specific criteria for subtypes of the LD diagnosis such as language impairment or reading disability failed due to a lack of critical inclusion criteria data.

Specific Language Impairment (SLI) and Language Learning Disability (LLD)

SLI is an oral language disorder not explained by inferior cognitive abilities, sensory deficits, or significant neurological damage (Leonard, 1998). SLI is frequently diagnosed in preschoolers but close to half of the affected children continue to experience language difficulties and go on to receive a diagnosis of LLD during school-age years (Paul, 2007). Longitudinal studies of SLI (Johnson et al., 1999; St Claire, Pickles, Durkin, & Conti-Ramsden, 2011) provide evidence for residual language difficulties as well as social and emotional problems in adults with a childhood history of LLD.

While a great deal of research has focused on describing the nature and identifying diagnostic markers of LLD in childhood, only a handful of such studies are available for their adult counterparts (Fidler, Plante, & Vance, 2011; Poll, Betz, & Miller, 2010; Tomblin et al., 1992). Tomblin et al. (1992) tested 35 young adults with a history of LLD (age range: 17 to 25) and a group of age matched controls (TD) who had no previous diagnoses of language impairment. The following standardized tests were administered: The Picture Peabody Vocabulary Test-Revised (Dunn & Dunn, 1981) to assess receptive vocabulary, the Modified Token Test (DeRenzi & Faglionoi, 1978) to

assess comprehension, the Reading Comprehension test and Written Spelling test of the Multilingual Aphasia Examination (the MAE, Benton & Des Hamsher, 1978), the Test of Word Finding (German, 1986) and the Boston Naming Test (Kaplan, Goodglass & Weintraub, 1983) to assess naming speed. The adults with a childhood diagnosis of LLD performed lower than the control group on the PPVT (SLI *mean (M)* = 81, TD *M* = 94*),* the Token Test (SLI *M* = 63, TD *M* = 85), the Written Spelling test of MAE (SLI *M* = 7, TD *M* = 10), and the Reading test of the MAE (SLI *M* = 16, TD *M* = 18). However, it is important to note that overlap in performance was observed on all of these tests indicating that none of these tests should be used alone for diagnosis of LLD in adults. Individuals with milder cases of LLD perhaps caused this overlap in performance as these individuals no longer presented with deficits in adulthood.

Poll et al. (2010) noted that manifestation of LLD in adulthood is similar to that in childhood and a combination of non-word repetition, sentence repetition, and grammaticality judgment tasks may serve to diagnose LLD in adults. Fidler et al. (2011) used a set of 9 different measures with 36 participants with LLD and 36 age- and education-matched controls. The participants with LLD were recruited through the University of Arizona disability office. Results from 3 of the measures are reviewed here: the nonword repetition task (developed by Kamhi & Catts, 1986), the Grammatical Morpheme subtest of the *Comprehensive Assessment of Spoken Language* (CASL) (Carrow-Woolfolk, 1999), and the *Peabody Picture Vocabulary Test- Revised (PPVT-R)* The individuals with LLD scored significantly lower on all three measures (the Non-word Repetition task: LLD *M* = 8.50, *SD* = 2.30, control *M* = 10.03, *SD* = 2.08; the

Grammatical Morpheme subtest: LLD *M* =87.78, *SD* = 19.19; control *M* = 100.75, *SD* = 12.76; the PPVT: LLD *M* = 92.86, *SD* = 12.35, control *M* = 100.4, *SD* = 11.29). The results of Fidler et al. (2011) suggest that individuals with LLD that are also enrolled in college continue to present with impairments in phonological memory, grammar, and semantics. However, if the standard deviations are considered, there (again) is overlap in performance on all three tasks between the LLD and the control groups. It is possible that although some of individuals in the study still had a current LLD diagnosis, their impairment was very mild in nature or may have already resolved.

Dyslexia

Developmental dyslexia is a neurological language learning disability and a subtype of reading disorder. Dyslexia affects approximately 10% of the school age population (Vellutino, Fletcher, Snowling, & Scanlon, 2004). Individuals with dyslexia often have a phonological impairment causing poor decoding and spelling which may/can lead to deficits in reading comprehension and vocabulary. Bishop and Snowling (2004) report that SLI and developmental dyslexia are often considered as different manifestations of the same impairment.

Ransby and Swanson (2003) examined oral language and reading comprehension performance in adults (ages 17-23) who had a childhood diagnosis of dyslexia. Results showed that adults with childhood dyslexia had significantly lower scores in vocabulary, reading comprehension, listening comprehension and working memory than chronological age and intelligence matched peers. Kinsbourne, Rufo, Gamzu, Palmer,

and Berliner (1991) administered a study with 23 adults with a current diagnosis of severe dyslexia, 11 adults with recovered dyslexia (i.e., these individuals had a childhood history of dyslexia but their current deficits were not severe enough to merit a diagnosis), and 21 normally reading adults matched for age, gender, education, and IQ. On the WRAT-Reading achievement test, individuals with severe dyslexia had a mean raw score of 47 *(SD* = 14*),* the individuals with recovered dyslexia had a mean of 67 *(SD* = 8*),* and the controls had a mean of 74 *(SD* = 8). The authors stated that adults with recovered dyslexia represented a subgroup of individual with dyslexia who continued to make an effort to improve their reading skills beyond secondary school. Bruck (1993) assessed 20 college students with childhood diagnosis of dyslexia. This group scored a mean *(M)* = *98* on the PPVT suggesting that semantics is not impaired in adults with dyslexia who are enrolled in college.

In summary, a review of the literature suggests large overlap in the behavioral profiles of SLI, LLD, and developmental dyslexia. These diagnostic labels represent a heterogeneous group of individuals whose impairment may vary anywhere from mild to severe. There is currently no gold standard in diagnosing LLD among adults (Fidler et al., 2011). A subgroup of adults with childhood diagnosis of LLD may show sufficient recovery from their language impairment and achieve age appropriate scores on language and reading tests. It is still unclear what mechanisms may enable these individuals to recover from language impairment. However, superior cognitive abilities, the use of compensatory strategies, reading habits and writing experience, and superior lexical

knowledge have been proposed to account for the extraordinary growth among these individuals (Fidler et al., 2011; Shaywitz et al., 2003).

Verbal Memory in LLD

Verbal memory refers to the ability to recall linguistic information that is either visually encoded or auditorily encoded (Isaki, Spaulding, & Plante, 2008). Verbal memory can be further differentiated into short-term memory, working memory, and long-term memory (Bjorklund, 2005). Short-term memory is defined as the temporary storage of information, whereas long-term memory is a more durable and permanent storage of information. Working memory involves both the storage and processing of information held in short-term memory. Working memory is necessary for long-term learning and ongoing higher-order cognitive functions such as comprehension and reasoning (Baddeley, 2003).

Numerous studies have documented deficiencies in phonological/verbal memory in LLD populations and suggested a link between verbal memory capacity and language achievement in both typically developing individuals and individuals with LLD (e.g., Baddeley, 2003; Isaki et al, 2008; Montgomery, 2002). For example, Archibald and Gathercole (2005) tested 20 children ages 7-11 with LLD. These children showed marked impairments in working memory and verbal short-term memory, which may have caused vocabulary learning deficits. Siegel and Ryan (1989) assessed working memory in children with reading disability and found that these children performed significantly worse on a sentence recall task than a control group.

Of particular relevance to the current study is Isaki et al.'s (2008) study of adults with LLD. Eighteen college students who had a current diagnosis of LLD or a history of LLD and 18 age- and gender-matched controls participated in 6 memory tasks that varied in memory type (working memory versus short-term memory) and linguistic load (low, moderate, high). The short-term memory tasks (i.e., forward digit span, forward word span, sentence span) require simple repetition of auditorily presented items evaluating storage capacity. In contrast, the working memory tasks (reverse digit span, reverse word span, working memory sentences) require the participants to both store and process the presented items. Significant between group differences were found only in the most taxing condition, namely, the working memory sentences task. In this task, the participants had to repeat a sentence after answering two true or false questions about the sentence. The author suggested that the participants with LLD may represent the relatively mild end of the LLD continuum, hence only showing deficits in the most challenging condition when the task demands exceeds their working memory capacity. Furthermore, significant correlations were observed between several memory tasks and performance on two standardized linguistic tests (i.e., the PPVT, and the Modified Token Test). However, these correlations only existed for the LLD group. The authors suggested that the control group may have reached a homogeneous state and demonstrated little inter-individual variation in language performance.

The List Recall Paradigm

One commonly used task to assess verbal memory is the list recall task. In this task, participants recall words presented without regard to the order of presentation (free recall). List recall tasks differ on the type of stimuli utilized. Some tasks utilize lists comprised of words that are related to each other while others use lists of unrelated

words. In one variation of the list recall paradigm (i.e., the Deese-Roediger McDermott [DRM] paradigm, Roediger & McDermott, 1995), participants listen to lists of words that are related to a critical non-presented word (e.g., *dog*) semantically (e.g., *hound, puppy, bite, pet, beware, bone, tail, cat*), phonologically (e.g. *log, hog, cog, doll, dig, dug, dock, dawn*), or both semantically and phonologically (e.g., *hound, log, puppy, doll, bite, dig, pet, dawn*). Watson, Balota, and Sergent-Marshall (2001) presented semantic lists, phonological lists, and hybrid (mixed semantic and phonological) lists to young adults, older adults and adults with Alzheimer's disease. All participants were more likely to accurately recall the words on the semantic lists (M = .55*)* than words on either phonological (M = .38) or hybrid (M = .40) lists. Sensitivity to semantic relationships may have led to better recall of words on the semantic list. The DRM paradigm has not been used with adults with LLD. It is unclear whether adults with LLD would show the same patterns of recall for various list types.

Recall accuracy also varies as a function of the word's position in a list (Tan & Ward, 2000; Watson et al., 2001). In particular, participants usually begin recall with words at the end of the list and recall them with the highest accuracy (the recency effect). In addition, words at the initial positions are recalled with higher accuracy (the primacy effect) than those in the middle of the list. List-final words are more easily recalled because these words are still accessible in working memory at the time of recall. The list-initial recall advantage is attributed to the increased opportunities for rehearsal of these items, which may result in these words' transfer to long-term memory. Words falling in the middle of the list are often lost because neither benefit is available.

Present Study

The purpose of this study is to further our understanding of language learning disability in adulthood. Specifically, the verbal working memory capacity in this population was explored and compared to normal controls in a DRM (Roediger & McDermott, 1995) list recall experiment. Adults will listen to lists of words that converged on a critical non-presented word (e.g., *cold*) on a semantic basis (e.g., *chill, warm, freeze, fever),* a phonological basis, (e.g., *told, old, sold, coal*), or a dual semantic and phonological basis (e.g., *chill, told, warm, old)*. This paradigm is often used to compare the salience of phonological versus semantic organizational principles through investigating the incidence of false memory intrusions (i.e., recalls of the critical non-presented word). In this thesis, only the accuracy of recall will be addressed as the patterns regarding memory intrusions are presented elsewhere (Blecher, 2011).

Because adults with LLD exhibit deficits in lexical knowledge and phonological memory (Fidler et al., 2011; Isaki et al., 2008; Poll et al., 2010; Tomblin et al., 1992), it is hypothesized that these individuals will show lower accuracy in recall. Because previous studies indicate great heterogeneity in adults with LLD, it is expected that some of the participants with LLD will perform within normal limits on recall as well as standardized language tests. Similar to Isaki et al. (2008), it is also expected that there will be a relationship between language test performance and recall accuracy among the current pool of participants.

With regard to list type, it is hypothesized that individuals with LLD will demonstrate better recall of words on the semantic lists than on the phonological and

hybrid list (Watson et al., 2001). However, the semantic list advantage may be reduced relative to typical controls due to less developed lexical-semantic knowledge (Fidler et al., 2011; Poll et al., 2010; Tomblin et al., 1992). Finally, it is also anticipated that the list position effect will be preserved in individuals with LLD as this effect appeared to be resistant to aging and cognitive decline (Watson et al., 2001).

Methods

Participants

Twenty eight adults (N= 14 females; N = 14males) ages 18;9 to 24;3 (years;months) participated in this pilot study. All adults were monolingual speakers of English with no history of cognitive, hearing or visual impairment per self-report and examiner observation/testing. Individuals were recruited for participation through a Student Services with Disabilities office via research opportunity email, flyers posted on the University of Texas campus, and word of mouth referrals.

Among the 28 participants, there were 14 young adults with language learning disability (LLD) and 14 age and gender matches with a negative history of language learning disability (i.e., typically developing [TD]). The mean ages of the LLD and TD groups were 20;11 (range 18;9 to 24;3) and 20;10 (range 19;1 to 22;4), respectively. Groups were also balanced for education level. The mean for years of education for the LLD and TD groups was 15 years 10 months and 15 years 11 months, respectively. Twenty- seven participants were undergraduate students at the University of Texas at Austin. One participant was an undergraduate student at another four-year university in Austin, Texas. All participants with LLD were recruited via email through the students with disabilities office at their respective universities. Twelve of the 14 LLD participants had a diagnosis of dyslexia, one person had a diagnosis of reading disorder, and one person had a language processing disorder. One individual with dyslexia also had a spelling disorder, and another person with dyslexia also had dyscalculia. Six of the

fourteen participants with LLD also had a diagnosis of ADHD, a disorder highly comorbid with LLD (Paul, 2007).

All participants met the following inclusion criteria: (a) had nonverbal IQ above 80 as measured by the Matrices subtest of the *Kaufman Brief Intelligence Test- Second Edition* (K-BIT-2; Kaufman & Kaufman, 2003); (b) had normal hearing and vision per self report on the background history form; (c) no self report of traumatic brain injury, and (d) were monolingual native speakers of English.

Participants in the TD group met the following additional criteria to verify their status as non -language impaired: (a) scored no lower than 1.3 standard deviation below the mean on the following measures: 1) Test of Adolescent and Adult Language-Written subtest and General Language (the TOAL, Hammill, Brown, Larsen, & Wiederholt, 1994), 2) the Peabody Picture Vocabulary Test, Fourth Edition (PPVT-IV)(Dunn & Dunn, 2007), 3) the Digit Memory subtests of the Comprehensive test of Phonological Processing (CTOPP; Wagner, Torgesen & Rashotte, 1999); and (b) observation by graduate clinician that speech and language are within normal limits. One TD participant had a standard score of 74 on the TOAL-Spoken subtest; however, he scored within the normal range on all the other tests. Six of the 14 TD participants scored below 1SD (a standard score of 6 or lower) on the nonword repetition subtest of the CTOPP. However, these individuals scored within the normal range on all the remaining tests. Scores on the TOAL-Written subtest were not available for 3 individuals with LLD and one person in the TD group because this this subtest was not administered to them due to timing constraints.

Participants in the LLD group met the following additional requirements to be included: (a) self report of language learning disorder, and (b) recruited from the SSD within a database of students qualifying for academic accommodations. The average scores on standardized measures of LLD and TD were compared to determine differences on receptive vocabulary, non-word repetition, digit memory, and written and spoken language (see Table 1). A two sample t-test revealed no significant differences in standard scores between the LLD group and the control group on any of the measures, *ts* < -1.6 , *ps*> 0.123.

Table 1: Participant data and mean standardized test scores

	Mean Age	Male: Female Ratio	Education (years)	K-BIT-II[a]	PPVT-IV[b]	TOAL-Written[c]	TOAL-Spoken[d]	TOAL[e]	NWR[f]	MD[g]
LLD	20.9	1:1	15.9	107	110	97	97	98	8	11
SD	1.5		1.2	15	13	12	10	13	3	3
TD	20.8	1:1	15.9	101	109	104	98	100	7	12
SD	1.1		0.9	13	10	8	11	9	2	2

a. Kaufman Brief Intelligence Test – 2nd Edition; b. Peabody Picture Vocabulary Test – 4th Edition; c. Test of Adolescent and Adult Language-Written Subtest– 2nd Edition; d. Test of Adolescent and Adult Language-Spoken Subtest– 2nd Edition; e. Test of Adolescent and Adult Language– 2nd Edition; f. Non-word Repetition subtest of CTOPP; g. Memory for Digits subtest of CTOPP

Stimuli

The stimuli consisted of forty-eight 12-item lists of words adapted from Watson, Balota, and Roediger (2003, Experiment 3) (see Appendix). Twelve non-presented critical targets (i.e., *bad, ball, car, dog, face, mail, man, pen, rain, right, top, wet*) were

selected from Watson et al.'s (2001) stimulus lists. For each target, four types of lists were constructed: pure semantic, pure phonological, hybrid semantic-phonological (HSP), and hybrid phonological-semantic (HPS). The first 12 semantic or phonological associates in Watson's 16-word lists were selected for the current study. Each target word (not presented) had high occurrences of semantic and phonological associates (Stadler, Roediger, & McDermott, 1999).

Procedures

Participants were tested within a single ninety-minute session. Participants received 20 dollars for their participation. Approval was received from the Institutional Review Board before testing and all participants read and signed consent to participate form. All sessions took place in a small, quiet room at the University of Texas Speech and Hearing Clinic. Each individual was given 4 semantic, 4 phonological, and 4 Hybrid (2 HSP and 2 HPS) lists associated with a total of 12 different non-presented critical targets. The 3 list types were presented in blocks with intervening standardized testing. The lists were presented through two computer speakers at a 60+dB level. Individuals sat approximately two feet away from the computer to ensure audibility of the signal. Two female native English speakers with a standard American accent recorded the stimuli and no difference in performance was observed between the two speakers. The lists were equally distributed across participants and order of list type was counterbalanced. Each participant was also administered two 12-word lists for practice at the beginning of the session. Participants were instructed, *"Now you are going to listen to lists of words.*

Please listen carefully and try to remember as many words as you can. When you are done listening, I will ask you to recall the words in no particular order. There are 12 words per list. Are you ready?" Once the expectations for the task were established, testing commenced and the remaining experimental trial lists were administered. Positive social reinforcement was provided throughout the memory tasks to encourage recall.

Coding

For the purpose of the current study, recalled words were coded as correct if they were on the list or incorrect if they were not on the lists. Recall of the critical non-presented target, repetitions, and/or morphological variations were counted as incorrect. Reliability of coding was attained by having another graduate student listen to the audio-recordings and independently code the recalls of 3 participants in the LLD group and 3 participants in the TD group. The two coders had 99% point-to-point agreement. A full list of error types and error data can be found in Blecher (2011).

Results

Before statistical analysis was conducted, accuracy of recall was calculated for each participant, at each list position, and for each type of list. The Hybrid Semantic-Phonological and Hybrid Phonological-Semantic lists were combined in all analyses because these two types of lists yielded a similar level of accurate recall. A mixed model ANOVA was conducted with group (LLD, TD) as the between-participant variable, and list type (semantic, phonological, hybrid) and list position (1-12) as the within-participant repeated measures. This analysis revealed two main effects (those of list type and list position) and two interactions (group x list position, list type x list position). The group effect was not significant. Nor did group interact with other factors. Each of the significant findings is presented below.

List Type Effect

There was a main effect of list type, $F\ (2, 52) = 58.73, p < .001, \eta_p^2 = .69$. Post-hoc Bonferroni tests indicated a higher level of recall accuracy for the semantic lists ($M = .51, SE = .015$) than for both the hybrid lists ($M = .40, SE = .013$) and the phonological lists ($M = .35, SE = .011$), $p < .001$ for both comparisons. Accuracy was also higher for the hybrid lists than for the phonological lists, $p = .002$. These patterns are presented in Figure 1.

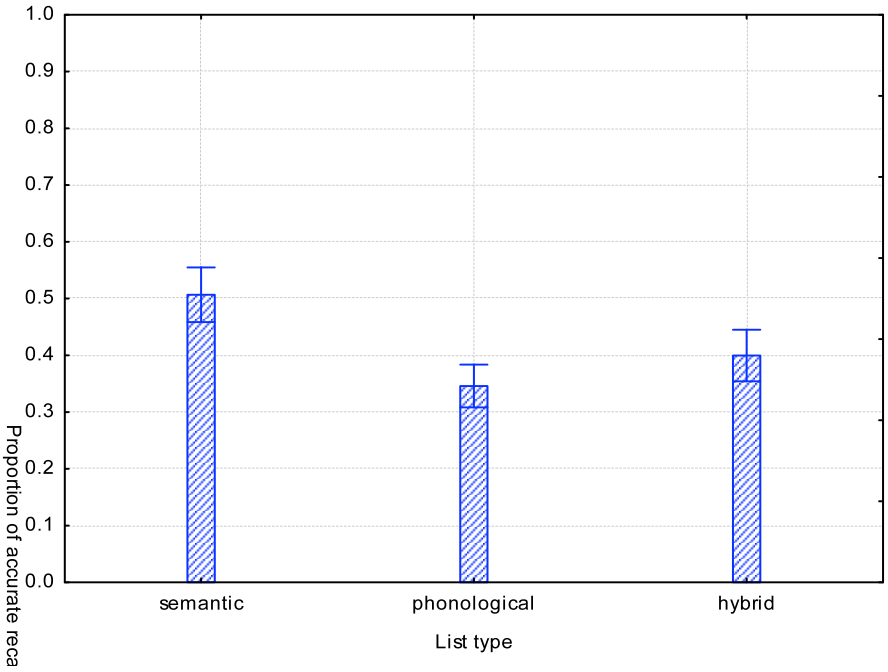

Figure 1. Recall accuracy by list type. Bars denote standard errors.

List Position Effect

The main effect of list position was also significant, $F\,(11, 286) = 40.91, p < .001$, $\eta_p^2 = .61$. The typical bow-shaped curve was apparent (see Figure 2). Words at the list-final positions (11 and 12) were recalled with the highest accuracy. Those at the list-initial position (1 and 2) were recalled with an intermediate and comparable level of accuracy as those in positions 8 and 9. Words in the medial position (3 to 7) were recalled with the lowest level of accuracy.

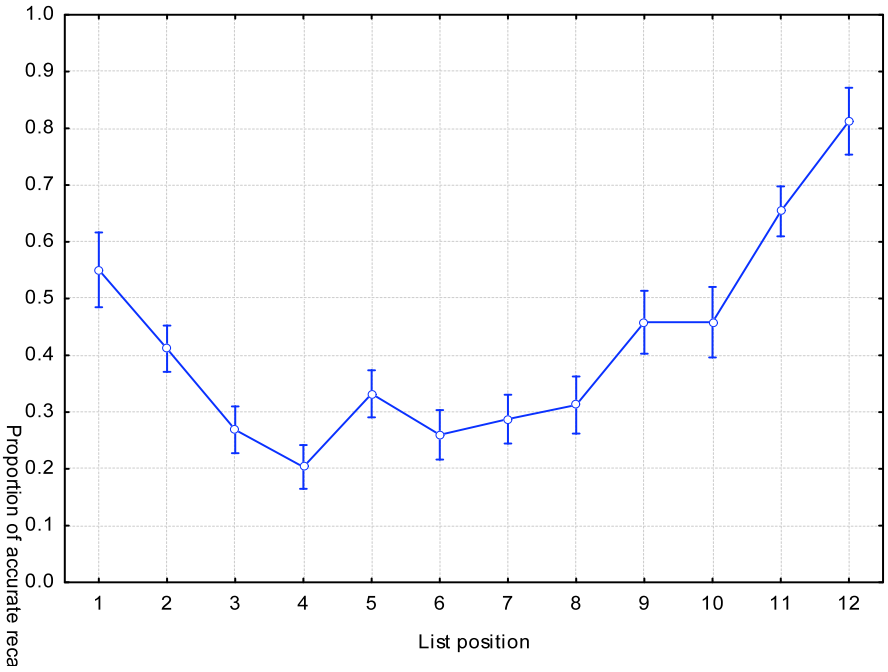

Figure 2. Recall accuracy by list position. Bars denote standard errors.

Group by List Position Interaction

Group and list position interacted, $F\ (11, 286) = 2.32, p = .01, \eta_p^2 = .08$. Inspection of Figure 3 reveals non-overlapping standard error values between the two groups for list positions 5 and 9. Planned t-tests were conducted to compare the LLD and TD groups' recall accuracy for these positions. The TD group ($M = .41, SD = .13$) was more accurate than the LLD group ($M = .25, SD = .13$) in recalling words at the 5th position, $t\ (26) = 3.32, p = .003, d = 1.26$; on the other hand, the LLD group ($M = .38, SD = .13$) was more accurate than the TD group ($M = .24, SD = .17$) in recalling words at the 8th position, $t\ (26) = 2.39, p = .02, d = .90$.

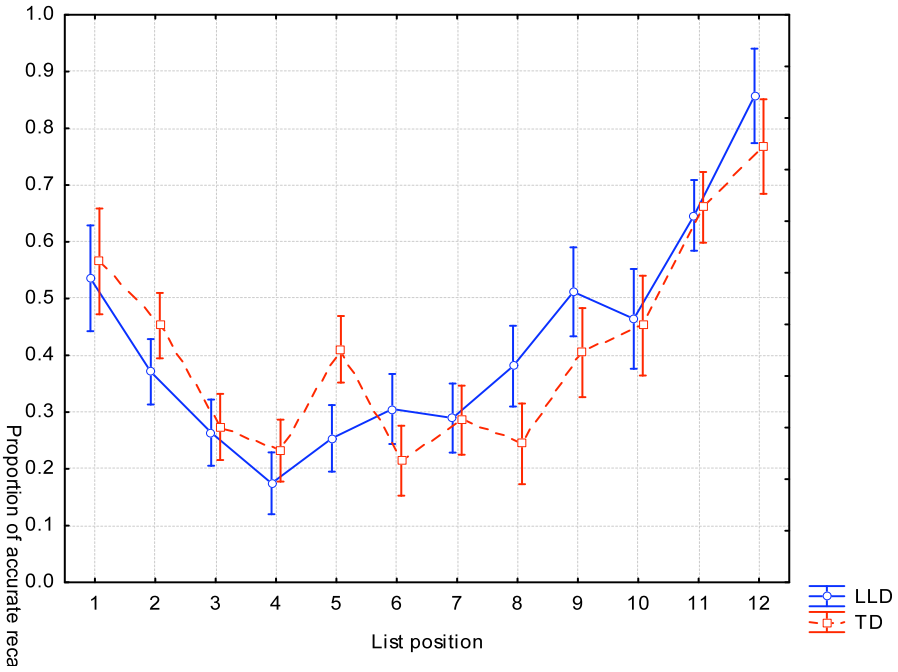

Figure 3. Recall accuracy by group and list position. Bars denote standard errors.

List Type by List Position Interaction

There was an interaction between list type and list position, F (22, 572) = 3.14, p < .001, η_p^2 = .11. As shown in Figure 4, recall of semantic list words was significantly higher than that of the phonological list words for all list positions except positions 5, 11, and 12. The semantic list recall advantage over the hybrid list words was significant at list positions 1, 2, 3, 4, 6, and 10. Participants also recalled more words on the hybrid than the phonological lists for positions 9 and 11. In other words, the semantic list recall advantage was particularly great at the list initial positions; whereas recall of the three list types were more similar at the medial and final positions.

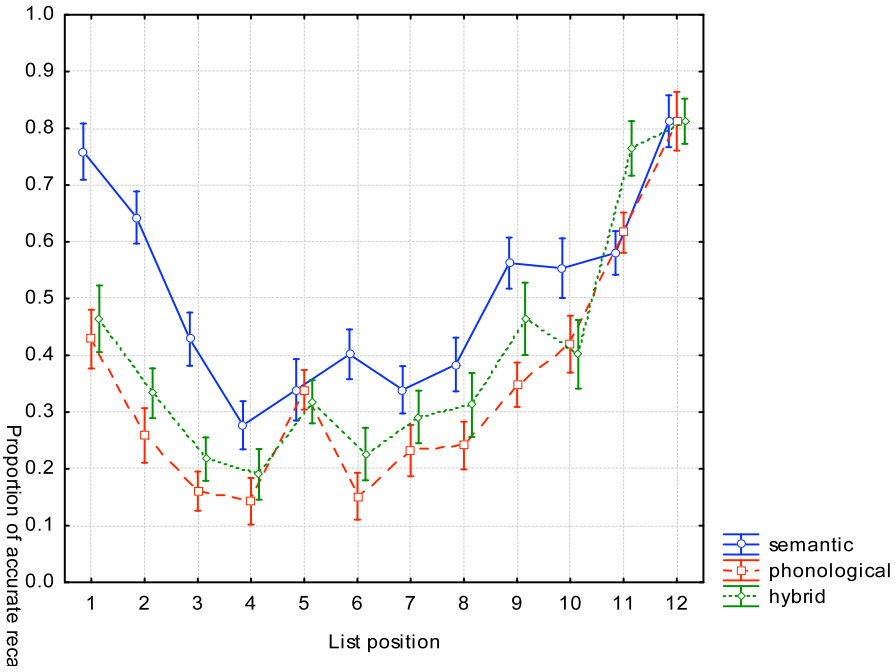

Figure 4. Recall accuracy by list type and list position. Bars denote standard errors.

Relationships Between Standardized Test Performance and Recall Accuracy

Correlational analyses were conducted between standardized test scores (i.e., the PPVT, the K-BIT, the digit memory and nonword repetition subtests of the CTOPP, and the spoken subtest of the TOAL) and overall recall performance with all lists combined for the LLD and TD groups, respectively. The TOAL-written subtest and the TOAL-general were not included in this analysis because scores were not available for 3 individuals with LLD and one person in the TD group. No significant correlations were found within the TD group, but significant correlations were found within the LLD group. The better an individual in the LLD group did on the *PPVT* , the Spoken Subtest of the *TOAL*, and the *Non Word Repetition Subtest of the CTOPP,* the more likely they

were to correctly recall words (PPVT: $r = .60, p = .02, r^2 = .36$; NWRT: $r = .54, p = .047, r^2 = .29$; TOAL: $r = .59, p = .03, r^2 = .35$).

Discussion

This study examined list recall performance in 14 individuals with language learning disorder and 14 age, gender, and education matched controls. Several pattern were revealed. First, there was no significant difference in the overall accuracy of recall between the two groups. However, when specific list positions were examined, there was an LLD advantage in recalling words at the 8th position, and a TD advantage in recalling words at the 5th position. Second, there were significant correlations between standard test scores (on the PPVT, the NWRT, and the spoken subtest of the TOAL) and recall accuracy in the LLD group but not in the TD group. Third, recall accuracy was the highest for the semantic lists, followed by the hybrid lists, and the lowest for the phonological list. This semantic list recall advantage was the most apparent for words at the initial position (1 through 4). Fourth, all participants demonstrated the list position effect, recalling list-final words with the highest accuracy (the recency effect), list-initial words with intermediate accuracy (the primacy effect), and words at the medial position with the lowest accuracy.

Recall Accuracy

Contrary to our hypothesis, there was no significant difference in the overall accuracy of recall between the two groups. Moreover, despite the fact that the participants in the LLD group were still receiving academic accommodation because of their LLD, these individuals achieved comparable performance on all standardized tests to the typical controls. We did not have information about the onset of LLD in these

participants so it is unclear how long these individuals have lived with this diagnosis and the amount of intervention they have received. Several possibilities may explain the between-group similarities. First, the participants with LLD may represent a subgroup of the LLD population that has recovered from their language or reading disorders (for similar arguments, see Kinsbourne et al., 1991).The fact that these students were attending a top-ranked university suggests that these individuals may have grown out of their LLD. Second, the participants with LLD may be more familiar with psycholinguistic testing than the controls. Indeed, several participants in the LLD group commented during testing that they had done similar tests repeatedly in the past. Familiarity with the test format and the use of strategies may have enabled them to perform at a level that exceeded their actual linguistic aptitude. On the other hand, the TD group may be at a disadvantage due to a lack of practice. Third, it is also possible that the present recall task as well as the standardized tests were not challenging enough. Recall that Isaki and colleagues (2008) found that the LLD cohort only showed a significantly lower score than the TD cohort on the most taxing working memory task. Future studies may need to include a more heterogeneous sample of individuals with LLD or employ more difficult tasks.

The correlation results warrant further discussion. Similar to Isaki et al. (2008), we found that individuals in the LLD group with a better performance on the PPVT, the Spoken Subtest of the TOAL and Non-Word Repetition produced higher accuracy of recall; but the same relationships were not observed for the TD group. These findings support the notion that the typical adults may have reached asymptote in their linguistic

ability. At the same time, the LLD group demonstrated greater variability in their lexical breadth, phonological processing and short-term memory, and oral language proficiency. Despite within normal range performance, the LLD group still showed more variation in their language skills.

List Type Effect

Consistent with what was predicted and also similar to previous studies (Watson et al., 2001, 2003), both groups were more likely to accurately recall words on the semantic lists than those on the phonological and hybrid lists. It is possible that all participants were sensitive to the semantic relationships among the presented words (e.g. *slippery, wet,* and *thunder* were all related to rain) and the cohesiveness of the stimuli lead to better recall. In comparison, accuracy of recall was lowest on the phonological lists for all participants. Phonological similarity among the words may lead to greater difficulty in rehearsal (Baddeley, 2003; Isaki et al., 2008). Indeed, the semantic-phonological difference was the greatest at list-initial positions, positions most sensitive to the facilitation effect of rehearsal. Performance on the hybrid lists fell between that of the semantic and phonological lists. Perhaps, the presence of semantically related words on the hybrid lists has led to this performance advantage over the phonological lists. Further analysis is required to determine if the enhancement in recall for the hybrid lists is driven by the recall of the semantically-related words.

List Position Effect

The bow-shaped list position effect has been widely documented in the psycholinguistic literature and was observed in the current study. Our participants demonstrated the recency effect as memory traces for words at the list-final positions have not suffered the same degree of decay as those in the initial and medial position. The participants also remembered words at initial word position better than words in medial list position. This advantage is typically attributed to the use of rehearsal strategies and, consequently, the storage of those rehearsed words in the speaker's long-term memory. Interestingly, individuals in the LLD group showed a significant advantage for list position 8 (significantly higher accuracy at this position), while the TD group demonstrated a significant advantage for list position 5. These patterns are difficult to interpret. Future studies with a larger sample may help to determine if these patterns are stable and to elucidate the possible underlying mechanisms for these differences.

Conclusion

This study revealed many similarities in list recall performance among college students with and without LLD. Individuals with LLD and typical controls recalled a similar number of items and both groups demonstrated sensitivity to semantic and phonological relationships among presented words. Semantic relatedness facilitates recall whereas phonological similarity hampers recall. Individuals with and without LLD demonstrated robust recency and primacy effects in list recall, suggesting that basic memory processes are intact in the face of language learning disorders. However,

participants in the current study may only represent the mild end of the LLD continuum, future studies should attempt to see if these processes are preserved in more severe cases of LLD.

Appendix. Experimental Stimuli

Wet Semantic	Wet Phonological	Bad Semantic	Bad Phonological	Ball Semantic	Ball Phonological
Slippery	Vet	Good	Had	Bounce	Doll
Damp	Watt	Rotten	Lad	Throw	Bile
Paint	Wheat	Harmful	Bat	Basket	Bail
Splash	Pet	Worse	Bag	Bowling	Balk
Dry	West	Villain	Bud	Golf	Wall
Humid	Bet	Severe	Band	Play	Fall
Water	Wed	Trouble	Dad	Tennis	Bald
Dripping	Well	Awful	Bide	Soccer	Pall
Soak	Net	Terrible	Bid	Round	Tall
Moist	Let	Evil	Pad	Catch	Bill
Saturate	Welt	Corrupt	Ad	Pitch	Bell
Sponge	Wit	Horrible	Bed	Moth	All

Car Semantic	Car Phonological	Dog Semantic	Dog Phonological	Face Semantic	Face Phonological
Auto	Char	Hound	Log	Mouth	Fake
Drive	Call	Puppy	Dodge	Expression	Vase
Engine	Care	Bite	Dug	Nose	Fuss
Wreck	Are	Mutt	Hog	Eyes	Faith
Garage	Card	Pet	Bog	Frown	Lace
Motor	Carp	Beware	Doff	Wrinkle	Fail
Van	Cot	Bone	Daub	Makeup	Fain
Truck	Core	Trail	Cog	Cheek	Ace
Crash	Par	Cat	Dock	Head	Case
Accident	Scar	Animal	Fawn	Mask	Fate
Trunk	Cart	Paw	Fof	Moustache	Fame
Tire	Far	Poodle	Dig	Beard	Race

Right Semantic	Right Phonological	Man Semantic	Man Phonological	Pen Semantic	Pen Phonological
Correct	Tight	Woman	Can	Ink	Pan
Perfect	Rye	Guy	Moon	Paper	Then
Equal	Rife	Sir	Main	Marker	Hen
Accurate	Night	Boss	Fan	Eraser	Ken
Fair	Bright	Super	Tan	Pencil	Pawn
Justify	Rile	Lady	Pan	Writing	Pain
Left	Ripe	Person	Mean	Notebook	Fen
Turn	Bite	Fellow	Map	Bic	Peg
Angle	Rat	Mister	Van	Point	When
Answer	Rot	Bachelor	Ran	Mark	Ben
Mistake	White	Uncle	Mat	Write	Pine
Wrong	Rice	Con	Mad	Scribble	Pun

Rain Semantic	Rain Phonological	Mail Semantic	Mail Phonological	Top Semantic	Top Phonological
Umbrella	Train	Stamp	Meal	Bottom	Mop
Drench	Main	Deliver	Nail	Peak	Stop
Weather	Ran	Receive	Mate	Hill	Tap
Hail	Wren	Bills	Mile	Over	Tup
Cloud	Pain	Letters	Hail	Roof	Chop
Dew	Rave	Send	Make	Summit	Bop
Pour	Raise	Fax	Mall	Pinnacle	Tock
Storm	Brain	Express	Sail	Zenith	Cop
Thunder	Bane	Post	Veil	Apex	Hop
Wind	Raid	Zip	Mill	Spin	Tape
Puddle	Rate	Address	Mole	Above	Taupe
Acid	Range	Envelope	Maid	Ceiling	Pop

The top column lists the critical non-presented word. The first list for each word represents the semantic associates for the non-presented word. The second list for each word represents the phonological associates for the non-presented words. Hybrid lists were comprised by taking the first word on the semantic list and the second word on the phonological list per each critical word for the Hybrid Semantic-Phonological lists, and vice versa for the Hybrid Phonological-Semantic lists.

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