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Memory Performance in Young Adults with Language and Learning Disabilities

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Memory Performance in Young Adults with Language and Learning Disabilities

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Dedication

This thesis is dedicated to my wonderful family who has supported me throughout my educational career. Mom, Dad, Jenny, and Erica, I am so thankful for you and I appreciate your love and encouragement more than you could possibly know! Thank you for being a constant in my life and pointing me to Truth when I need it most. Love y'all!

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Abstract

Memory Performance in Young Adults with Language and Learning Disabilities

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This thesis investigated the memory skills of young adults with and without language and learning disabilities (LLD) using the Deese-Roediger-McDermott word recall paradigm (Roediger & McDermott, 1995). Three types of word lists were presented: semantic lists consisted of words that are related to a non-presented critical item (CI) (e.g., bad) in meaning (good, rotten, harmful, worse); phonological lists included words related to the CI in sound (e.g., had, lad, bat, bag); and hybrid lists included words related to the CI in both meaning and sound (e.g., good, lad, rotten, bat). Individuals with diagnoses of LLD were classified as "true LLD" or "compensated LLD" based on language test scores and a discriminating composite score, while those without LLD were considered the "typical language" (TL) group. Hypotheses were made regarding veridical recall and memory intrusions, including intrusions of the non-presented critical item (CI). For veridical recall, the compensated LLD and TL groups were expected to have higher recall accuracy than the true LLD group. As for CI intrusions, two possible outcomes were considered: the true LLD group may recall more CIs due to inability to discriminate between presented and non-presented words (Kirchner & Klatzky, 1985); or they may recall fewer CIs due to difficulties forming traces of the gist of the word list (Weekes et al., 2005). Data from 30 participants (ages 18 to 25)—12 true LLD, 8 compensated LLD, and 10 TL—were included in this thesis. Results indicated that the true LLD group showed a non-significant tendency to have lower recall accuracy scores than the other two groups, and a higher number of CI intrusions. List-type also affected accuracy and CI intrusions, as semantically-related lists increased recall accuracy and hybrid semantic-phonological lists increased CI intrusions. Possible conclusions from these data are presented along with recommendations for future research.

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Introduction

Language and Learning Disorders

Language impairment is a common diagnosis for school-age children who struggle with the processing and expressing of oral language. These children typically receive speech-language therapy services until they meet grade level expectations or "phase out" of speech therapy. However, children with true language impairment do not simply "grow out of it" as they continue with their education. Language impairment in adults may manifest itself as dyslexia, a learning disability, or a reading disorder, and may not be diagnosed until secondary or post-secondary school. We will refer to this group of diagnoses as language and/or learning disorders (LLD). Attention deficits often co-occur with these types of learning disabilities, and adults with LLD frequently present with attention deficit disorder (ADD) and/or attention deficit hyperactivity disorder (ADHD). In addition, auditory processing skills may be a weakness in adults with LLD due to overall language processing difficulties. Therefore, central auditory processing disorder (CAPD) co-occurs often in adults with LLD as well (Paul, 2007).

University students are the most accessible group of adults for many research studies. The same is true of studies involving LLD. However, one study suggests that college students with LLD may be less likely to meet criteria as true LLD due to the high achievement levels required at the university level (Sparks & Lovett, 2009). Sparks and Lovett consider this cohort of high-functioning students with LLD to be a "compensated LLD" group, who have clearly adapted to the expectations required of them to achieve for success in the classroom. Some of these methods of compensation may include: study

and/or learning strategies, compensatory supports, classroom accommodations, educational counseling, and self-advocacy (Reis, McGuire, & Neu, 2000). In fact, some of these compensated LLD students may be considered "gifted" despite an LLD diagnosis; researchers are finding a growing number of students with above-average IQs who simultaneously have difficulties with learning (Brody & Mills, 1997).

Working Memory and LLD

Language and learning disabilities in adults manifest themselves in several ways, but one of the most significant aspects is their impact on memory. Memory skills are intricately involved in both learning and language ability. In order to learn anything, working memory, short-term memory, and long-term memory skills are employed, as well as the language foundation needed to comprehend instructions, ask questions, and explain what was learned. Therefore, one would expect to find reduced memory capacity in persons with LLD. In fact, impairment of memory is often considered to be a symptom of learning disability (Isaki, Spaulding, & Plante, 2008). It is important to note, however, that this deficit in memory skills is most often reported in more difficult testing conditions where cognitive demands or needs for language-processing are high (Isaki, et al., 2008). Less cognitively taxing tests of memory will likely not elicit a significant difference between LLD and non-LLD groups.

Working memory seems to be the memory type most affected by LLD. Henry (2010) compared a group of children with LLD to their same-age peers. Four subgroups were considered (typical, borderline LLD, mild LLD, and moderate LLD) and assessed using seven tests of working memory ability. These subgroups were determined using

the British Ability Scales II (BAS-2), a comprehensive cognitive assessment which has scores that highly correlate with verbal IQ scores (Cook, 1988). The BAS-2 provided a General Conceptual Ability score. Children in the typical intellectual ability group had a range of scores between 84 and 123; the scores of the borderline group ranged from 70 to 79; the mild learning disabilities group ranged from 55 to 68, and the moderate learning disabilities group ranged from 40 to 52. Working memory highly correlated with the degree of LLD severity, meaning that children with more severe LLD experienced greater impairments of memory (Henry 2010).

Compensated LLD

College students with LLD who have compensated for their disability may not differ from their non-LLD peers in tests of memory skill. Trainin and Swanson (2005) compared the cognitive performance of students with LLD to students without LLD on various tasks, and did not find any significant difference in the working memory or general processing measures. The students with LLD were classified as such if they had a previous diagnosis of LLD, scored below the 25^{th} percentile on a phonological processing task, and had an average IQ (>84). Another study described similar findings, noting that university students with LLD tend to perform within the average range on standardized intelligence and achievement tests, but with scores that are typically lower than their non-LLD peers (Sparks & Lovett, 2009).

False Memory and DRM List Recall

The present study focuses primarily on the performance of adults with LLD on false memory tasks. False memory refers to recollections of memories that never actually happened. Many psychologists have studied the types and causes of false memories. Historically, studies use stories and videos to elicit reconstructive memories that most easily lead to false memories (Bartlett, 1932). For example, Bartlett asked participants to repeatedly retell a story presented during the session. As they retold the story, the participants added details or events to the story that were not actually presented in the original telling of the story. More recently, Roediger and McDermott developed what is known as the Deese-Roediger-McDermott (DRM) paradigm, which uses word lists to elicit false memories. The DRM word lists consist of words that relate to a critical non-presented item (Roediger & McDermott, 1995). For example, a DRM list for the critical item (CI) "car" may consist of *auto, drive, engine,* and *wreck.* While all of the presented words are related to car and will likely elicit the false memory of hearing the word car, the CI itself is never presented. These researchers later collaborated to develop norms for a number of DRM word lists to determine the expected rate of false recall of the critical item for each list (Stadler, Roediger, & McDermott, 1999).

Research utilizing DRM list recall tasks often focus on accurate recall and CI intrusions. To interpret these types of recall, two different theories will be considered. First, the fuzzy-trace theory suggests that veridical recall improves when the individual successfully determines the overall gist or theme of the presented words (Brainerd & Reyna, 2002). He is then able to employ that gist as a tool to recall other words that were

stored under the same conceptual theme. This theory applies specifically to word lists that fully or partially related by semantics, as phonologically-related words do not share a common gist.

Another theory, the activation-monitoring account of memory intrusions, may explain CIs (Roediger & McDermott, 1995). This theory suggests that hearing a particular word will activate other semantically- and phonologically-related words within the lexicon of the individual. Because the CI is related either semantically- or phonologically-related to all of the words in the presented list, the CI has an increased likelihood of being activated, which may cause the individual to recall it as an intrusion.

Several studies have examined the performance on DRM tasks among individuals with LLD or suspected LLD. Watson and colleagues (2005) administered a DRM recall task with an alternating calculation task to college students to assess complex working memory. The participants were categorized in groups of "high-span" and "low-span" working memory levels using a Stroop (1935) color naming task; the "low-span" group made more errors in this working memory task than the "high-span" group. Results showed that "high-span" individuals had higher veridical recall levels and fewer CI intrusions than the "low-span" individuals.

Kirchner and Klatzky (1985) performed a word recall study with 12 school-age children with LLD and 12 TL children. The TL group produced high levels of accurate recall, while the LLD group produced more CI intrusions, but only for semantically-related word lists.

More recently, Weekes and colleagues (2008) completed a similar study of DRM lists involving children with and without reading comprehension difficulties (2008). They found that children with poor comprehension abilities had lower recall accuracy and recalled fewer CI intrusions in the semantic condition than their TL counterparts. This difference was not found for the phonological condition.

To summarize, individuals with LLD or suspected LLD demonstrated a lower level of recall across all three studies; however, they differed regarding CI recall. Watson et al. (2005) found that individuals with lower working memory abilities, or suspected LLD, recalled more CI intrusions, while Kirchner and Klatzky's study revealed similar findings, but only noticed more CI intrusions for the LLD group in semantically-related word lists (1985). By comparison, Weekes et al. (2008) found that children with reading comprehension difficulties, a subtype of LLD, recalled fewer CI intrusions than their TL peers for semantically-related words (2008).

The Present Study

This study seeks to analyze the impact LLD have on memory, specifically recall of words from DRM lists including correct recall, false recall of the CI, and other recall errors. To avoid recalling the CI from the presented lists, working memory is crucial. One study tested the effect of working memory capacity on false memory recall in young adults (Watson et al., 2005). These individuals did not have LLD but presented with a range of working memory capacity. The results suggested that working memory capacity influenced cognitive control, thereby reducing the number of CIs recalled in persons with high working memory. Improved veridical recall was observed in the participants with

higher spans of working memory. While people with LLD certainly have deficits in memory, it is unclear whether their production of false memories may be similarly affected. In particular, the current study will consider both correct recall and false recall (including recall of the CI and other kinds of intrusion errors) among adults with LLD, both true and compensated, in relation to their typical language peers.

In this study, true LLD refers to participants with a diagnosis of LLD and scored at least one standard deviation below the mean on one or more standardized language test. Compensated LLD refers to individuals with a diagnosis of LLD, but their standardized language test scores were within one standard deviation of the mean. A composite score was also employed to confirm group classification, and will be discussed further in the Methods section to follow.

It is hypothesized that college students with true LLD will have lower levels of accuracy than the compensated LLD or TL groups, as supported by the findings of Watson, et al. (2005). In regards to CI intrusion, we did not make a firm hypothesis due to conflicting findings from previously discussed research. Participants with true LLD may recall more non-presented CIs than the compensated LLD or TL groups, which would follow the work of Kirchner and Klatzy (1985) and of Watson et al. (2005). In both of these previous studies participants with LLD were more likely to recall semantic intrusions in word recall than their TL peers. However, it is also possible that individuals with true LLD will recall fewer CIs than the compensated LLD or TL groups, as another study found that students with LLD recalled fewer semantic CI intrusions than the students without LLD (Weekes et al., 2008).

Methods

Participants

Thirty university students, ages 18 to 25 years old, participated in this current study. Individuals were recruited through flyers posted on a university campus, e-mails sent out on a weekly university-wide mailing list, and referrals from the university's Student Services department. Twelve students (6 females) were classified as true LLD, eight (6 females) as compensated LLD, and ten (4 females) as typical-language (TL). All participants met the following inclusion criteria: monolingual English speaker, no history of hearing, social-emotional, or frank neurological problems per self-report, normal or corrected-to-normal vision, and nonverbal IQ measured at or above a standard score of 80 using the Matrices subtest of the *Kaufman Brief Intelligence Test- 2nd Edition* (*K-BIT-2*) (Kaufman & Kaufman, 2003). Students with LLD were matched by gender and number of years of schooling to TL students.

Participants in the TL group did not have a previous or current diagnosis of LLD, per self-report. These individuals met the following additional criteria to verify their status as typically-developing: performed no lower than one standard deviation below the mean on the *Test of Adolescent and Adult Language- 4th edition* (*TOAL-4*; Hammill, Brown, Larsen, & Wiederholt, 2007) and, the Non-word Repetition subtest of the *Comprehensive Test of Phonological Processing- 2nd Edition* (*CTOPP-2*; Wagner, Torgeson, & Rashotte, 1999).

Three additional tests were administered: the Word Definitions subtest of the *Clinical Evaluation of Language Fundamentals- 4th edition* (*CELF-4*; Semel, Wiig, &

Secord, 2003), the Modified Token Test (Morice & McNicol, 1985), and a 15-word spelling task (Fidler, Plante, & Vance, 2011). Following Fidler et al., a discrimination formula was applied to calculate a composite score for these three tests and all participants in the TL group had negative composite scores. According to Fidler et al., negative composite scores on these tests are indicative of intact language ability.

Participants in both true and compensated LLD groups met the following criteria for inclusion as adults with language or learning disability: current diagnosis of and/or academic accommodations for language or learning disability, including central auditory processing disorder (CAPD), attention-deficit hyperactivity disorder (ADHD), or reading disorder (including dyslexia).

Among the 20 people who had a LLD diagnosis, 12 met the criteria for being true LLD. These individuals had positive composite scores based on the Word Definitions subtest of the *CELF-4*, the Modified Token Test, and the 15-word spelling task. According to Fidler et al. (2011), this method of classifying adults into LLD and non-LLD subgroups achieved above 80% sensitivity and specificity values in three separate samples of adults. Eight individuals were classified as compensated LLD because these participants self-reported a language or learning disability, but their TOAL and Non-Word Repetition test scores were within the normal range (no more than one standard deviation below the mean). These participants also had discrimination formula scores less than zero, which suggest typical language ability. Therefore, these individuals represented a group who appeared to be normal on a comprehensive battery of language tests despite a current LLD diagnosis. The discrepancy between the diagnosis and these

scores could be attributed to the use of compensatory strategies and/or prescribed medications to improve attention.

An analysis of variance (ANOVA) revealed no group difference on age ($p = 0.81$), level of education ($p = 0.77$), or K-BIT scores ($p = 0.68$), indicating participants were well-matched on these background characteristics. There was a significant between-group difference on CTOPP scores, $F(2, 27) = 4.82$, $p = 0.016$, $\eta_p^2 = 0.26$). Post-hoc tests with Bonferroni corrections indicated that the true LLD group had significantly lower scores than the TL group, but the compensated LLD group did not differ significantly from either the TL or the true LLD group. For the TOAL-Spoken test, the scores of the compensated LLD group and TL group were not significantly different from each other, but both groups scored significantly higher than the true LLD group $F(2,27) = 6.67$, $p = 0.004$, $\eta_p^2 = 0.33$). The TL group did not differ significantly from either LLD group on the TOAL-Written test, but the compensated LLD group performed significantly better than the true LLD group $F(2,27) = 3.88$, $p = 0.033$, $\eta_p^2 = 0.22$). See Table 1 for means and standard errors.

Table 1. Participant Information

	True LLD	Compensated LLD	TL
n=30	12	8	10
Age	20.59 (.54)	20.42 (.67)	20.98 (.60)
Education	15.04 (.55)	14.75 (.67)	15.40 (.60)
TOAL-Spoken	95.67 (3.06)	108.75 (3.75)	111.00 (3.36)
TOAL-Written	103.17 (3.21)	116.38 (3.93)	112.70 (3.52)
K-BIT-2	108.25 (3.56)	112.50 (4.36)	112.10 (3.90)
Non-Word Repetition	7.83 (.52)	9.38 (.64)	10.20 (.57)
Composite score	.64 (.13)	-.42 (.16)	-.62 (.14)

All participants were also given the *Competing Language Processing Task* (Gaulin & Campbell, 1994) as a measure of complex working memory. The task requires the participant to listen to a set of sentences (such as, "Apples are black."), determine if the statements are true or false, and then recall the last word from each sentence. Scores are determined based on accuracy of true/false classification as well as number of words recalled correctly. This is not a standardized test; therefore, it was not used as a classification measure, but it was included as a descriptive measure.

Stimuli

The stimuli consisted of 48 lists of 12 words each, adapted from Experiment 3 in Watson et al. (2003) and listed in Appendix A. Each list contained words related to a non-presented CI. Three list types were presented: semantic (SEM), phonetic (PHO), and hybrid (HYB). The SEM lists had words that were semantically related to the CI, the PHO lists were phonetically related to the CI, and the HYB lists alternated semantically and phonetically related words. An example of a SEM word list with the word CAR as the CI would have related words such as "park", "drive", "auto", and "engine". Although "car" was never actually presented, a participant may include "car" in his recall of the presented words, which would be considered a false memory of the CI. A PHO word list for the same CI would have words such as "cart", "cat", "bar", and "scar", and the HYB list would have words from both the SEM and PHO list types.

A female native English speaker with a standard American accent recorded the false memory task stimuli in a soundproof booth with one second between each word. The recording was then segmented into sound files containing one word list each.

Procedures

A total of two practice lists and 12 experimental word lists were presented via speakers to each participant during a single session. Each person was pseudo-randomly assigned 12 lists, including four semantic (SEM), four phonological (PHO), and four hybrid semantic-phonetic (HSP) or phonetic-semantic (HPS), which each list having a different CI. The three types of lists (semantic, phonological, hybrid) were presented in blocks of four alternated with standardized testing.

Standardized testing for confirming inclusionary criteria was completed in between each block of four lists. Testing took place in the following order: false memory (FM) list 1, *TOAL-4* subtests 1-3, FM list 2, *K-BIT-2* matrices, FM list 3, *TOAL-4* subtests 4-6, and Non-Word Repetition subtest of *CTOPP-2*. Students also participated in a second session of testing as part of a complementary study, during which the 15-word spelling task, the Word Definitions subtest of the *CELF-4*, the Modified Token Test, and the *WJ-III* Broad Reading Cluster were administered.

The participants were given the following instructions: "*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. Let's practice. Are you ready?*" Two trial word lists were presented and understanding confirmed before presenting the experimental lists. The examiner recorded all responses in the order given. Some participants verbally stated their completion of each list (e.g. *"That's all."* or *"I don't know."*), and the examiner confirmed completion with the others if this information was not provided.

Recordings were played through computer speakers for each participant in a small therapy room at the university's speech and hearing clinic. The participants sat perpendicular to the computer with speakers facing them from approximately two feet away, while the examiner sat facing the computer screen nearby.

Coding

Two trained undergraduate students in Communicative Sciences and Disorders completed the coding of false memory task responses. Two graduate students in Speech-Language Pathology also assisted with coding. Responses were coded into the following categories: correct, CI, phonological intrusion, semantic intrusion, phonological-semantic intrusion, previous list, repetition, inflection, previous list-phonological, previous list-semantic, and unrelated. Descriptions and examples of each response type are listed in Table 2.

Table 2. Error Types

ERROR TYPES	**Description**	**Example Responses**
Critical Item (CI)	Non-presented critical lure.	CAR: auto, drive, *car*
Phonological Intrusion (PI)	Same onset and same number of syllables, or rhymed with word from presented list.	BALL: doll, bail, pall, *pail* (rhymes with 'bail' and has same onset as 'pall')
Semantic Intrusion (SI)	Semantically related to any word from presented list.	FACE: mask, eyes, *brow* (categorically related to 'eyes')
Phonological-Semantic Intrusion (PSI)	Fit criteria for phonological and semantic intrusion.	CAR: wreck, par, drive, *park* (phonologically related to 'par' and categorically related to 'car')
Inflection (INF)	Different form of presented word.	PEN: pan, paper, pal, *erasing* ('eraser' was the presented word)
Previous List (PL)	Presented in previous list.	BALL: play, soccer, *dad* (from previous list, not related phonologically or semantically)
Repetition (REP)	Repeated response (correct or incorrect) within recall period.	RAIN: wind, puddle, *wind* (first as correct, second as REP)
Previous List-Phonological (PLP)	Presented in previous list *and* fit criteria for phonological intrusion.	(see example for PI)
Previous List-Semantic (PLS)	Presented in previous list *and* fit criteria for semantic intrusion.	(see example for SI)
Unrelated (UNR)	Did not fit any other category.	

Results

Level of accuracy in list recall was calculated for each participant and for each type of list. The HSP and HPS lists were combined to form a hybrid list category in all analyses because these two types of hybrid lists yielded a similar level of accurate recall in both groups (Sheng, Byrd, & McGregor, in preparation). A mixed-model ANOVA was conducted with language group (true LLD, compensated LLD, TL) as the between-subjects variable, and list type (SEM, PHO, HYB) as the repeated measure. This analysis revealed a main effect of list, $F(2,54) = 60.09$, $p < .001$, $\eta_p^2 = .70$. The list type effect was due to better accuracy in the SEM lists ($M = 27.84$, $SE = .85$) than the PHO ($M = 19.32$, $SE = .66$) or HYB lists ($M = 20.44$, $SE = .74$). The group effect was not significant, $p = .28$. However, as seen in Table 3, the true LLD group had a mean accuracy level that was slightly lower than the means of the other two groups.

Table 3. Means of Recall by Group

MEANS	True LLD	Compensated LLD	TL
# of correct recalls	21.39 (.89)	22.71 (1.09)	23.50 (.98)
CI	2.00 (.20)	1.17 (.25)	1.43 (.22)
Gist-type intrusions	4.58 (.40)	2.75 (.49)	3.07 (.43)
REP	1.77 (.30)	.58 (.37)	.63 (.33)

CI recall levels were calculated for each participant and each list type. A mixed-model ANOVA was conducted with language group as the between-subjects variable and list type as the repeated measure. This analysis revealed a main effect of group, $F(2, 27) = 3.74$, $p = .04$, $\eta_p^2 = .22$ and a main effect of list type, $F(2, 54) = 14.94$, $p < .001$, $\eta_p^2 = .36$. These main effects were followed up with post-hoc comparisons. Post-hoc

comparisons for the group effect did not show any statistically significant pairwise difference, however, the comparison between the true LLD and compensated LLD group approached significance, $p = .06$, with the true LLD group recalling more CIs than the compensated LLD (see Table 3 for means). The list type effect was due to more CI recalls in the HYB lists ($M = 2.33$, $SE = .20$) than in either SEM ($M = .98$, $SE = .20$) and PHO ($M = 1.29$, $SE = .19$) lists; the latter two did not differ from each other.

Gist-type recall levels were calculated for each participant and list type. Gist recall levels were determined by combining similar types of intrusion errors for each list type. SEM gist intrusions included all intrusions that had semantic relations to any of the presented words, encompassing CI intrusions, semantic intrusions (SI), and phonetic-semantic intrusions (PSI). PHO gist intrusions included all intrusions that had phonological similarity to any of the presented words, and encompassed CI, PSI, phonetic intrusions (PI), and previous-list phonetic (PLP) intrusions. HYB gist intrusions included all intrusions that were either semantically or phonologically related to any presented words, and encompassed CI, PI, SI, and PSI. Three one-way ANOVAs were conducted for SEM, PHO, and HYB lists, respectively. This analysis revealed a tendency ($p = .095$) for true LLD ($M = 2.92$, $SE = .32$) participants to have more gist intrusions in the SEM lists than the compensated LLD ($M = 1.50$, $SE = .64$) or TL ($M = 1.30$, $SE = .57$) groups. Similarly, this tendency was observed in the PHO lists ($p = .051$), with true LLD ($M = 5.92$, $SE = .66$) participants having more gist intrusions than the compensated LLD ($M = 3.50$, $SE = .82$) or TL ($M = 3.90$, $SE = .73$) groups. For the HYB lists, the

three groups had similar levels (true LLD: M = 4.92, SE = .67; compensated LLD: M = 3.25, SE = .82; TL: M = 4.00, SE = .73) of gist intrusions (p = .29).

Repetitions in list recall were also calculated for each participant and for each type of list. A mixed-model ANOVA was conducted with language group as the between-subjects variable, and list type as repeated measures. This analysis revealed a main effect of group, F (2, 27) = 4.40, p = .02, η_p^2 = .25, and list type, F (2, 54) = 7.13, p = .002, η_p^2 = .21. Post-hoc comparisons revealed that there was a tendency for true LLD participants to have more repetitions than the compensated (p = .08) and the TL (p = .06) groups (see Table 3 for means and standard error). The list type effect was due to higher repetition errors in the SEM lists (M = 1.63, SE = .35) than the PHO (M = .74, SE = .18) or HYB lists (M = .63, SE = .20).

Correlation coefficients were calculated to determine the relationships between list recall performance and test scores from the *CTOPP*-2, *TOAL*-S, and *CLPT* (see Table 4 for correlation values). Significant correlations were found on the SEM word lists. Higher *CTOPP-2* scores correlated with higher accuracy and lower gist-type intrusions. Similarly, higher *TOAL*-S scores correlated with higher accuracy on the SEM lists. Higher scores on the *CLPT* were correlated with higher accuracy on both the SEM and HYB lists.

Table 4. Correlation Coefficients between Language Test Scores and Recall Performance

CORRELATION	**CTOPP**	**TOAL-S**	**CLPT**
Accuracy:			
SEM	.50**	.46*	.45*
PHO	.10	.29	.34
HYB	.08	.32	.44*
Gist-type intrusions:			
SEM	-.49**	-.31	-.35
PHO	-.14	-.004	.13
HYB	-.17	-.20	-.12

Discussion

This study examined DRM list recall performance in 12 individuals with true LLD, 8 with compensated LLD, and 10 age- and education-matched controls. The effects of group and list type on list recall accuracy, CI intrusions, gist-type intrusions, and repetition errors were investigated.

Group Effects

In regards to veridical recall, the compensated LLD and TL groups were expected to score higher than the true LLD group. While no significant group effect was found, there was a tendency for compensated LLD and TL individuals to produce higher recall accuracy scores. The present study included a small sample size, but had more participants been involved, a significant difference may have been revealed.

With regard to CI intrusions, we did not make a firm hypothesis because previous studies have revealed conflicting results (Kirchner & Klatzky, 1985; Watson et al., 2005; Weekes et al., 2008). Our results indicated a tendency for the true LLD group to have more CI intrusions than the other two groups. This finding is consistent with Kirchner and Klatzky (1985) and Watson et al. (2005) and suggests that young adults with LLD have more difficulty differentiating between words with similar meaning or form.

An additional analysis was conducted to determine the effect of group on gist-type intrusions. SEM gist intrusions included CI intrusions, semantic intrusions (SI), and phonetic-semantic intrusions (PSI). PHO gist intrusions included CI, PSI, phonetic intrusions (PI), and previous-list phonetic (PLP) intrusions. HYB gist intrusions included CI, PI, SI, and PSI. There was a tendency for the true LLD group to have more gist-type

intrusions in the SEM and PHO lists, but this tendency was not noted in the HYB lists. Higher frequencies of gist-type intrusions could be related to an increased difficulty with differentiating between words that have similar meaning or phonological form, as was suggested for the CI intrusions.

Further analysis was also conducted in regards to repetition errors. All repetitions were counted as errors. Results revealed that there was a tendency for the true LLD group to have more repetitions than the other two groups. This could be related to impaired self-monitoring skills that are correlated with LLD (Singer & Bashir, 1999). With reduced self-monitoring skills, these individuals may have more difficulty holding already-stated words in their working memory, allowing more repetitions to occur.

A surprising finding was revealed through the correlation coefficients. The *CTOPP-2* measures phonological working memory, yet higher *CTOPP-2* scores were correlated with higher accurate recall for the SEM lists. No significant correlation was observed for the PHO lists, which would be expected. This could be related to a wider range of recall scores for the SEM list, which may have increased the likelihood of finding significant correlations.

List-Type Differences

A significant list type effect was found for veridical recall, revealing that participants had higher accuracy in the SEM lists compared with the PHO and HYB lists. This could be explained by the fuzzy-trace theory (Brainerd & Reyna, 2002). This theory suggests that the participants determined the overall gist that related the words from the SEM lists, and used that gist to store and retrieve words for the recall task. Because the

PHO lists are not united by a common gist, this strategy would not be helpful and would explain why SEM list recall accuracy was higher. Instead of using a fuzzy-trace recall strategy, individuals must employ verbatim-trace recall for the PHO lists, which allows for more competition as the words differ by only one sound segment.

Similarly, only half of the HYB list words shared a common gist, while the others were only phonologically related. Integrating the semantically-related and phonologically-related words in the HYB lists makes it more difficult to discern the overall theme, thereby reducing the facilitative effect of gist for the veridical recall of HYB lists.

List type effects were also noted for CI intrusions. The HYB lists caused more CI intrusions than the SEM and PHO lists. This could be explained by the activation-monitoring account of memory intrusions (Roediger & McDermott, 1995). According to these researchers, hearing a word activates other words that are semantically and phonologically related within an individual's lexicon. Because the HYB lists include words that are both semantically- and phonologically-related to the CI, these word lists activate both semantic and phonological representations of the CI. With the CI so strongly activated in the listener's lexicon, the HYB lists make CI intrusions much more likely.

A list type effect was also found in regards to repetitions, revealing that the SEM lists led to more repetition errors than the PHO or HYB lists. This could be related to total word recall for the SEM lists. As seen in Table 5, participants responded with more words (correct or incorrect) for the SEM lists than the PHO or HYB lists. An overall

higher level of recall may have increased likelihood of repeating responses. In other words, individuals were able to recall words from the SEM lists more easily, and may have been more willing to provide responses (even if they were repetitions). When recalling PHO and HYB lists, the individuals may have felt more hesitant in their responses because of the increased difficulty of the lists, which would lead to uncertainty about which words were actually heard or not. For this reason, easier word lists (such as SEM lists) may result in higher recall levels, and therefore, more repetition errors.

Table 5. Mean Number of Words Recalled by List Type

MEANS	Total # of Words Recalled
SEM	31.83 (5.56)
PHO	24.93 (4.27)
HYB	26.10 (4.62)

Future Directions

Future analyses will include comparisons between specific types of LLD, which may provide insight into which types of LLD are more likely to be considered "compensated" or have less prominent deficits in language and memory. In addition, primacy and recency effects will be investigated in regards to list recall. Finally, these data will be combined with two other datasets to yield a larger sample size (n = 57) and more power to confirm or refute the patterns identified in the present study.

Appendix

DRM lists: Semantic

WET	slippery	damp	paint	splash	dry	humid	Water	dripping	soak	moist	saturate	sponge
BAD	good	rotten	harmful	worse	villain	severe	Trouble	awful	terrible	evil	corrupt	horrible
BALL	bounce	throw	basket	bowling	golf	play	Tennis	soccer	round	catch	pitch	moth
CAR	auto	drive	engine	wreck	garage	motor	Van	truck	crash	accident	trunk	tire
DOG	hound	puppy	bite	mutt	pet	beware	Bone	tail	cat	animal	paw	poodle
FACE	mouth	expression	nose	eyes	frown	wrinkle	makeup	cheek	head	mask	moustache	beard
RIGHT	correct	perfect	equal	accurate	fair	justify	Left	turn	angle	answer	mistake	wrong
MAN	woman	guy	sir	boss	super	lady	person	fellow	mister	bachelor	uncle	con
PEN	ink	paper	marker	eraser	pencil	writing	notebook	Bic	point	mark	scribble	pal
RAIN	umbrella	drench	weather	hail	cloud	dew	pour	storm	thunder	wind	puddle	acid
MAIL	stamp	deliver	receive	bills	letters	send	fax	express	post	zip	address	envelope
TOP	bottom	peak	hill	over	roof	summit	pinnacle	zenith	apex	spin	above	ceiling

DRM lists: Phonological

WET	vet	watt	wheat	pet	west	bet	wed	well	net	let	welt	wit
BAD	had	lad	bat	bag	bud	band	dad	bide	bid	pad	ad	bed
BALL	doll	bile	bail	balk	wall	fall	bald	pall	tall	bill	bell	all
CAR	char	call	care	are	card	carp	cot	core	par	scar	cart	far
DOG	log	dodge	dug	hog	bog	doff	daub	cog	dock	dawn	fog	dig
FACE	fake	case	fuss	faith	lace	fail	fain	ace	case	fate	fame	race
RIGHT	tight	rye	rife	night	bright	rile	ripe	bite	rat	rot	white	rice
MAN	can	moon	main	fan	tan	pan	mean	map	van	ran	mat	mad
PEN	pan	then	hen	ken	pawn	pain	fen	peg	when	ben	pine	pun
RAIN	train	main	ran	wren	pain	rave	raise	brain	bane	raid	rate	range
MAIL	meal	nail	mate	mile	hail	make	mall	sail	veil	mill	mole	maid
TOP	mop	stop	tap	tup	chop	bop	tock	cop	hop	tape	taupe	pop

DRM lists: Hybrid (Semantic-Phonological)

WET	slippery	watt	paint	pet	dry	bet	water	well	soak	let	saturate	wit
BAD	good	lad	harmful	bag	villain	band	trouble	bide	terrible	pad	corrupt	bed
BALL	bounce	bile	basket	balk	golf	fall	tennis	pall	round	bill	pitch	all
CAR	auto	call	engine	are	garage	carp	van	core	crash	scar	trunk	far
DOG	hound	dodge	bite	hog	pet	doff	bone	cog	cat	dawn	paw	dig
FACE	mouth	vase	nose	faith	frown	fail	makeup	ace	head	fate	moustache	race
RIGHT	correct	rye	equal	night	fair	rile	left	bite	angle	rot	mistake	rice
MAN	woman	moon	sir	fan	super	pan	person	map	mister	ran	uncle	mad
PEN	ink	then	marker	ken	pencil	pain	notebook	peg	point	ben	scribble	pun
RAIN	umbrella	main	weather	wren	cloud	rave	pour	brain	thunder	raid	puddle	range
MAIL	stamp	nail	receive	mile	letters	make	fax	sail	post	mill	address	maid
TOP	bottom	stop	hill	tup	roof	bop	pinnacle	cop	apex	tape	above	pop

DRM lists: Hybrid (Phonological-Semantic)

WET	vet	damp	wheat	splash	west	humid	wed	dripping	net	moist	welt	sponge
BAD	had	rotten	bat	worse	bud	severe	dad	awful	bid	evil	ad	horrible
BALL	doll	throw	bail	bowling	wall	play	bald	soccer	tall	catch	bell	moth
CAR	char	drive	care	wreck	card	motor	cot	truck	par	accident	cart	tire
DOG	log	puppy	dug	mutt	bog	beware	daub	tail	dock	animal	fog	poodle
FACE	fake	expression	fuss	eyes	lace	wrinkle	fain	cheek	case	mask	fame	beard
RIGHT	tight	perfect	rife	accurate	bright	justify	ripe	turn	rat	answer	white	wrong
MAN	can	guy	main	boss	tan	lady	mean	fellow	van	bachelor	mat	con
PEN	pan	paper	hen	eraser	pawn	writing	fen	Bic	when	mark	pine	pal
RAIN	train	drench	ran	hail	pain	dew	raise	storm	bane	wind	rate	acid
MAIL	meal	deliver	mate	bills	hail	send	mall	express	veil	zip	mole	envelope
TOP	mop	peak	tap	over	chop	summit	tock	zenith	hop	spin	taupe	ceiling

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