

Comparing Two Compensatory Remediation Strategies
for Improving Verbal Memory in Schizophrenia

by

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Abstract

Cognitive impairment is a core feature of schizophrenia and verbal memory is a specific area of marked deficit. Deficits are observed as early as the illness' prodromal phase and persist, as antipsychotics do not ameliorate deficits in cognition, resulting in compromised functional outcome. Compensatory remediation strategies that employ verbal presentation of paired-image interactions have been used to enhance verbal episodic memory in cases of traumatic brain injury, temporal lobectomy, and Korsakoff's syndrome, but never in schizophrenia. This study investigated the effects of two different imagery compensatory strategies on verbal memory in schizophrenia. One strategy, the story, orally presented target words in the context of a narrative, linking pairs of words with an interaction. The second method, imagery, verbally guided participants to imagine target words interacting in pairs on their own. The control condition involved identical exposure to target words and interactions with assessors, but provided no strategy. Generalization of strategy-driven improvements was assessed by changes in performance following training on word list recall and prose recall tasks. Forty participants with schizophrenia or schizoaffective disorder were randomly assigned to one of three groups. Blinded assessors tested participants before and after training, and at a one-week follow-up. The story strategy produced significant improvements on training task performance. No evidence of immediate generalization was observed, however, preliminary evidence revealed that the story method elicited a delayed benefit on prose recall. These findings suggest that paired-image interactions do improve verbal memory in schizophrenia, however conclusions regarding the generalizability of this improvement deserve further investigation.

I. Introduction

Schizophrenia, as defined by the DSM-5, is a major psychiatric illness that consists of an array of behavioral features that affect mental stability and functioning. This disorder afflicts roughly 1% of the global population. (Regier et al., 1993). The focus of this report is on the development of novel behavioral remediation strategies for treating the cognitive impairment that is characteristic of schizophrenia.

A. Schizophrenia

Current definitions of schizophrenia reflect initial descriptions that date back to the late 19th Century. The disorder was first labeled “dementia praecox,” a term that Emil Kraepelin, a German psychiatrist, popularized in his publication, *Compendium der Psychiatrie*. The term “dementia praecox,” is Latin for “premature dementia,” and was selected for the disorder’s presumed onset in young adulthood (Jablensky, 2010), an observation that is confirmed by updated reports (McGrath et al., 2008), and the presumed worsening of the disorder over time. Current etiological models suggest a neurodevelopmental rather than degenerative mechanism (Keshavan and Diwadkar, 2012, pp. 28). In regards to age of onset, evidence suggests that onset is later for women, appearing after the age forty 10% of the time (Loranger, 1984).

In *Compendium der Psychiatrie*, Emil Kraepelin made an effort to improve diagnostic practices by profiling the disorder with sharper language, and by eliminating vague descriptions. His work distinguished schizophrenia from other manifestations of psychosis for the first time (Walker et al., 2004). Kraepelin noted a fairly consistent trajectory to the illness’ course (poor outcome) and highlighted cognitive and behavioral

impairment as hallmarks for this arc. He organized his observations and generated subtypes for “dementia praecox,” (Table 1) all of which he suggested were unified by their consistent illness course, a novel approach to clinical practice at the time (Jablensky, 2010).

Kraepelin’s Nine Subtypes of “dementia praecox”
Dementia praecox simplex
Hebephrenia
Depressive dementia praecox
Circular dementia praecox
Agitated dementia praecox
Periodic dementia praecox
Catatonia
Paranoid dementia
Schizoaphasia

Table 1: Kraepelin’s nine subtypes of “dementia praecox” (Jablensky, 2010).

Though abandoned today for providing no significant prognostic and predictive outcome value (Jablensky, 2010), Kraepelin’s subtypes highlighted features of the disorder that are still included in today’s DSM-5 (APA, 2013).

In 1911 Eugen Bleuler introduced the clinical term “schizophrenia,” a word whose etymological root means, “torn apart,” or “split.” Bleuler suggested that people with schizophrenia experienced a splitting of “psychic functioning” (Moskowitz and Heim, 2011). Apart from introducing lasting nomenclature, Bleuler also presented the “four A’s,” a paradigm of affected areas in schizophrenia behavior: association, affect, autism and ambivalence (Moskowitz and Heim, 2011). The first A, which Bleuler described as a “loosening of associations,” exists in today’s dialogue as “disorganized thought/speech” (APA, 2013). This symptom refers to an individual’s incoherence in

thought and speech, and lack of direction in thought and speech (APA, 2013). Bleuler introduced two dichotomies regarding symptoms of schizophrenia: fundamental (unique to schizophrenia) vs. accessory (not unique to schizophrenia), and primary (consequence of biological etiology) vs. secondary (consequence of other symptoms). He classified loosening of associations as both fundamental and primary, highlighting this feature's central significance in the illness, still recognized today.

Both Kraepelin and Bleuler's constructions of schizophrenia (proposing subtypes and prioritizing symptoms, respectively) did not last because they did not reliably provide information to clinicians regarding an individual's outcome potential or regarding an individual's diagnostic needs. Other attempts to usefully define subtypes of schizophrenia were proposed but without success. For example, the "familial vs. sporadic" dichotomy, which highlights hereditary onset of schizophrenia and random onset of schizophrenia, respectively, though intrinsically valuable in understanding the nature of schizophrenia's complex etiology, did not offer clinical utility (Roy et al., 1994).

B. DSM-5

Schizophrenia is a challenging disorder to define. The ideal definition would both acknowledge its heterogeneity and defend its deserving one unique diagnosis in the DSM. The American Psychiatric Association tightened its definition of the disorder in the most recent edition of the DSM (the fifth), which was released in 2013. Though the changes between editions four and five are slight, they do reflect a matured understanding of schizophrenia in the context of diagnostic utility. Subtypes are no

longer identified, and the symptomatic threshold for diagnosis has been elevated to two criterion A symptoms, which are considered core symptoms of schizophrenia (APA, 2013). The DSM-5 considers five criterion A symptoms of schizophrenia: Delusions, hallucinations, disorganized speech, abnormal motor behavior and negative symptoms. In order to qualify, an individual must exhibit at least two of these symptoms for one month, with at least one of the symptoms being among the first three listed (delusions, hallucinations, and disorganized speech). Cognitive impairment appears in the chapter as an “associated feature” of schizophrenia (APA, 2013).

In the dialogue leading up to the DSM-5’s publication, Bora et al. (2010) expressed an interest in presenting cognitive impairment as a more defining symptom of schizophrenia. Before schizophrenia’s formal definition emerged, cognitive impairment was a recognizable characteristic of the disorder. Kraepelin highlighted cognitive deficits in the pattern of disease course. With Bleuler’s fundamental vs. accessory classification, cognitive impairment was considered a fundamental symptom while hallucinations appeared as accessory (Jablensky, 2010). What is worth noting is the persistence of cognitive impairment in the profile of schizophrenia. It may not characterize schizophrenia in a unique manner, and it may not be a necessary prerequisite for diagnosis, but cognitive impairment is a core feature of schizophrenia. Cognitive impairment is a reliable and stable feature of the illness’ course (Gold, 2004), and it is predictive of illness onset in first-degree relatives of affected individuals (Erlenmeyer-Kimling, 2000). Furthermore, cognitive abilities reflect the extent to which individuals can respond to daily demands, and are heavily relevant in determining

functional outcome (Green et al., 2000). As a result, cognitive impairment is a core area of schizophrenia research (Medalia, 2008, Gold, 1993).

C. Etiology

Kraepelin insisted that the disorder could be explained biologically (Jablensky, 2010). One hundred years later, schizophrenia's etiology remains a mystery. The pathogenic mechanism behind the disorder is unknown. The most promising biological explanation is the dopamine hypothesis that implicates hyperdopaminergia (Toda and Abi-Dargham, 2007). Empirical evidence supporting this hypothesis is that antipsychotics successfully abate psychotic symptoms by antagonizing D2 receptors in the striatum and limbic systems, where receptor density is greatest (Toda and Abi-Dargham, 2007; Seeman, 2002; Agid et al., 2006). Several factors contribute risk to developing schizophrenia, some of which involve dopamine, others that do not, and no etiological model fits all cases. One motif in the conversation surrounding schizophrenia's etiology is multi-hit hypotheses. The "multi-hit" idea suggests that individuals can be primed with vulnerability (perhaps genetically, or environmentally) and their symptoms of schizophrenia can be triggered by risk factors that function as multiple "hits" to evoke onset (Caspi et al., 2005, Corcoran et al., 2003). These models integrate evidence for both hereditary and environmental contributors to schizophrenia's etiology and acknowledge that one factor is not wholly responsible.

Genetic and Environmental Influences

Genetic factors are supported by statistics regarding families. Relatives of people with schizophrenia are at greater risk than the general population in developing the disorder. This risk increases as degrees of separation between an individual and their afflicted relative decreases, likely because closer relatives share a greater percentage of genetic information, as similar risk trends observed in cases of mania and schizoaffective disorders also reveal (Cardno et al., 1999). More specifically, first-degree relatives are ten times more at risk than the general population (Kurtz and Marcopolus, 2012, pp. 2). This relationship is not observed among relatives that are adopted but is observed in biological relatives (Lewis and Levitt, 2002), indicating the extent to which this trend is supported biologically, and not environmentally. One genetic disorder that has garnered attention as a model for schizophrenia is the 22q11 deletion, a deletion on chromosome 22 that produces developmental abnormalities in cognition and biological systems (Swillen et al., 2000). This deletion is rare as it is only found in 0.025% of the population, but 25% of the time, the deletion correlates with symptoms that satisfy DSM criteria for schizophrenia (Walker et al., 2004). Meanwhile, other findings demonstrate that only 2-10% of diagnosed patients exhibit this deletion (Walker et al., 2004, Horowitz et al., 2005), challenging its relevance in schizophrenia since schizophrenia's prevalence is so high in comparison. There is no genetic profile that exhibits a 100% risk of developing schizophrenia. Even among monozygotic twins of individuals with schizophrenia, with virtually identical genomic make up, only 25-50% (Gottesman, 1991) also develop schizophrenia. Meanwhile, this statistic is significantly higher than the risk of onset associated with dizygotic twins of individuals

with schizophrenia (Cardno and Gottesman, 2000). This means that genetics alone do not explain the etiology of schizophrenia. Nevertheless, the focus on genetic contribution is widely explored as these findings do suggest the gravity of its role in the illness.

A closer look at schizophrenia's prevalence reveals striking correlational findings. At-risk populations have been studied according to factors such as month of birth, altitude of birthplace, and environment of upbringing, both geographically and culturally (McGrath and Murray, 2011, pp. 235). For example, a study conducted in England found that schizophrenia appeared with the greatest incidence among African-Caribbean and Black-African immigrant populations (Fearon et al., 2006). This finding supports the idea that the experience of immigration, a stressful experience, perhaps triggered schizophrenia, making these minority groups a population with elevated risk (Fearon et al., 2006). In the United States, despite demonstrating no relevant significant differences biologically, African-Americans exhibit an elevated prevalence of schizophrenia compared to other ethnicities (Bresnahan et al., 2007). This suggests that social factors, such as social adversity and other quality of life characteristics, may be contributing factors to the illness.

Prenatal Exposure

Many factors that contribute to schizophrenia risk seem to operate within a critical window, particularly during prenatal development. Maternal viral exposure has received attention. In 1988, Mednick et al. reported that mothers in Helsinki who were exposed to the 1957 influenza during their second trimester of pregnancy were more

likely to produce children who would later develop schizophrenia. A novel idea at the time, Mednick et al. was limited to reports of influenza exposure, with no biological evidence. In 2004, Brown et al., followed up on this idea. Supported by serologic evidence, these findings strengthened the case for prenatal exposure to influenza as a risk factor. Brown et al. (2004) reported that mothers who were exposed to influenza in their first trimesters were seven times more likely to produce offspring who would develop schizophrenia. Contrary to Mednick et al. (1988)'s findings, a significant risk from second and third trimester exposure was not detected from these findings. People with schizophrenia demonstrate elevated levels for certain viral antibodies (e.g. *Toxoplasmosis gondii*, a parasite associated with lasting aberrant central nervous function (Brown et al., 2005), suggesting the relevance of viral exposure in the etiological dialogue. However, it is unclear whether these elevated levels reflect vulnerability as a result of their illness, or if these levels do in fact precede onset (McGrath and Murray, 2011, pp. 229).

Neuroanatomy

Reduced hippocampal volume is a replicated finding in people with schizophrenia (Nelson et al., 1998, Harrison, 2004). Reviving the case for prenatal exposure to influenza, it was observed that pregnant mice that were exposed to the virus gave birth to mice with significant reductions in reelin-positive Cajal-Retzius cells in their hippocampi (Fatemi et al., 1999), a biological feature that has been observed in post-mortem studies involving human subjects with schizophrenia (Fatemi et al., 2000). This finding sheds light on the potential consequences of prenatal viral exposure that

contribute to schizophrenia disease course. Van Erp et al. (2002) found evidence for genetic contributions to hippocampal volume in populations with schizophrenia and first-degree relatives, demonstrating a step-wise relationship between genetic load and reductions in hippocampal volume. Another factor that contributes to volumetric reduction of the hippocampus, among other neurodevelopmental consequences, is fetal hypoxia, a common birth complication (Cannon et al., 2002). Schmidt-Kastner et al., (2006) invited into the conversation multi-hit explanations for this neuroanatomical trend by demonstrating a “gene-environment” relationship. They found that fetal hypoxia caused aberrant gene expression, thus affecting the genetic load, creating a scenario that elevates one’s risk of developing schizophrenia. Hippocampal volume fits into many proposed etiological models, but consistent with schizophrenia’s etiological study, no model explains 100% of cases.

Dopamine

Hyperdopaminergia is cited as a pathological mechanism of psychosis (Rao et al., 1993, Laruelle and Abi-Dargham, 1999, Toda and Abi-Dargham, 2007). In the case of schizophrenia, antipsychotics are prescribed to alleviate psychotic symptoms. The common pharmacodynamics effect of all antipsychotics is dopamine antagonism, specifically at D2 striatal receptors (Toda and Abi-Dargham, 2007) supporting hyperdopaminergia as a critical feature of the illness. Amphetamine abuse has received attention because it is known to induce psychosis (Connell, 1957). Several reports have been made exploring amphetamine psychosis as a means to model schizophrenia (Snyder, 1973, Bell, 1965), because both conditions implicate hyperdopaminergia.

Greater sensitivity to dopamine upregulation may correlate with greater vulnerability to psychotic symptoms. What can be gathered from these findings is that up-regulation of dopamine is involved in the cascade that promotes symptoms of schizophrenia.

D. Impaired Cognition in Schizophrenia

The focus of this study is impaired cognition in schizophrenia. Meta-analyses confirm that cognitive impairment is a pre-morbid feature of schizophrenia, evident in the prodromal phase of disease course (Fusar-Poli et al., 2012). Cognitive impairment does not worsen over the course of the illness, a characteristic that is referred to in literature as “static encephalopathy” (Goldberg et al., 1993). This quality of impairment has been confirmed in multiple studies where long-term follow-ups were employed (Sponheim et al., 2010, Irani et al., 2011). Despite pharmacological strides in successfully relieving patients of psychotic symptoms, cognitive deficits persist. Evidence suggests that delusional and hallucinatory symptoms and cognitive impairment share no relation (Wykes and van der Gaag, 2001). Antipsychotics are not designed to relieve cognitive impairment, and any evidence of relief is not significantly supported (Keefe et al., 1999). This prevailing cognitive impairment results in functional impairment (Dickerson et al., 1996, Green et al., 2004, Fujii et al., 2004).

Before exploring cognitive impairment in schizophrenia, it is important to highlight how neurocognition is assessed. The following section is devoted to briefly outlining the general areas of cognition that are assessed in a standardized cognitive battery. This list is based on findings provided by the National Institute of Mental Health’s Measurement and Treatment Research to Improve Cognition in

Schizophrenia (MATRICS) initiative. The MATRICS project employed a panel of experts to develop a beta-battery consisting of 20 tests from a pool of 90 different cognitive tests. This battery was administered to 176 participants with schizophrenia, schizo-affective disorder, or depression. The integrity of the test battery was judged based on test and re-test reliability, its applicability to functional outcome, and tolerability (Nuechterlein et al., 2008). The battery highlights the follow cognitive domains:

- Processing Speed
- Attention
- Working Memory
- Verbal Learning and memory (the focus of this study)
- Visual Learning and Perception
- Problem Solving/Reasoning Abilities
- Social Cognition

Findings from cognitive tests that target these cognitive domains demonstrate that 80% of people living with schizophrenia perform worse than 84% of the general population (Keefe and Fenton, 2007), indicating the extent to which cognitive deficits are exhibited. Another study demonstrated that people with schizophrenia performed up to one-and-a-half standard deviations below average performance among healthy controls in a broad range of neuropsychological tasks, (Heinrichs and Zakzanis, 1998).

Evidence from a longitudinal study suggests that cognitive impairment contributes to inadequate performance of activities of daily living (i.e. managing

finances, maintaining hygiene, and other associated demands) (Fujii et al., 2004), highlighting the detriment cognitive impairment applies to functional outcome both socially and in terms of life quality (Dickerson et al., 1996, Green et al., 2004). Meta-analyses of studies focusing on neurocognitive deficits (including those observed in verbal memory, the focus of this report) demonstrate that these deficits affect community functioning as well, and impair one's ability to learn new social skills (Green et al., 2000). The APA reports in the DSM-5 that 70-80% of people living with schizophrenia are unemployed (APA, 2013). McGurk and Meltzer (2000) attributed unemployment in schizophrenia to impaired neurocognition after conducting analyses with education as a controlled for factor. Despite pharmacological achievements (Keefe et al., 1999, Green et al., 1997), it is clear that psychiatric stability does not equate to lifestyle normalcy, as functionality in daily life is still impaired.

Verbal Episodic Memory

Verbal episodic memory refers to conscious recollection of information related to specific facts and specific events (Cirillo and Seidman, 2003). Erlenmeyer-Kimling (2000)'s longitudinal study, executed through the New York High Risk Project, recruited the offspring of people living with schizophrenia -- a population that is statistically considered to be "at risk" because of their first-degree relationship with the disorder (Kurtz and Marcopolus, 2012, pp. 2) -- found that a majority of the participants who *did* develop the disease demonstrated an array of cognitive deficits. Verbal memory deficits were exhibited in 83% of the participants who did develop schizophrenia, making them the area of greatest impairment among cognitive deficits

leading up to illness onset, perhaps suggesting the predictive potential of verbal memory impairment (Erlenmeyer-Kimling, 2000). The early presence of impaired verbal memory is supported by other studies that note its presence in first-episode patients that have not yet received antipsychotics (Hill et al., 2004). The findings in Erlenmeyer-Kimling's study do not confirm anything about cognitive impairment's role as a risk factor or as an early symptom of schizophrenia, but they do highlight the relevance of verbal memory in schizophrenia's profile.

Verbal memory is a key treatment target field of cognitive remediation. Verbal memory deficits limit improvement in other areas of cognition, many of which are social (Mueser et al., 1991, Kern et al., 1992, Corrigan et al., 1994) and the acquisition and application of community living skills within outpatient populations (Jaeger and Douglas, 1992, Lysaker et al., 1995). One could argue that verbal memory performance is a limiting factor to treatment, as if its improvement is a prerequisite for subsequent functional improvement. Fiszdon et al, (2005) cited verbal memory ability as a predictor of cognitive remediation success overall, agreeing with findings that suggested that verbal memory performance was predictive of the intensity of remediation necessary for effective cognitive treatment (Fujii and Wylie, 2002). Her work also suggests that improvements made in memory correlate with improvements in quality of living (Fiszdon et al., 2008).

Cirillo and Seidman's (2003) review synthesizes the findings of numerous meta-analyses that confirm that deficits in verbal episodic memory are widely evident in the schizophrenia population. Particular impairment has been seen in the first stage of learning and memory: encoding (Paulsen et al., 1995). Koh et al., (1973) explored

encoding deficits by comparing word-list recall among patients with schizophrenia to healthy controls, and to other non-schizophrenic psychiatric patients. Recall was impaired in the group with schizophrenia compared to healthy controls, and impaired compared to non-schizophrenic psychiatric patients, although to a lesser extent. Koh et al. (1973) noted how participants with schizophrenia had trouble employing mnemonic techniques, categorizing words into clusters, and employing subjective organization (ie. consistently recalling words in a particular sequence). That same study also revealed that recognition was a preserved skill among people with schizophrenia. Findings such as these were considered in developing our intervention. This study focuses on the *encoding* of verbal episodic memory in schizophrenia.

E. Cognitive Remediation Therapy

Cognitive Remediation (CR) is a training-driven approach to generating durable and generalizing improvements in neutral areas of cognition (Wykes and van der Gaag, 2001). Several meta-analyses that focus on CR studies report that the benefits of CR range between slight and moderate at best (Krabbendam and Aleman, 2003, Twanley et al., 2003, Wykes et al., 2011). Meanwhile, Penades et al. (2006) assessed the benefits of CR in a schizophrenia outpatient population and found that CR yielded significant improvements in both neurocognition and social functioning. Verbal memory was highlighted as an area of particularly significant improvement. This improvement was lasting as a 6 month long follow up was conducted as well (Penades et al., 2006). These findings very much support the interest in expanding CR in rehabilitation programs for

people with schizophrenia. In fact, a meta-analysis by Wykes and van der Gaag (2001) noted a rise in CR related publications focusing on schizophrenia.

Penades' work, unlike other CR studies, addresses functioning as an outcome measure, in areas such as self-care and communication. The majority of CR analyses omit this important outcome measure, which challenges the integrity of their findings regarding CR's effectiveness (McGurk et al., 2007). These are critical points because the goal of remediation is to produce results that improve quality of life. The experimental aspect of this study is a remediation technique geared towards improving verbal episodic memory, with the greater significance being the potential to better the functionality of people with schizophrenia. Findings from studies like Penades et al. (2006) demonstrate that combatting schizophrenia's "static encephalopathy" is a goal that is within reach.

Deeper Encoding

In other instances of verbal memory impairment such as traumatic brain injury, Korsakoff's Syndrome, and temporal lobectomy, it was found that "deeper encoding," by use of imagery, could be used to improve verbal episodic memory performance. Based on findings in literature that implicate problems with encoding, this study focuses on recall as a measure of healthy encoding.

Korsakoff Syndrome is a neurological disorder caused by severe alcoholism. It is characterized by severe verbal episodic memory deficits (Talland, 1965). Memory focused studies reveal that the deficit occurs not only in retrieval of information (a long-term process), but also in immediate recall (Cermak, 1975). Even more interesting is

the nature of the deficit. Korsakoff patients do not have trouble remembering images, as image-based matching tasks have revealed (Huppert, 1973). The deficit is rooted in conscious verbal recall. A study with Korsakoff patients demonstrated effective remediation in immediate recall by using interacting imagery exercises as a strategy to memorize verbal paired-associations (Cermak, 1975). These findings, coupled with earlier findings regarding imagery, specifically *interacting* imagery, provide useful insights regarding strategy building for verbal memory remediation (Cermak, 1975, Baddeley and Warrington, 1973). Findings by Baddeley and Warrington (1973) suggest that imagery interactions need to be limited in order to result an effective improvement in recall. They found that an interaction consisting of four verbal items was not effective, which is why Cermak limited the imagery interactions to pairs. To further support the promise of imagery as a remediation tool, Cermak also demonstrated that imagery aided retrieval. To calibrate the relative efficacy of imagery as a strategy, cue-based remediation was also employed because of its known efficacy. Cue-based remediation refers to using an additional verbal piece of information that is presented during stimuli-pair presentation and again during retrieval exercises to link two verbal items (Baddeley and Warrington, 1973). The difference between the imagery strategy and the cue-based training would be item A interacting with item B, and item C being presented as a cue for items A and B (not interacting), respectively. Imagery produced better results than cue-based training for retrieval.

Other studies have explored imagery techniques to help patients suffering from other sources of verbal memory impairment, such as temporal lobectomy, performed in order to treat epilepsy. Jones (1973) reported that patients with left temporal

lobectomies benefitted from imagery training and exhibited improvements in verbal memory performance. However, this was not the case for people with amnesia and right temporal lobectomies. She too used paired-associations and guided patients to imagine them interacting. Crovitz (1979) used imagery to improve word list retrieval performance among individuals suffering from traumatic brain injury and Korsakoff's syndrome. His approach was different in that instead of guiding participants to imagine pairs of words interacting, a story was presented. However, every sentence of the story described a visual interaction, thus achieving the paired interaction that Baddeley and Warrington (1973) and Cermak (1973) stressed would be most effective. In all of these examples, verbal information is presented, and interpreted as visual information, only to be re-presented verbally. Cermak (1975) called this "translation" and "retranslation." This is a compensatory approach to remediation because a preserved area of function (in this case, imagery-based memory) is applied to an area that is deficient (in this case, verbal memory). The challenge with schizophrenia is its heterogeneity, as verbal memory deficits vary in their severity and nature in schizophrenia (Calev et al 1983). Jones' (1973) finding revealed that this image-based strategy of "deeper encoding" did not benefit all participants that suffered from verbal memory impairment. Improvements in performance were only seen for participants that shared the same source of verbal memory impairment: left temporal lobectomy. Part of this movement towards building remediation strategies is establishing whether imagery is even effective in schizophrenia.

Koh et al. (1980) presented findings that suggest that image-based encoding might be effective because it involves providing context. The strategy used in Koh's

study involved making meaning of random words by integrating them into a logical sentence. When recall of sentences was required, patients with schizophrenia performed comparably to healthy controls. Before strategy training, patients with schizophrenia performed worse than healthy controls on recall. These findings suggest that contextualizing verbal information by linking items may be a promising strategy for compensatory remediation of verbal memory.

F. An Experimental Approach

The purpose of this study was to improve verbal episodic memory, specifically at the level of encoding, among individuals with schizophrenia. The experimental intervention involved two compensatory strategies for remediating deficits in verbal episodic memory:

1. **The Story:** A narrative technique in which participants listened to a story, standardized in the protocol, that linked target words sentence by sentence in an interaction. The following is an excerpt from the full script (Appendix, Figure 5).

The first word is poster and you can remember that however you like. The second word is barrel because a wanted poster was hung on the side of a barrel. The third word is rainbow because the end of the rainbow was in the barrel...

2. **Imagery:** An imagery technique in which participants were guided to imagine target words interacting. The following is an excerpt from the full script (Appendix, Figure 6).

First I want you to picture a poster. Now imagine a barrel interacting in some way with a poster. Now imagine a rainbow interacting in some way with a barrel...

Image-based interactions were employed in both strategies; identical number of presentations of the training word list in the presence of an assessor was the control condition, as it offered no compensatory strategy, just repetition of the target words.

It was hypothesized that both the imagery and story strategies would (1) significantly improve verbal memory performance on the strategy training task, (2) the benefits of these strategies would generalize by demonstrating significant improvements on non-trained verbal memory tasks (list learning and prose recall tasks), (3) and that these generalized benefits would last by demonstrating significant improvements on a one-week follow-up assessment.

II. Methods

A. Participants

Participants were recruited from day programs at Hartford Hospital's Institute of Living in Hartford, CT. and mental health groups at InterCommunity in East Hartford, CT. All procedures for the study met relevant institutional review board (IRB) approval and written, informed consent was obtained. More specifically, procedures for enrolled outpatients diagnosed with schizophrenia or schizoaffective disorder met institutional review board approval at Hartford Hospital and Wesleyan University.

In order to qualify for this study, participants needed to be diagnosed with either schizophrenia or schizo-affective disorder according to DSM-IV criteria, and they needed to be stabilized on antipsychotic medication. Exclusion criteria were a history of loss of consciousness lasting more than thirty minutes and any neurological disorders that would affect neurobiological function (e.g. Epilepsy). Forty patients participated in this study in total. Eight participants dropped out of the study after the first post-training assessment and did not complete the one-week follow-up assessment.

B. Group Assignment

Participants were randomly assigned to one of three study groups (one control, two compensatory strategies) with equal probability of being assigned to each group. Random assignment was achieved by using an electronic random assignment generator. At the time of study entry there were no significant differences (all $p > 0.05$) between groups on relevant demographic or clinical variables (Table 2). Group assignment was kept hidden from assessors that performed baseline and follow-up assessments to preserve the single-blinded nature of the study. Investigators that were responsible for scoring these outcome measures were also blinded.

Demographic Profiles of Three Study Groups			
Characteristic	Control	Story	Imagery
Gender (% Male)	56%	70%	77%
Age (years old)	36.1	30.9	38.1
Duration of Illness (years)	12.7	10.1	11.6
Age of Onset (years old)	23.4	20.9	25.4
Number of Hospitalizations	6.08	4.80	8.33
Education (years)	12.7	11.8	13.0
Percent African-American	30.8%	27.3%	25%
Percent Asian	7.70%	9.09%	0.00%
Percent Caucasian	53.8%	45.5%	62.5%
Percent Hispanic	7.70%	18.2%	12.5%

Table 2: Mean statistics for each study condition did not demonstrate significant differences in demographic profiles.

C. Experimental Groups

Before being introduced to the strategy, each participant listened to a list of fifteen randomly generated words and was tested for immediate recall. They were then re-exposed to the words one of the following ways depending on their random group assignment.

The story condition: Participants listened to the fifteen target words embedded in a story that related each word by presenting the pairs of words in a visualize-able

interaction. This image-based strategy was designed from the findings of a study by Crovitz (1979) that trained patients with traumatic brain damage to utilize “elaborate encoding” to improve their declarative memory. (See Appendix for Crovitz’s script and story strategy script, Figures 7 and 5).

The imagery condition: Participants listened to the fifteen target words embedded in a verbally guided task that required participants to actively consider the words interacting. This strategy was also designed based on Crovitz’s story method, but was designed to encourage the participant to construct his/her own image. (See Appendix for imagery script, Figure 6).

Control Condition: Participants were exposed to the training word list two times, the same number of times as the two training groups, to control for passive word-list exposure. To control for non-specific effects of social interaction, this condition also involved participants meeting with an experimenter (See Appendix for script, Figure 4).

Participants in all three of the study groups were tested for recall of the trained word list after receiving training in their respective study groups. Change in recall was measured by subtracting pre-training recall from post-training recall.

D. Outcome Measures

To test for generalization of the strategies’ benefits, the word-list recall and prose recall tasks were administered at baseline and at two follow-up assessments: One follow-up assessment immediately after strategy training, and the second follow-up assessment one week after the cessation of training (Table 3).

Study Design (N=40)

Study Group	Sample Size	Repeated Measures
Story	11	Base, FU-1, FU-2
Imagery	16	Base, FU-1, FU-2
Control	13	Base, FU-1, FU-2

Table 3: BASE= verbal episodic memory assessment prior to training; PT-1=Post-training verbal episodic assessment after one of two compensatory strategy interventions or control period; PT-2= Post-training verbal episodic memory assessment one week after strategy training or control session.

The Hopkins Verbal Learning Test- Revised (HVLT-R): was used to assess immediate free recall of word lists, each with twelve words. Six alternate forms for this task, each containing three categories of words (e.g. occupations/professions, sports, vegetables) have demonstrated reliability (Benedict et al., 1998), and thus were considered appropriate for use in this protocol.

The Rivermead Behavioral Memory Task (RBMT): was used to measure prose recall, and involved recall of plot details, rather than word lists, with greater scores awarded to details that were reported verbatim. Three stories were used in total, each consisting of 21-plot points that were embedded in one five to six-sentence long paragraph.

E. Statistical Measures

A data analytic strategy was formulated to determine whether either approach to strategy training selected for this study produced significant improvements in verbal episodic memory function. To assess the within group effects of training, in step one, paired-sample t-tests for all three groups comparing pre-training performance to immediate post-training performance and performance at a one-week follow-up on the

trained memory items as well as the two measures of generalization of training effects (HVLTR and RBMT), were evaluated. In step two, in order to assess between group effects of training on outcomes, a series of ANCOVAs using post-training scores on the HVLTR and RBMT as the dependent measures (immediate or one-week follow-up), and pre-training scores as the covariate, followed by any necessary post-hoc analyses, were run between groups. These analyses were designed to determine whether one or both compensatory strategies resulted in benefits that were significantly greater than the control condition.

III. Results

A. Baseline Performance

An ANOVA conducted on measures at baseline revealed a significant difference in performance on the HVLTR ($F(2,36)=3.99, p=0.027$). Post-hoc tests revealed that participants in the story group performed better than participants in the imagery and control groups (Figure 2). Significant differences in baseline performance were not observed on the RBMT or on the word list created for training (all $p>0.05$).

B. Training Word List Performance

All three study groups (control, story and imagery) demonstrated significant within-group improvements on the training word list ($t(12)=3.12, p=0.009$; $t(9)=5.25, p=0.001$; $t(15)=4.03, p=0.001$, respectively). A between-group ANCOVA using the performance on the training word list after training as the dependent variable and baseline training task scores as a covariate, revealed significant differences between

groups ($F(2,36)=3.34, p=0.047$). (Figure 1). A post-hoc analyses revealed that the story group produced the significance found in improved training task performance.

C. Measures of Generalization (RBMT and HVLTR)

Paired-sample within-group t-tests were run to compare baseline performance on HVLTR and RBMT to performance on follow-up assessments administered immediately after training in each group. These within group analyses demonstrated no significant changes (all $p>0.05$). A between group ANCOVA using scores immediately after training as the dependent measure and baseline scores as the covariate revealed no significant differences between groups (all $p>0.05$) (Figures 2, 3).

Paired-sample T-tests were run to compare HVLTR and RBMT performance at cessation of training as compared to assessments administered one week after training. This within group analysis revealed no significant changes in performances (all $p>0.05$) (Figures 2, 3). A between-group ANCOVA comparing these two time points also revealed no significant differences (all $p>0.05$).

Data from the one-week follow up assessment were also analyzed with respect to baseline performance. Paired-sample t-tests were run within each treatment group. This within group analysis demonstrated a significant change in RBMT performance for the story group ($M=4.22, SD=5.29, t(8)=2.40, p=0.043$) but not in the other two study groups (all $ps> 0.05$) (Figure 3). None of the three groups exhibited significant change on HVLTR performance (all $p>0.05$). An ANCOVA using one-week follow-up scores as the dependent variable and baseline scores as the covariate revealed a between group effect for the RBMT ($F(2,27)=4.06, p=0.029$) but not the HVLTR

($p > 0.05$). (Figure 3). Post-hoc analyses revealed that the story group demonstrated significantly greater benefits from the training than the imagery group ($p = 0.047$) and approached significance ($p = 0.069$) compared to the control group.

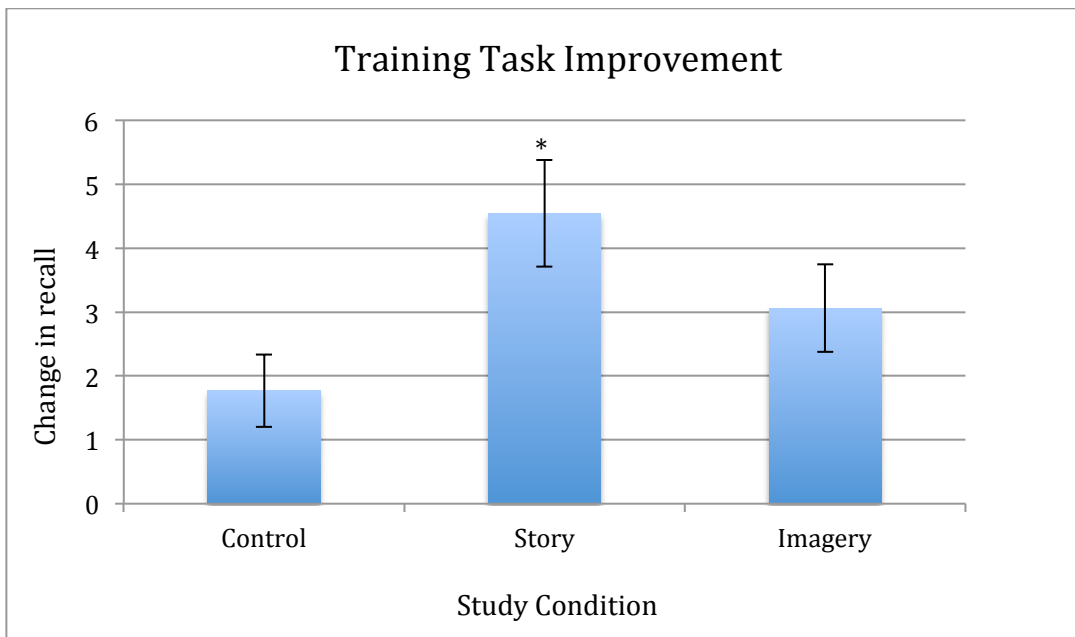


Figure 1: Mean change (with standard error bars) in performance from pre-training to post-training on the training word list task for three study conditions: control, story, and imagery.

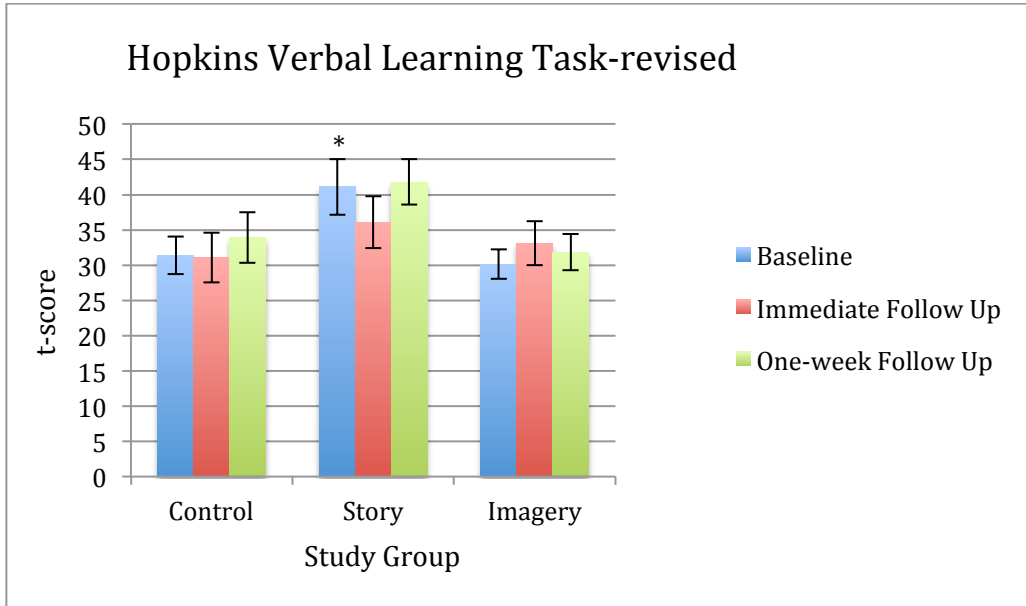


Figure 2: Mean Hopkins Verbal Learning Task-revised (HVLTR) performance t-scores (and standard error bars) of the three study groups (control, story, and imagery) at baseline at follow-up immediately after strategy training and one week later.

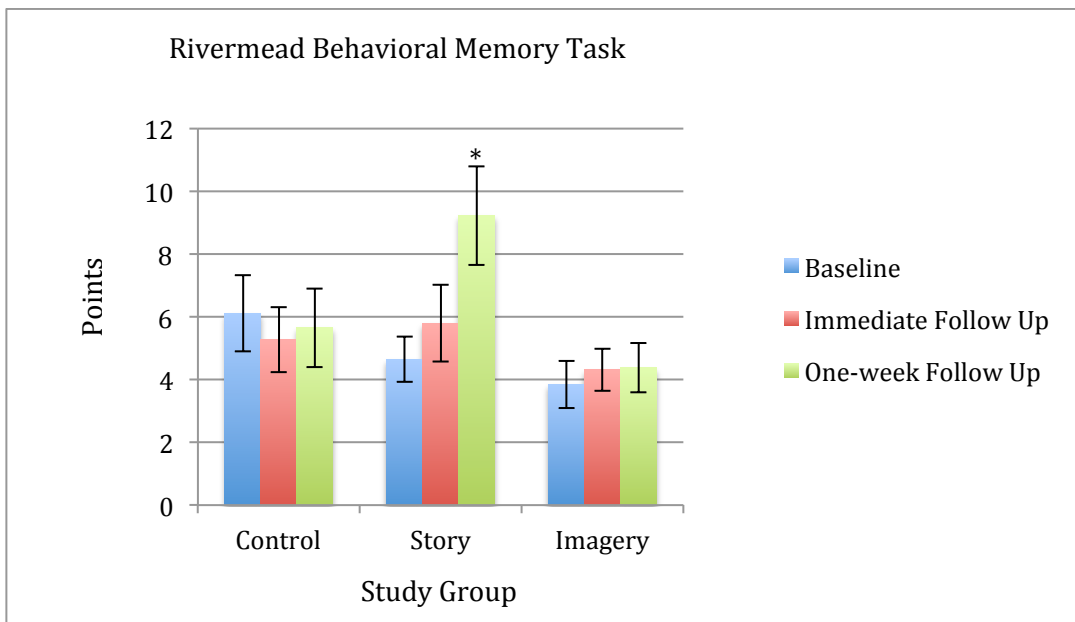


Figure 3: Mean points earned (with standard error bars) on Rivermead Behavioral Memory Task (RBMT) for three study groups (control, story, and imagery) at baseline at follow-up immediately after strategy training, and at follow-up one week later.

IV. Discussion

A. Evaluating the Hypotheses

This study investigated the effect of two novel compensatory strategies for improving verbal memory performance among people with schizophrenia: The “story strategy,” which involved embedding images associated with target words in a narrative that described paired-image interactions, and the “imagery method,” in which participants were guided to visualize objects represented by words interacting as pairs. The control condition consisted of identical exposure to the training word list as in the first two groups without provision of strategy training. It was hypothesized that the two compensatory strategies would result in greater improvements in recall of verbal information at the cessation of training on (1) the word-list recall task that was trained in each condition, and (2) two standardized verbal memory tasks (a list learning task and a prose recall task) administered immediately after training, containing words different from those used during training and thus assessing generalization of these training procedures. Further, it was predicted that (3) these effects would be durable, exhibited in a follow-up assessment one week later.

With respect to hypothesis 1, all three groups benefited significantly from both compensatory strategy training and the control condition (simple repetition) for training-task performance, and the story strategy demonstrated significantly greater benefits than the control conditions. With respect to hypothesis 2, no evidence of significant improvement on measures of generalization to an untrained task was

observed. With respect to hypothesis 3, unexpected, significant, delayed improvement was seen in the story group for prose recall performance.

Hypothesis 1: Effects on Trained Word List

The findings regarding changes in performance on the strategy training tasks support the idea that a compensatory strategy would produce improvements in recall on the trained items that were significantly better than those produced by simple repetition. There was no evidence that suggested that the imagery group benefited participants significantly more than the control condition, and no significant differences were seen between the story group and imagery group. The significant finding with regard to hypothesis 1 is that the story group resulted in significantly greater benefits than the control condition. This finding supports the findings of Crovitz (1979) who used the story method to improve the memory of patients with compromised verbal memory as a result of traumatic brain injury. Unlike this study's approach, Crovitz used stimulus-response recall to demonstrate the benefit of the paired-association of image-based interactions employed by the story presentation of information. This means that to elicit retrieval of B, Crovitz provided A. Our training task simply demanded recall of the target words without any stimulus-response information presented during the recall task. Nevertheless, the presentation of the paired-associations during strategy training was preserved in both studies. Crovitz's study did not test for generalizability as participants were only tested on training material. With result to our study, the significant benefits on training task material seen in the story group affirms that the story strategy was administered effectively and produced expected changes in verbal

episodic memory. The imagery strategy has not been employed by other studies and does not suggest significant benefits from the imagery strategy. This may be due to the challenging self-generated nature of the strategy.

Hypothesis 2: Generalization of Training to Untrained Measures of Verbal Episodic Recall

The two measures of generalization effects used in this study were a 12-item verbal list learning task (HVLTR) and a prose recall task (RBMT).

HVLTR

HVLTR demands immediate recall of word lists. Despite improvements in recall observed on the training task across groups, within-group paired-sample t-tests revealed that no significant changes between baseline and immediate follow-up scores were observed. This demonstrates that upon immediate assessment, any benefits observed on the training-task performance did not generalize to another word list learning task. Both Crovitz (1979) and Koh (1980) explored these strategies of “deeper encoding,” but did not test for generalization to untrained verbal items. In addition, Cermak (1975) and Jones (1973), who worked with Korsakoff patients and temporal lobectomy patients, respectively, only used the paired-image interaction strategies for training tasks and did not look for generalization. Meanwhile, a recent meta-analysis by Wykes et al. 2011 summarizing all existing CR studies in schizophrenia, demonstrated that CR effects do generalize to untrained tasks for nearly all cognitive domains studied, including verbal memory. The vast majority of studies in this meta-analysis involved

multi-component training and it remains unclear whether any of the studies included in this report utilized the visualizations strategies selected for the current study.

RBMT

RBMT, a prose recall task, demands recall of plot details upon hearing a story. Findings from this measure also failed to support generalization of strategy training effects at an immediate recall test. Together, these findings do not support the hypothesis that benefits from strategy training would be observed in other verbal memory tasks immediately after training. These results suggest that improvements on training tasks do not generalize immediately after training, suggesting the limited application of acutely administering compensatory strategy-training.

Hypothesis 3: Sustained Improvements One-Week Later

Durability

There was no evidence to suggest that performance significantly differed between immediate follow-up and one-week follow-up assessments. Performance was not significantly better or worse. However, when the same analysis of covariance was applied to compare performance at baseline and at the one-week follow-up, significant differences were seen between groups for the RBMT. Paired-sample within group t-tests revealed significant improvements in the story group only. On average, performance improved by almost 100% between baseline and one-week follow-up assessment. However, the significance of this finding remains elusive. The initial hypothesis was made in regards to lasting generalized improvement in verbal memory

performance. The current finding does not support there being a lasting improvement, but rather a delayed generalization training effect on prose recall performance. Wykes and van der Gaag (2001) expressed that without maintenance of CR, durability would be difficult to achieve because of the relapsing nature of schizophrenia, and highlighted the scarcity of durability measures employed in CR studies. In updated meta-analyses, durability is demonstrated even after 8 months (McGurk et al., 2007; Wykes et al. (2011), indicating that CR effects can be durable.

The story strategy verbally presents seemingly random target words as a narrative, providing a contextual link between every word. Perhaps this training is most beneficial for improving verbal memory performance in prose recall since this was the only instance of generalization extracted from the data. The use of image-based interaction in the context of a narrative (Story method) may be useful in schizophrenia to more deeply encode verbal information that is presented as a narrative. The strategy asks that participants contextualize information by noting how each element of the story interacts with each subsequent element, ultimately creating a string of image-based interactions that chronicle the story. The RBMT is designed as a story with 21-items (i.e. plot points). These findings in the story group suggest that the strategy is applicable to deeply encoding plot points. Koh et al. (1980)'s verbal memory study demonstrated that people with schizophrenia could improve their sentence recall performance after receiving sentence-building training. Note that Koh et al. (1980) did not demonstrate an improvement in free recall of words, but rather recall of logical sentences. Similarly, the story method generated delayed generalized improvement in plot recall, but not in free call of words.

Koh et al. (1980)'s findings and the preliminary findings of this current study suggest the limited application of the story strategy in improving performance on types of verbal memory tasks. It is possible that the story method is only beneficial for improvements in contextualized verbal memory tasks, such as prose recall. In regards to the delayed nature of this benefit, it is possible that the strategy did not consolidate immediately.

B. Implications for Verbal Memory Remediation

The purpose of this study was to isolate effective strategies for verbal memory remediation. Multiple commentaries on CR have referred to studies such as this one as “ingredient” builders for CR because a CR regime would consist of several of these strategies (Wykes and Spaulding, 2011; Wykes et al., 2011). Based on these results, the story strategy is a potential “ingredient” as one session of training resulted in improved verbal memory on training task material. The extent to which this strategy generalizes is unclear. The delayed generalization of the story strategy's benefit for a measure of prose recall at a one-week post-training follow-up is difficult to explain, and warrants revisiting as data continues to be collected. This is an ongoing study and the sample sizes are expected to grow. These preliminary findings confirm the utility of deeper encoding strategies, such as the story method, to improve verbal memory performance.

The implications of this experiment's results speak to a greater obstacle in cognitive remediation, particularly in schizophrenia. Jones (1973) highlighted the limited efficacy of visual mnemonics in aiding verbal memory performance when she reported that patients with different sources of memory damage exhibited varying levels

of improvement from the mnemonic strategy. Schizophrenia is a disorder that is intrinsically heterogeneous (Joyce et al., 2007). Baseline HVLTR findings demonstrate this heterogeneity. HVLTR performance at baseline was significantly elevated in the story group relative to the other groups (Figure 2) even though strategy group assignment (which occurred after baseline assessment) was conducted randomly. Analysis of the mean HVLTR performances at baseline and one-week follow-up in the story group did not indicate any significant changes, demonstrating the group's return to baseline performance after training ended. One explanation for this finding is a ceiling effect: Participants in the story strategy performed so well at baseline that they did not demonstrate improvement after training. This significant elevated performance exhibited by participants in the story group is particularly worth scrutinizing because this very same cohort exhibited the delayed benefits on RBMT prose recall performance one-week after training.

It may be the case that this delayed effect seen on RBMT only occurs for participants that perform well on baseline recall tasks, suggesting that a certain aptitude of verbal memory is a prerequisite for benefitting from the story strategy. Alternatively, the story strategy may only benefit people in prose recall performance, and have no effect on word list recall, suggesting the limited utility of the strategy. Both of these explanations emphasize the potentially restricted effects of the Story Method of compensatory memory training. Without further testing, perhaps with a more diverse population of baseline performance, this question regarding explanation cannot be resolved. These points suggest that clinicians may need to consider factors, such as baseline cognitive standing, to better tailor remediation plans to individualized

impairment profiles, a thought also expressed by multiple publications focusing on CR (Wykes and van der Gaag, 2001; Wykes and Spaulding, 2011).

The protocol of this study was developed using Crovitz (1979)s script as a template for presenting the target words in the training task (Appendix, Figure 7), but was executed uniquely. In terms of testing, our protocol did not rely on stimulus-response recall, but instead simply demanded free recall (i.e. Unlike Crovitz (1979)'s training test, one component of the pair was not presented to elicit recall of the other). In addition, unlike Koh et al. (1980)'s study that employed sentence-building as a strategy for better recall, this study's protocol was designed such that participants were aware that a recall task would follow their training, a consideration. Unlike Crovitz (1979)'s method, Koh et al. (1980) employed strategies that demanded that participants actively build context (i.e. sentences). This study employed both by presenting the story strategy and the imagery strategy, which achieved the passive and active paired-image interactions, respectively. They are especially unique in the context of CR for schizophrenia as this paired-image interaction approach has, not, to our knowledge, been employed for schizophrenia. Acknowledging the nuances of these strategies is important for standardization of effective practices.

C. Limitations

The screening process for this study was not that stringent relative to those employed by a number of other CR studies, which use cognitive tests to ensure that only participants that fall within a skill range are included (O'Carroll et al., 1999, Penades et al., 2006). Had there been a prerequisite for verbal memory impairment,

we may not have seen a statistically significant difference between groups at baseline HVLTR performance.

In Koh et al. (1973, 1976, 1980)'s studies, participants with schizophrenia were matched with a cohort of healthy controls. The implications of findings extracted from a study with healthy controls differ from those that do not. Without healthy controls, it was difficult to assess to what extent these strategies were bringing participants to a "healthy" level of verbal memory performance. In this respect, the results of this study were limited to speculations regarding the strategies' effect trend, but could not shed light on the extent to which any benefits reached a healthy range of verbal memory performance. This study is ongoing, and there are thoughts to expand the protocol and include a cohort of healthy controls.

In the training script of this report's study, administrators of the training were instructed to tell participants to use their strategy for memory-related tasks such as grocery lists and task lists (Appendix, Figures 5 and 6). The script did not explicitly encourage participants to use the strategy in their follow-up testing, perhaps to allow participants to arrive at this application on their own. Koh et al. (1973) noted the qualitatively idiosyncratic and diverse approaches to verbal memory tasks employed by people with schizophrenia. After several sessions of strategy training, perhaps the volition to use the strategy could be fostered, but after just one session, perhaps it is necessary to provide at least minimal guidance on follow-up tasks.

D. Future Direction

The design targeted improvement in verbal memory performance via targeted one-session training. Many of the remediation techniques employed in previous remediation studies demonstrated promising results after weeks. In McGurk et al. (2007)'s meta-analysis of CR studies, a distinction is made between hours of remediation devoted to strategy training and hours in remediation devoted to practice. The investigators of this analysis reported that prolonged strategy training resulted in the greatest improvements in verbal learning and memory. The meta-analysis proposed that lasting improvement was linked to hours of remediation devoted to practice, but suggested this based on limited preliminary findings (McGurk et al., 2007). These relationships are worth considering for building effective treatment.

In the study reported in this write-up, the focus was to assess potential active elements for more comprehensive programs for remediation. This study would benefit from a greater sample size, in all treatment groups. Significant improvements in immediate follow-up performance after gathering more data would perhaps warrant introducing additional strategy training sessions to the protocol. However, perhaps repeated training sessions would provide the necessary exposure to the strategy to elicit generalization.

While the story strategy has demonstrated significance in its potential to improve training-task performance, this finding is being reported with a relatively small sample size. The strategies in this study were designed to encode information differently: "Translation" and "Re-translation," as Cermak (1975) called it. Given the heterogeneous nature of memory deficits in schizophrenia (Calev et al., 1983, Joyce,

2007), it would be valuable to see how performance on these tasks, as well as training-related improvements are being reflected in functional magnetic resonance imagery (fMRI). This neuroimaging technique is used for its advanced spatial resolution and temporal resolution (Detre and Wang, 2002), technical elements that are important to consider if one is interested in investigating areas of activation during a cognitive probe task. Results gathered from fMRI would shed light on several features of verbal memory impairment in schizophrenia including a potential common area of dysfunction, and activation of functional areas that may be strategy-dependent.

O'Driscoll et al. (2001) reported on potential areas of interest by exploring volumetric differences in the temporal lobe, an area of interest highlighted in multiple studies exploring verbal memory impairment and neuroanatomical features of schizophrenia (Jones, 1973, Chow et al., 2001), between healthy controls and first-degree relatives of people with schizophrenia. This particular cohort was selected because verbal memory deficits are both prominent and arguably predictive of eventual onset (Erlenmeyer-Kimling, 2000). O'Driscoll et al. (2001) found that deficits in delayed recall of verbal information were significant in first-degree relatives compared to healthy controls. This significant behavioral difference was reflected in volumetric differences in the amygdala-anterior hippocampus junction. O'Driscoll et al. (2001)'s findings among others provide insight regarding where to focus imaging studies.

V. Conclusions

The findings from this study support the utility of compensatory strategies on improving verbal episodic memory in schizophrenia. The story strategy, a compensatory strategy that employed paired-image associations in a narrative context, resulted in significant improvements in training-task performance. In addition, the findings from this study do not support generalization of compensatory strategy training benefits on verbal memory performance immediately after training, but rather potential delayed benefits induced by the story strategy. The imagery strategy, a compensatory strategy that demanded that participants actively generate paired-image associations from a word list, produced no significant benefits relative to the story strategy or control condition, and this condition produced no evidence of generalization at either and immediate post-training assessment or at a one-week follow-up.

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Appendix

The following text is a script used by de-blinded investigators to train participants in their respective strategy groups.

To begin: Each participant completes one form of the HVLTR and prose recall test from Rivermead (to establish a baseline performance)

Control condition: “I am going to read you a list of words. When I am finished, I would like you to tell me as many words from the list as you can remember. Ready?”

Poster / Barrel / Rainbow / Canoe / Soup / Beard / Carnation / Bluebell / Emerald / Peach / Toilet / Bell / Boot / Deer / Ring

“Now I am going to read the list again, but this time each word will be repeated twice. When I am finished, I would like you to tell me as many words from the list as you can remember. Ready?”

(Researcher reads each word aloud twice – e.g. “poster (pause) poster; barrel (pause) barrel”)

Poster (pause) Poster

Barrel (pause) Barrel

Rainbow (pause) Rainbow

Canoe (pause) Canoe

Soup (pause) Soup

Beard (pause) Beard

Carnation (pause) Carnation

Bluebell (pause) Bluebell

Emerald (pause) Emerald

Peach (pause) Peach

Toilet (pause) Toilet

Bell (pause) Bell

Boot (pause) Boot

Deer (pause) Deer

Ring (pause) Ring

Figure 4: Script for baseline training task assessment, and control condition.

Story condition: “I am going to read you a list of words. When I am finished, I would like you to tell me as many words from the list as you can remember. Ready?”

(Researcher reads above list) “Now tell me as many words as you can remember” (record responses on response sheet)

“Now I am going to read you a story using those words and, when I am finished, I would like you to tell me as many of the target words as you can remember. Ready?”

“The first word is poster and you can remember that however you like. The second word is barrel because a wanted poster was hung on the side of a barrel. The third word is rainbow because the end of the rainbow was in the barrel. The fourth word is canoe because a man was rowing a canoe across the rainbow. The fifth word is soup because the canoe was filled to the brim with soup. The sixth word is beard because the man had a long beard that touched his knees. The seventh word is carnation because the man had a carnation sprouting forth from his beard. The eighth word is bluebell because next to the carnation there was a bluebell. The ninth word is emerald because at the center of the bluebell was a loose emerald. The tenth word is peach because the man ate a peach and dripped juice onto the emerald. The eleventh word is toilet because the peach accidentally fell into a toilet. The twelfth word is bell because a bell rang when the toilet flushed. The thirteenth word is boot because the bell was attached to the toe of a boot. The fourteenth word is deer because a deer was wearing four boots. The fifteenth word is ring because the deer also had rings on each antler.”

“Now tell me as many words as you can remember” (record responses on response sheet)

After participant has finished recalling words, say “Great job. This is a strategy you can use to help remember word lists such as grocery lists when you go shopping or run errands.” Participant then completes a second form of the HVLIT-R and prose test from Rivermead.

Figure 5: Script for story strategy. Story modeled after Crovitz (1979)’s “Airplane List” (Figure 7).

Imagery condition:

“I am going to read you a list of words. When I am finished, I would like you to tell me as many words from the list as you can remember. Ready?”

(Researcher reads above list)

“Now tell me as many words as you can remember.”

(Record responses on response sheet)

“Now I am going to read you the same list words, but this time I want you to imagine each word interacting in some way with the previous word. Anything you imagine will be fine, whatever helps you best remember each word. When I am finished reading the list of words, I want you to tell me as many words as you can remember.”

First I want you to picture a poster. Now imagine a barrel interacting in some way with a poster. Now imagine a rainbow interacting in some way with a barrel. Now imagine a canoe interacting in some way with a rainbow. Now imagine soup interacting in some way with a canoe. Now imagine a beard interacting in some way with soup. Now imagine a carnation interacting in some way with a beard. Now imagine a bluebell interacting in some way with a carnation. Now imagine an emerald interacting in some way with a bluebell. Now imagine a peach interacting in some way with an emerald. Now imagine a toilet interacting in some way with a peach. Now imagine a bell interacting in some way with a toilet. Now imagine a boot interacting in some way with a bell. Now imagine a deer interacting in some way with a boot. Now imagine a ring interacting in some way with a deer.

“Now tell me as many words as you can remember.” (record responses on response sheet)

After participant has finished recalling words, say “Great job. This is a strategy you can use to help remember word lists such as grocery lists when you go shopping or run errands.” Participant then completes a second form of the HVLT-R.

Figure 6: Script for imagery strategy.

THE FIRST WORD IS AIRPLANE. REMEMBER THAT HOWEVER YOU LIKE. THE NEXT WORD IS GIRAFFE, BECAUSE THE AIRPLANE IS FILLED WITH GIRAFFES SITTING IN THE SEATS. THE NEXT WORD IS BOLOGNA, BECAUSE EACH OF THE GIRAFFES IS HOLDING A BOLO- GNA AND TAKING BITES OUT OF IT. THE NEXT WORD IS MOON, BECAUSE THE MOON IS REALLY MADE OUT OF BOLOGNA, NOT GREEN CHEESE. THE NEXT WORD IS ELEPHANT, BECAUSE THERE IS AN ELEPHANT ON THE MOON, NOT A MAN IN THE MOON. THE NEXT WORD IS BALL, BECAUSE THE ELEPHANT IS HITTING A BALL WITH HIS TRUNK. THE NEXT WORD IS GRASS, BECAUSE THE BALL IS COVERED WITH GRASS, NOT LEATHER. THE NEXT WORD IS WALL, BECAUSE THE GRASS IS GROWING ALL THE WAY TO THE GREAT WALL OF CHINA. THE NEXT WORD IS CABINET, BECAUSE THE PRESIDENT'S CABINET IS HA VING A MEETING INSIDE THE W ALL. THE LAST WORD IS STREET, BECAUSE THE CABINET GETS FIRED AND GOES OFF DOWN STREET LOOKING FOR WORK.

Figure 7: Story titled “Airplane list” from Crovitz (1979) study utilizing paired-image associations in the context of a narrative to aid verbal memory recall.