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Evidence for impaired mnemonic strategy use among patients with schizophrenia using the part-list cuing paradigm

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Abstract

Purpose: Strategic and mnemonic abilities of person with schizophrenia (SCZ) were studied using a part-list cuing (PLC) task. In this task, presentation of retrieval cues in the form of a subset of studied words typically impairs recall of the remaining items. This impairment is thought to reflect a disruption of participants' natural retrieval strategies.
Methods: Participants with SCZ and healthy controls (*n*s=28) studied word lists with three different levels of semantic organization: (a) unrelated, (b) categorized, but presented in a random order, and (c) presented by category. For each type of list, participants recalled words under both free-recall and PLC conditions.
Results: Consistent with SCZ-related impairment of strategic retrieval processes, the SCZ group was less disrupted by PLC interference than controls in the unrelated-list condition. Comparison of free recall across lists also indicated a consistent deficit in SCZ despite varying levels of difficulty and retrieval contexts. Nonetheless, the SCZ group demonstrated parallel improvement to the healthy group with increasing list organization.
Conclusions: These results provide evidence of deficient retrieval processes in SCZ in a context placing maximal requirements for utilization of self-initiated, effortful, mnemonic strategies. Unlike most extant results demonstrating mnemonic impairment in persons with SCZ, the present results cannot be accounted for by task difficulty; SCZ participants' recall was less disrupted by PLC than was that of healthy participants. Results also demonstrated that SCZ participants could benefit, in terms of recall and strategy use, from list organization when this structure was explicitly provided at test.

Keywords: Schizophrenia; Part-list cuing interference; Memory; Semantic organization; Mnemonic strategy

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1. Introduction

Deficits in declarative memory are particularly robust among persons with schizophrenia (SCZ; Aleman et al., 1999; Bilder et al., 2000; Heinrichs and Zakzanis, 1998; Saykin et al., 1991, 1994; Weiss and Heckers, 2001). However, the specific underlying mechanisms of this impairment remain largely unclear. One notable aspect of deficient memory in SCZ is a reduction in the spontaneous application of organizational strategies to aid recall, including deficits in relational (Titone et al., 2004), subjective (Chan et al., 2000), and semantic (Brebion et al., 2004) organization of to-be-remembered material. Furthermore, persons with SCZ typically require a more objective, salient, and/or explicit representation in order to benefit from any inherent organizational structure in study material (e.g., Gold et al., 1992). Interpretations of many SCZ memory findings are complicated, however, by a confounding of differential deficit with task difficulty (e.g., less organized lists are more difficult to recall). The challenge of equating tasks for difficulty in order to demonstrate a "true" differential deficit is non-trivial and Chapman and Chapman (1973) suggest an alternative solution: use experimental manipulations where deficits actually improve performance or disrupt it less compared to healthy individuals (see also Place and Gilmore, 1980, for a classic example).

In this regard, one promising approach for investigating differential strategic mnemonic processes in SCZ involves interference via part-list cuing (PLC). This effect, originally reported by Slamecka (1968), is evidenced when the provision of a subset of previously studied words as retrieval cues interferes with recall of the remaining non-cued target items. In this vein, it is more appropriate to consider PLC as providing a retrieval context than a recall aid (Roediger et al., 1977; Slamecka, 1968). Basden and colleagues (Basden and Basden, 1995; Basden et al., 1977) have conceptualized PLC interference as a retrieval strategy disruption. From this view, the structure of recall output is a reflection of an organized retrieval plan that may be influenced by information at study and/or test (Basden and Basden, 1995; Slamecka, 1968; Sloman, 1991). In other words, PLC alters the retrieval environment and prompts participants to switch from self-generated strategies aimed at free recall of the whole list to a less efficient plan that is guided by the external, experimenter-supplied cues. That PLC results in a temporary disruption at retrieval is further supported by observations that recall for "forgotten" target items returns if tested again under uncued conditions (Basden and Basden, 1995; Incisa della Rocchetta and Milner, 1993). Although several theoretical accounts of PLC have been proposed (Bäuml and Aslan, 2004; Mueller and Watkins, 1977; Nickerson, 1984; Raaijmakers and Phaf, 1999; Raaijmakers and Shiffrin, 1981; Rundus, 1973; Sloman et al., 1991), the strategy disruption hypothesis remains a particularly prominent, accepted, and tenable account (Basden and Basden, 1995; MacLeod et al., 2003). This hypothesis predicts that PLC will result in less disruption to individuals who are less able to utilize techniques that enhance memory organization. In this regard, diminished interference in SCZ would signify organizational memory deficits unencumbered by difficulty confounds.

Importantly, several factors influence the magnitude and direction of PLC effects, which depend on the compatibility of participants' free (uncued) recall strategies with the organization imposed by retrieval cues and its relation to the remaining targets (Basden and Basden, 1995; Sloman et al., 1991). Of particular relevance is the importance of list structure (Nickerson, 1984). Manipulations of list structure may be used to induce common output strategies between participants. For example, presenting category members consecutively encourages participants to encode those items as exemplars of a common category. Consequently, when using organized lists, cues facilitate recall to the extent that they remind participants of super-ordinate categories. However, increasing the proportion of cues from a given category increasingly impairs recall of remaining members of those categories (Basden and Basden, 1995; Bellezza and Hartwell, 1981; Lewis, 1971; Nickerson, 1984; Penney, 1988; Roediger, 1973, 1974; Roediger et al., 1977; Rundus, 1973). This result presumably arises because the presence of cues encourages participants to switch from their "natural" retrieval order to a strategy by which they use cues to elicit memories for unpresented items.

In contrast to lists blocked by category, scrambled presentation of exemplars from multiple categories

may lead participants to form categories that are more narrow or broad than intended by the experimenter (Lewis, 1971). More varied and idiosyncratic organizational strategies are even more expected with lists of unrelated words, where the likelihood of congruency between random/experimenter-selected cues with participant-generated strategies may reduce to chance (Penney, 1988). Thus, increased semantic organization across these three list types–unrelated, scrambled, and blocked–should facilitate more homogenous mnemonic strategy use across individuals. To the extent that persons with SCZ are similarly influenced by semantic organization, increased list structure should produce more similar PLC profiles.

Although extensively investigated in healthy samples, application of PLC to clinical populations has been rare (Bäuml et al., 2002; Incisa della Rocchetta and Milner, 1993). Attenuated PLC interference in SCZ was indirectly suggested by the multinomial processing model of Riefer et al. (2002) who separately demonstrated that (a) PLC in healthy individuals affected only retrieval parameters and that (b) performance of a SCZ group tested only on free recall implicated reduced storage as well as greater retrieval deficits. However, only one prior study has directly studied PLC in SCZ and concluded that similar PLC profiles to a healthy group "indicates normal retrieval performance in SCZ patients under conditions of part-list cuing" (Kissler and Bäuml, 2005, p. 278). Visual inspection of these data, however, suggests that the study may have been underpowered to detect a subtle differential PLC effect in SCZ. In fact, their power to detect even a large interaction effect (f=.40) was only .57 (alpha=.05; n'=15; Cohen, 1988). Not only are these weak grounds for concluding a null hypothesis, but significance hypothesis testing only allows for a 'failure to reject' it. Alternatively, the scrambled category lists used may not be sensitive to differential interference in SCZ. Clearly these results from this single study underscore the need for increased research of the PLC phenomenon in SCZ.

In sum, this study's purpose was to investigate mnemonic strategy use in SCZ via PLC, for which deficient organizational retrieval processes would lead to less interference, a result not accounted for by a difficulty confound. Given the importance of list structure for both general recall and PLC effects, we assessed performance across three levels of semantic organization: (a) unrelated lists, whose recall relies most on participant-generated strategy; (b) scrambled category lists; and (c) blocked category lists that explicitly define organizational structure. We predicted a Group x Cue x List type interaction such that the SCZ group would demonstrate attenuated PLC interference especially with unrelated lists, but show a similar effect of cuing when provided an organizational strategy in the blocked condition.

2. Methods

2.1. Participants

Thirty persons with either SCZ or Schizoaffective Disorder were recruited via the Schizophrenia Registry for Research at the Centre for Addiction and Mental Health (CAMH, Toronto, Canada), poster advertisement at the CAMH, and referrals from health professionals; 30 healthy control (HC) participants were recruited from the community via local newspaper advertisements or word of mouth. However, data for two participants per group were excluded due to technical problems during the PLC computer program; all results reported are based on the remaining (n=28) sample.

Inclusion criteria included ability to provide informed consent, age between 18 and 60 years, English as the primary language, and (corrected-to-) normal vision. Exclusion criteria consisted of a history of neurological injury/disease (including brain injury with loss of consciousness), lifetime history of any (HC) or any non-psychotic (SCZ) Axis I psychiatric disorder (including alcohol/substance dependence or abuse—SCZ accepted if abuse >6 months prior), first-degree relative with a psychotic disorder (HC), recent (<2 weeks) use of psychotropic drugs (HC) or change in use of antipsychotic medication (SCZ), and prescribed medications with known deleterious cognitive effects (i.e., tricyclic antidepressants, anticholinergics). Three patients prescribed benzodiazepines ("as needed") and who abstained from these for at least 3 days prior testing were accepted, as were six patients prescribed serotonin specific re-uptake inhibitors and one prescribed bupropion for depressive symptoms. Confirmation of SCZ diagnoses and

screening of HC participants were made via the Structured Clinical Interview for DSM-IV-TR Axis I Disorders (First et al., 2002a,b). The Research Ethics Board at the CAMH approved the study and participants were provided compensation of $10.00/h.

Descriptive information for the SCZ group is provided in Table 1. As shown in Table 2, the groups did not differ significantly with regards to sex, age, or education; but, expectedly, the SCZ group had lower levels of competitive employment. Symptom ratings confirmed that the SCZ group was clinically stable with respect to patient norms (Table 1), but reported greater psychopathological symptomatology than HCs (Table 2). All HC participants were within normal limits on all symptom measures (save one scoring in the mildly elevated range on the depression and stress scales).

2.2. Neuropsychological assessment

Assessment of general intelligence failed to reveal group differences (see Table 2). Consistent with relative impairment of declarative memory, however, measures of verbal and visual memory were inferior in SCZ. Nonetheless, both groups' mean performance was in the average range across these measures.

Table 1
Frequencies and medians (ranges) of SCZ patient characteristics

	*n*s or Md (range)
Diagnoses	24 schizophrenia, 4 schizoaffective
Antipsychotic medication[a]	
Atypicals	23 (12[b] olanzapine, 6[b] resperidone, 4 quetiapine, 2 clozapine)
Typicals	3 (loxapine, zuclopenthixol, perphenazine + methotrimeprazine)
CPZe/DDD[c] (mg)	246 (0–833)/300 (0–1170)
Years of illness	9.5 (1–33)
PANSS-General *T*-score	34 (32–52)
PANSS-Negative *T*-score	33 (30–57)
PANSS-Positive *T*-score	42 (31–60)
AIMS	0 (1–10[d])
BARS	0 (1–3)

Abbreviations: AIMS = Abnormal Involuntary Movement Scale (Munetz and Benjamin, 1988); BARS = Barnes (1989) Akathisia Rating Scale; CPZe = Clorpromazine equivalents (Bezchlibnyk-Butler and Jeffries, 2004); DDD = defined daily dose (WHO, 2005); PANSS = Positive and Negative Symptom Scale (Kay et al., 1987).

[a] Two patients had been neuroleptic free for several weeks.

[b] Includes one or both olanzapine and resperidone.

[c] CPZe-values were unavailable for zuclopenthixol, perphenazine, and methotrimeprazine; DDD was unavailable for methotrimeprazine; data include nil values from the two neuroleptic-free patients.

[d] One individual taking double the conventional dose of antipsychotics scored 10 on the AIMS; the next highest value was 3.

2.3. Experimental word lists

Three list types were constructed: (a) unrelated; (b) scrambled (semantically related words in random order, without replacement); and (c) blocked (clustered by category). The organized lists (b, c) were derived from 24 of the taxonomic lists in Battig and Montague (1969; median category potency, Md = 6.86). Eight words per category were selected, omitting the two highest frequency exemplars to reduce guessing biases. For each SCZ–HC pair, four lists (designated Blocked sets A and B and Scrambled sets A and B), comprised of eight words selected randomly from six categories (i.e., 48 words per list), were created. Unrelated sets A and B (48 words each) were obtained from the MRC Psycholinguistics Database (Wilson, 1988) to match the psycholinguistic characteristics of the categorized lists (3–10 letters; concreteness 426–645; imagability 461–640; written frequency < 203). The final 96 nouns randomly selected from this pool further met requirements that they could not be easily grouped into semantic categories and did not belong to any categories used in the organized lists. Each of the six sets was presented twice in a row during the learning phase to aid encoding, but such that no two words followed each other in both presentations, in order to negate the use of serial order as a mnemonic strategy. Scrambled lists also required that words from the same category did not immediately follow each other. Additionally, blocked lists were formed such that adjacent pairs of categories differed between study presentations. All random-order procedures were conducted on an individual SCZ–HC pair-wise basis (i.e., 30 series of list sets were created).

Sets A and B for each list type were counterbalanced within groups to either the free (FR) or cued recall (QR) condition. Free recall sheets consisted of six columns of blank lines for participants' responses. Sheets for the blocked and scrambled conditions provided category labels as column headings (in lower-case) in a pseudo-randomized order to limit the experimental manipulation to word (as opposed to

Table 2
Demographic and clinical characteristics of the HC and SCZ groups

	HC	SCZ	t or χ^2	p
Demographic characteristics:				
Sex (n males/females)	15/13	16/12	0.07	.788
Age[a]	34.75 ± 13.61	38.54 ± 10.54	1.16	.250
Education[a]	15.04 ± 2.29	14.36 ± 2.48	−1.06	.292
Employment status (u/s/e/r)[c]	5/10/13/0	15/2/9/2	13.06	.005
Clinical and symptom rating scales:				
Global assessment of functioning[b,d]	90 (65–92)	51 (28–72)	−13.26	<.001
DASS-21 depression[b]	2 (0–10)	4 (0–30)	2.93	.005
DASS-21 anxiety[b]	0 (0–6)	4 (0–32)	3.67	.001
DASS-21 stress[b]	2 (0–16)	7 (0–18)	2.19	.033
Personality Assessment Screener[a,e]	11.22 ± 5.56	17.38 ± 7.53	3.38	.001
PAI-alcohol problems[b]	45 (41–57)	44 (41–61)	0.54	.591
PAI-drug problems[b]	44 (42–62)	42 (36–74)	1.08	.287
PAI-negative impression management[b]	44 (44–66)	55 (44–88)	3.92	<.001
PAI-positive impression management[a]	57.75 ± 6.99	54.00 ± 10.17	−1.61	.113
Neuropsychological tests:				
WAIS-III FSIQe[a]	115.50 ± 14.77	110.36 ± 10.09	−1.52	.134
WRAT-3 Reading[a]	107.89 ± 8.57	105.04 ± 9.53	−1.18	.243
WMS-III				
Logical memory—immediate[a]	12.68 ± 3.18	9.89 ± 2.92	−3.42	.001
Logical memory—delayed[a]	12.82 ± 2.89	10.39 ± 3.58	−2.79	.007
Visual reproduction—immediate[a]	11.32 ± 3.41	9.43 ± 3.56	−2.03	.047
Visual reproduction—delayed[a]	12.11 ± 3.66	10.39 ± 2.89	−1.95	.057
Spatial span[a]	10.93 ± 3.60	9.64 ± 2.91	−1.47	.147

[a,b] Use of (a) means ± standard deviations ($M \pm$ S.D.) or (b) medians (range) reflect normal or non-normal distributions of data, respectively, in either group; t-test results are reported for both as these paralleled non-parametric results.
[c] Employment status: unemployed/student/employed/retired; significant χ^2 reflects more ($z > 2$) unemployed SCZ and student HC participants.
[d] First et al. (2002a,b).
[e] Morey (1991); data excludes four SCZ participants with incomplete ratings.
Abbreviations: DASS-21 = 21-item version of the Depression, Anxiety and Stress Scale (Antony et al., 1998; Lovibond and Lovibond, 1995); PAI = Personality Assessment Inventory (Morey, 1990); WAIS-III FSIQe = estimated full-scale intelligence quotient derived from the Matrix Reasoning and Information subtests of the Wechsler Adult Intelligence Scale—Third Edition (Sattler and Ryan, 1998; Wechsler, 1997a); WMS-III = Wechsler Memory Scale—Third Edition (Wechsler, 1997b); WRAT-3 = Wide Range Achievement Test—Third Edition (Wilkinson, 1993).

category) recall (Roediger, 1978; Tulving and Pearlstone, 1966); the order for blocked lists did not match that at study. Cued recall sheets included 30 studied words (cues) in capital letters and 18 blanks to be filled in with the respective target words. Cues and blanks were presented pseudo-randomly such that adjacent words differed from their presentation at study and no more than three cues or two blanks were presented consecutively; for organized lists, five exemplars per category were cues and three were deemed targets. Three random assortments defining targets and cues were created for each of the unrelated sets and the category lists and these configurations were assigned haphazardly among participants.

2.4. PLC procedure

Unrelated lists were presented first, followed by the blocked and scrambled lists in a counterbalanced order. Within each list condition, FR preceded QR. At encoding, participants made pleasantness judgements ("Like", "Dislike") to single words presented on a computer monitor for 2 s each (ISI = 1 s). Study words were presented in uppercase type and lowercase labels preceded each category in the blocked condition. Participants were also instructed to remember the words. After each list was shown twice, a 90-s buffer consisting of recall instructions plus a symbol cancellation task was inserted to avoid any differential effect of short-term memory loss (Rundus, 1973;

Slamecka, 1969). Recall of each list was then limited to 7 min. For blocked and scrambled conditions this was divided into 1-min per category (remaining categories covered), plus a seventh for any additional recall. On QR trials, participants were instructed to read the cues and consider them as aids.

2.5. Data and analyses

The primary measure of interest was the number of correctly recalled target words, equating FR and QR measures to a score out of 18. Two additional measures provided validity checks: (a) percent correct of available words to recall (FR/48, QR/18), where comparable results indicate appropriate randomization in target selection (Slamecka, 1968); and (b) QR − FR difference as a percent of total correct (QR+FR), given the potential for general ability to influence differences between specific tasks (Chapman and Chapman, 1988, 1989, 2001), including PLC conditions (Bäuml et al., 2002; Kissler and Bäuml, 2005). These analyses yielded parallel results to those with raw targets and thus, we present only the latter more conventional data. For clarity, the remaining word types are termed "cues" (QR) or "non-targets" (FR) depending solely on the cuing condition under which they were administered.

Target recall revealed no significant outliers or violations regarding normality, homogeneity of variance, or sphericity. Deviation from normality was present among clinical ratings (Tables 1 and 2), but parametric results reported did not differ from transformed or nonparametric analyses.

Results were evaluated at an alpha-level of .05 with accompanying effect-sizes.

3. Results

3.1. Target recall

An omnibus three-way mixed-factor ANOVA revealed main effects of all factors on target recall, Group (SCZ<HC), $F(1, 54)=6.77$, $p=.012$, $f=0.35$, List (Unrelated<Scrambled<Blocked), $F(2, 108)=254.60$, $p<.001$, $f=2.17$, and Cue (QR<FR), $F(1, 54)=33.44$, $p<.001$, $f=0.79$. Importantly however, these effects were qualified by their three-way interaction, $F(2, 108)=4.69$, $p=.011$, $f=0.29$ (see Fig. 1). Follow-up ANOVAs of Group x Cue for each List type revealed a two-way interaction only with Unrelated lists, $F(1, 54)=10.77$, $p=.002$, $f=0.45$. This finding reflected that the SCZ group was impaired in FR, $t(54)=-2.88$, $p=.006$, $d=-0.77$, but that a greater interference effect among HCs resulted in equivalent Unrelated-QR performances, $t(54)=-0.07$, $p=.944$, $d=-0.02$. Similar analyses of Scrambled and Blocked Lists revealed only main

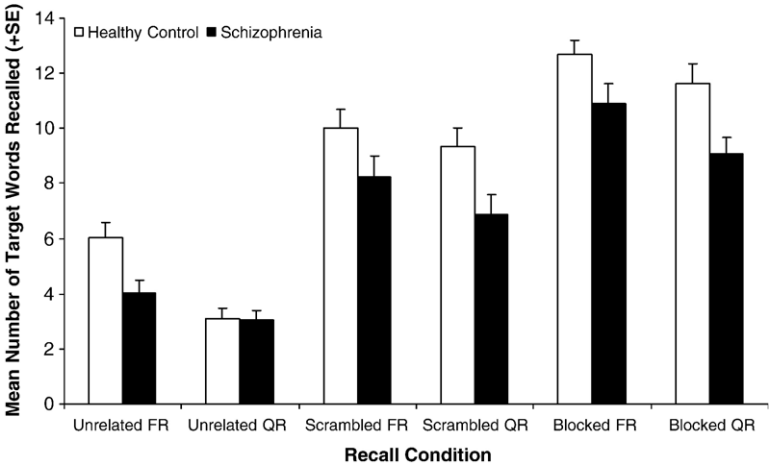

Fig. 1. Mean recall of target words (+S.E.) in HC and SCZ groups during free recall (FR) and cued recall (QR) conditions at each of the three levels of semantic organization. Note the attenuated interference of part-list cues in SCZ for the most difficult unrelated-list condition.

effects of Cue and Group; that is, although overall recall was reduced in SCZ, similar PLC interference was observed in the context of organized lists.

In addition to within-list effects, it was of interest to examine the effects of list organization. Main effects of Group and List were maintained in separate two-way ANOVAs on FR and QR (see Fig. 1). List organization aided FR of both groups similarly, $F(2, 108)=0.07$, $p=.934$, $f=0.03$. In contrast, a Group x List interaction, $F(2, 108)=6.01$, $p=.003$, $f=0.33$, reflected a SCZ deficit in QR only with organized lists.

3.2. Errors in recall

There was no overall difference in error production between the SCZ (Md=6.00, range: 0–23) and HC groups (Md=6.50, range: 0–39), $t(54)=0.34$, $p=.733$, $d=0.09$. Moreover, the groups did not differ significantly in their rates of any specific error types and thus, these are primarily of task-related interest. Most common were semantic intrusions in organized-list recall (170 by 86% of HC, 124 by 75% of SCZ), which proved sensitive to PLC interference (FR>QR), $F(1, 54)=4.30$, $p=.043$, $f=0.28$. Intrusions of irrelevant/unrelated words were also common (48 and 62 by 61% of both HC and SCZ, respectively), the majority (88%) occurring with Unrelated lists. Thus, a majority of participants produced intrusions in recall that may reflect guesses (Roediger, 1973) and/or false memories (Smith et al., 2002). Perseverations of cue words were also somewhat frequent (13 by 32% of HC, 23 by 43% of SCZ), indicating that participants wrote down cue words that were printed in front of them. Other types of errors were rare.

3.3. Individual differences and correlational analyses

Last, it was of interest to assess individual differences in PLC effects and their correlations with other sample characteristics. The FR–QR interference effect was of most interest in this regard. Because of problems with raw difference scores, we instead used standardized residualized scores as suggested by Chapman and Chapman (1989). That is, QR performance of HC participants was first regressed on their FR scores, then these results were used to compute standardized residuals (z_{QR}) for both groups that represented the degree to which each participant's QR performance deviated from that predicted from his/her FR score. The mean z_{QR} for the HC group is thus zero and the z-scores for SCZ participants indicate their deviation from the HC expected values.

Regression of HC QR on FR scores confirmed significant, positive, and medium to large associations, Unrelated $R^2=.27$, $p=.005$, $f^2=0.37$, Scrambled $R^2=.67$, $p<.001$, $f^2=2.03$, Blocked $R^2=.17$, $p=.028$, $f^2=0.20$. A two-way ANOVA of z_{QR}-scores revealed identical effects of List and Group x List interaction, both Fs$(2, 108)=3.91$, ps$=.023$. This interaction supported the previous raw target analyses and indicated better QR performance in SCZ than expected from the HC regression line in the Unrelated condition, $t(27)=2.52$, $p=.018$, $d=0.48$. Inter-correlations further supported a division between Unrelated and organized PLC interference: there was no relation between Unrelated and Scrambled, HC, $r(28)<.01$, $p=.996$, SCZ, $r(28)=-.25$, $p=.209$, or Blocked z_{QR}'s, HC, $r(28)=.01$, $p=.957$, SCZ, $r(28)=.16$, $p=.408$. In contrast, correlations between the organized lists were significant, positive, and large, HC, $r(28)=.51$, $p=.005$, SCZ, $r(28)=.50$, $p=.006$.

Correlations among the PLC z_{QR} scores with demographic, diagnostic, symptom, medication, and cognitive measures only revealed notable relations between increased ratings of depression, anxiety, and stress (Antony et al., 1998; Lovibond and Lovibond, 1995) with greater PLC interference (lower z_{QR}'s) among HC participants on the organized lists (r's$<-.40$). It is not immediately clear how to interpret these relations or why they were only found in the HC group; replication of these observations may prove interesting for future study.

4. Discussion

Strategic and mnemonic abilities in SCZ were investigated using PLC at three levels of semantic organization. Cuing at retrieval and increasing within-list semantic structure were successful in interfering and facilitating recall output, respectively. An overall deficit in SCZ across PLC and neuropsychological measures of memory was also expected. Most importantly, the three-way interaction reflected a differential PLC effect in the unrelated-list condition

only. In the context of maximal requirements for effortful, self-initiated, strategic organization, the SCZ group demonstrated impaired FR but equivalent performance to the HC group in the more difficult QR condition. That is, the SCZ group was *less* disrupted by PLC interference, consistent with hypothesized deficits in the aforementioned abilities. In contrast, the SCZ group showed a similar ability to that of HC participants to benefit from the semantic organization provided by scrambled and blocked lists, and furthermore, showed a similar PLC effect under these conditions. In contrast to the parallel improvement in FR, Gold et al. (1992) reported no change from unrelated to scrambled recall in SCZ. A key difference was our provision of labels and forced category recall, both known to facilitate FR (Basden et al., 1997; Incisa della Rocchetta and Milner, 1993; Roediger, 1978; Tulving and Pearlstone, 1966). Together these studies show that SCZ participants can benefit from organization, but only when this structure is explicitly provided at test, and support a utilization deficit in SCZ, where the cognitive resources required to organize/maintain mnemonic strategies limit their advantage (Bryan and Christensen, 2003).

This study is unique in concurrently assessing PLC across unrelated and categorized lists within one experiment, let alone within participants. Interference was most pronounced among HCs in recall of unrelated compared to organized lists, consistent with earlier suggestions of this effect (Lewis, 1971; Sloman, 1991). The ability to form relational associations (Basden and Basden, 1995) or integrate items in memory (Bäuml and Kuhbandner, 2003) seems to provide some 'escape' from interference. The similar effects across scrambled and blocked conditions suggest that both groups employed similar categorical representations to each other and to those intended. The observed semantic intrusions, and their susceptibility to interference, further demonstrate participants' use of category-related strategies (Basden et al., 1997; Marsh et al., 2004) and can be attributed to false memories elicited by semantic processes at retrieval (Smith et al., 2002). In contrast, greater disruption to unrelated recall in HCs is consistent with their use of more idiosyncratic strategies (e.g., imagery, forming sentences; Penney, 1988). The differentially reduced FR and PLC effect with unrelated lists support the hypothesis that persons with SCZ are particularly less apt to self-generate and employ effortful organized retrieval strategies. That is, the SCZ results indicate use of an initially less efficient and less organized strategy during FR, which only reduces to an equally inefficient strategy as the HC group during QR (see Fig. 1). In sum, the current results are consistent with previous findings and strategy disruption accounts of PLC (Basden and Basden, 1995). Moreover, we suggest that increased organization according to pre-existing semantic representations allows for increased flexibility and automaticity at the item (word) level, yet within a more consistent hierarchical (categorical) framework both work to 'protect' from interference.

As reviewed, study of PLC with special populations and the underlying neural mechanisms is limited. In contrast to enhanced interference in mixed-amnesia (Bäuml et al., 2002) and left-frontal lesion groups (Incisa della Rocchetta and Milner, 1993), a left-temporal/hippocampal group showed decreased FR but not QR (Incisa della Rocchetta and Milner, 1993) with organized lists. Our SCZ results are most consistent with the latter, but particularly those from our unrelated condition. Despite prefrontal and temporal contributions to mnemonic deficits in SCZ (Cirillo and Seidman, 2003; Weiss and Heckers, 2001), we replicated Kissler and Bäuml's (2005) failure to observe differential interference with organized lists. The opposing effects of PLC suggested above may account for this lack of overt difference given combined frontal–temporal dysfunction in SCZ. An alternative functional–anatomic distinction is that between archicortical (e.g., dorsal–lateral prefrontal, hippocampus) and paleocortical (e.g., orbital–frontal, amygdala) systems (Christensen and Bilder, 2000), where preferential archicortical dysfunction is supported in SCZ (King et al., 2003, 2005). Functionally, the archicortical trend is associated with controlled, effortful, volitional, goal-directed behaviour as required for maximizing FR scores and susceptibility to PLC interference in the unrelated condition. Conversely, the paleocortical trend functions in a more automatic fashion towards which the highly structured, organized list conditions likely catered. This duality is consistent with dependence of PLC interference on recollective processes (Basden et al., 1991), lack of interference on more automatic tasks

(Huffman et al., 2001), and higher reliance on familiarity-based gist retrieval versus conscious recollection in SCZ (Huron and Danion, 2002; McAnanama et al., 2004).

The impetus for the current investigation was to examine strategic retrieval deficits unencumbered by a difficulty confound. As predicted, this result was obtained specifically with unrelated lists, where interference in HCs was greatest and SCZ least (Fig. 1). Comparing across lists also indicated a consistent deficit in SCZ–FR, at the varying levels of difficulty and retrieval contexts, likely reflecting a more general deficit in declarative memory. One must also be cognizant of the related psychometric issue of discrimination power (Chapman and Chapman, 1973, 1978; Melinder et al., 2005; Miller et al., 1995). However, post-hoc comparison of the variances across conditions indicated that unless reliabilities differ by at least twofold, which seems unlikely, a generalized deficit sensitive to task discriminating power cannot account for the current results (data not shown).

Beyond episodic memory, providing a subset of to-be-generated items leads to similar interference effects across several domains (Basden and Basden, 1995; Bäuml and Aslan, 2004; Brown, 1981, 1968; Goernert, 1992; Nickerson, 1984; Parker and Warren, 1974; Peynircioğlu, 1987; Roediger, 1978; Sloman, 1991). Indeed, a more global point is that manipulations that alter strategy (organization, cuing) affect performance. However, even when successful, efforts to remediate memory performance in SCZ often do not generalize to patients' self-initiated utilization of learned strategies to other memory tasks (e.g., Medalia et al., 2000). Thus, further understanding the types of cues and structure that facilitate or impair retrieval and how sensitive SCZ persons are to these manipulations will be important. The current results support that memory performance in persons with SCZ will benefit most from structured information that minimizes requirements for volitional and effortful strategic organization.

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