INFORMATION PROCESSING DEFICITS IN PSYCHIATRIC POPULATIONS: IMPLICATIONS FOR NORMAL WORKLOAD ASSESSMENT*

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Schizophrenic and manic patients have been described as impaired information processors since the earliest definitions of these diagnostic categories (e.g., Kraepelin, 1;2). It has taken until recent years, however, before these descriptions were developed to the point where the specific characteristics of their dysfunctions have begun to be operationalized effectively. Recent reports focusing on auditory information processing have identified several specific aspects of information processing in manics and schizophrenics that differentiate them from normals and provide ideas about group-specific aspects of performance. The characteristics of these deficits suggest in large part that psychotic information processors perform in certain ways that could be seen to be qualitatively similar to normals, but operating at lower levels of performance and being more responsive to overloading conditions.

For example, Oltmanns (3) found that both manics and schizophrenics were more distractible than normals in processing both digits and words in the presence of similar distracting information. In a closer examination of the word-span task, he found that the distraction deficits of the schizophrenics were specific to the primacy portion of the serial position curve of the presented information. He also found that schizophrenics did not shift effort to process irrelevant information, but were apparently impaired in the processing of relevant information in the presence of irrelevant information. His interpretation was that distraction impaired schizophrenics' ability to process information when higher-level cognitive processes were required, but that their processing deficits were not qualitatively different from an overloaded normal processor.

In a similar study, Pogue-Geile and Oltmanns (4) used a dichotic shadowing task to examine distraction effects in schizophrenics, manics, depressives, and normals. They found that none of the subject samples was affected by being required to shadow information in the presence of an irrelevant text passage. Interestingly, the schizophrenic subjects manifested a deficit in their ability to answer content-based questions about the shadowed information presented in the presence of distraction. These results also suggest that distraction in

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schizophrenic populations interferes with higher level processes, particularly those relevant to the encoding of information for later recall.

The same general conclusions have held up across a number of studies (many of which were reviewed by Koh, 5; Neale & Oltmanns, 6; & Callaway and Naghdi, 7) of the information processing competence of schizophrenic subjects. In many different studies schizophrenics manifest deficits in tasks measuring what Schneider and Schiffrin (8) would call controlled, but not automatic, information processing. As controlled processes are defined as those that are capacity-limited and load sensitive in normals, the conclusion would appear to be that schizophrenic subjects under load simply perform like normals under a higher level of load.

The two present studies were designed to examine overload processes in schizophrenics with an eye toward several critical questions not addressed by other studies. In most earlier information processing studies, load was not manipulated directly and its effect measured. In our study number 1 we manipulated information processing load in digit serial recall and examined the overall and serial position effects. We wanted to examine the extent to which varied aspects of information processing were load responsive and exactly how much more impaired the schizophrenics were than normals at similar load levels.

The second study examined dichotic shadowing and recall of textual material that varied in terms of its organization. We examined varied aspects of both the shadowing and recall of the material, including level of organization shadowed, number of concepts shadowed, as well as more standard indices of shadowing such as percentage correctly shadowed and errors of commission. We used the same measures for shadowing and recall in order to see directly if deficits in specific aspects of shadowing (e.g., level of organization) led to recall deficits at the same level of processing. Finally, we were interested in the specific effect of distraction in order to localize its effect in terms of which aspect of performance was maximally affected.

Study 1

Subjects

Subjects in this study were 20 schizophrenics, 13 manics (bipolars), and 10 normals. All patient subjects were acute admissions to a state psychiatric center and had been assessed with a structured rating instrument (SADS; Spitzer et al., 9) and diagnosed with DSM-III (10). All normals had been screened for a personal or familial history of psychiatric care or hospitalization. All patients were examined within 10 days of their admission to treatment and the normals were matched to them on age, sex, and other demographic characteristics.

Task and Procedure

The recall task involved the presentation at a 2-second rate of digit stimuli in trial lengths of 4,6,8, or 10 digits. Four trials per length were used and the information was presented in a tape-recorded format in a fixed, random order. Subjects were given ordered recall instructions and were asked for an immediate recall of the information at the end of the trial. Subjects were not informed before the onset of the trial as to how many digits were to be presented. The undergraduate research assistant who tested the subjects stopped the tape between trials and recorded the subjects' reponses verbatim.

Results

We scored the subjects' recall protocols using free recall methods in order to avoid as much as possible modifications of the serial position curve noted by Drewnowski and Murdoch (11). We performed analyses of both total score performance and of serial position performance. The data for the total scores are presented in Table 1 and the serial position curves are presented in Figure 1.

For the total score analyses we performed a 3(Diagnosis) x 4(Trial Length) repeated-measures ANOVA, with the final factor repeated. We found a significant 2-way interaction of Diagnosis x Trial length, F (6,120)=2.92, p <.05. In order to examine this interaction, simple-effects tests were used, finding significant diagnostic effects at lengths 8 and 10 only. In both cases, Newman-Keuls Tests indicated that normals performed better than manics, who performed better than schizophrenics.

For the serial position analyses we performed Diagnosis x Position ANOVAs within each trial length. No significant effects were detected at length 4, so that length is not further discussed. At length 6, a significant effect of diagnosis was detected, F (2,37)=4.56, p <.05, with Newman-Keuls tests finding that normals performed better than manics who in turn performed better than schizophrenics. At lengths 8 and 10 significant 2-way interactions of Diagnosis x Position were detected. In order to interpret these interactions, we used Newman-Keuls tests, comparing the three diagnostic groups across the varied positions, with the results of these analyses presented in Table 2.

The schizophrenic subjects were always the most deviant on the primacy portion of the serial position curve and were never more deviant than the manics on the recency.

Discussion

On this task it appears as if schizophrenics' total performance is much like that of a normal processor under a higher load level. For example the total performance of the

schizophrenics at length 4 is similar to that of the normals at length 8 and the normals' performance at length 10 is similar to the schizophrenics' at length 6. The manics' performance was intermediary to that of the schizophrenics and normals. In the serial position analyses, particularly at lengths 8 and 10, the schizophrenics were particularly more deviant on the primacy than the other subjects, with recency performance apparently reflecting a generalized psychotic deficit. The serial position performance of the patients was particularly distorted at length 10, with both manics and schizophrenics manifesting serial position performance that was particularly poor in the recency, probably reflecting either retrieval interference effects or generalized inability to handle both item and order information in such high loads.

A general conclusion is that schizophrenics appear to function like more highly loaded normals, with primacy performance being particularly poor. Schizophrenics appear to be almost completely overloaded at length 10, with free recall scoring producing only a 42% level of performance with no recall delay or interspersed information. Relative changes in primacy performance were considerably greater for the schizophrenics than for the normals, suggesting a particular vulnerability of resource limited functions in this population.

Study 2

Subjects

Subjects in the second study were 20 schizophrenics, 16 manics, and 16 normals. The subjects were selected and diagnosed as described above and the samples of subjects in the two studies were completely independent.

Experimental Task and Procedure

Subjects were asked to shadow and recall verbatim 8 descriptive text passages. Four passages were random collections of stories about a commonplace topic (e.g., summer) and four passages were completely organized stories. The level of organization was determined to be the maximum possible according to the Waters and Lomenick (12) descriptive passage rating scale. Four stories (2 per organization level) were presented by themselves and four were presented concurrently to the presentation of distraction story read in a female voice in the unattended ear. The ear of presentation was varied across the stories in order that each subject received one target story per organization level per distraction condition per ear. Subjects were instructed to shadow the story exactly as presented and to be prepared to recall it verbatim immediately after shadowing.

Subjects' shadowing and recall were tape-recorded and were transcribed for examination. The shadowing dependent variables that were scored by raters who were blind to all aspects of the

procedure were the percentages correctly shadowed, the number of concepts (subjects of clauses) shadowed, level of organization shadowed, accurate paraphrase errors, and semantically relevant errors. Recall DV's were the number of words used in recall, the level of organization present in recall, and the number of concepts recalled.

Results

The data regarding shadowing performance are presented in Table 3 and the data regarding recall are presented in Table 4. As we are primarily interested in distraction effects and their implications for overload, the data regarding shadowing errors are not presented since no distraction effects were found to be present in the error variables for any subjects. Analyses that yielded effects other than distraction or interactions involving distraction will not be discussed either.

A significant Diagnosis x Distraction interaction was discovered for the percentage of words correctly shadowed, $F(2,49)=4.25$, $p<.05$. Simple effects tests found that schizophrenics and no other subjects were signficantly affected by the addition of distraction. For the number of concepts correctly shadowed, another Diagnosis x Distraction interaction was detected, $F(2,49)=4.29$, $p<.05$. The same pattern of group differences was found with simple effects tests: schizophrenics were the only distractible group. For the level of organization shadowed, a triple interaction of Diagnosis x Distraction x Organization was detected. Simple effects tests revealed that for both normals and manics a significant effect of organization was present and that there were no distraction effects. For schizophrenics, a different pattern of results emerged. Schizophrenics were not affected by distraction in the random passages, probably because of floor effects, but there was a sigificant reduction in the amount of organization present in organized passages in distraction relative to nondistraction.

For the recall variables, the only variable that produced an interaction involving distraction and diagnosis was the level of organization at recall. That variable generated a significant triple interaction of Diagnosis x Distraction x Ear, $F(2,49)=3.20$, $p < .05$. Simple effects tests were used to interpret the interaction. Schizophrenic subjects had the most interesting results, where it was discovered that they manifested a right ear advantage for recall of structural information of organized passages under distraction and a left ear advantage for recall of structure of organized passages under nondistraction conditions.

Interestingly, in none of the groups was any of the shadowing and recall variables correlated, suggesting that they are measuring largely unrelated aspects of recall performance. Furthermore, within all subject groups, all the shadowing variables and all of the recall variables are correlated with each other.

Discussion

In this study we have found that distraction has a relatively specific effect of cognitive processing in schizophrenia. It appears as if distraction disrupts the ability to effectively shadow information to a greater extent than it disrupts the ability to encode information for recall. It is possible, of course, since distraction did not completely disrupt shadowing for schizophrenics, that the distraction manipulation was simply not powerful enough to interfere with encoding performance. It may be that the act of shadowing serves to focus attention to the extent that encoding can be accomplished despite any interference provided by the presence of distracting information. In addition, manic subjects performed essentially the same as normals, not being affected by distraction to any significant extent and manifesting relatively normal recall of the information presented.

Our results clearly suggest that overload effects in schizophrenics need to be carefully examined and that assumptions about the relative similarity between tasks may need to be tested. Obviously the processes of encoding for recall have some commonalities with the processes that are operating during the shadowing process. It seems, however, as if the moment-to-moment monitoring processes involved in shadowing are either more disruptive than the processes involved in encoding or that they are responsive to lower levels of interfering information.

General Discussion

If one allows the assumption that our first study has demonstrated that schizophrenics perform similarly to more highly loaded normals, then the results of the two tasks have expanded our knowledge of what might happen to normal operators during overload in shadowing. It might be the case that shadowing problems due to overload would not be reflective of the actual extent to which an operator has processed a message. Even if the basic organizational structure of the passage is appreciably disrupted, as happened to our schizophrenic subjects in the shadowing study, the extent to which the message is recalled is not impaired. This finding holds up with multiple indices of recall, including verbatim, gist, and structure aspects. One should expect, then, that normal operators who are called upon to monitor a message and then to recall or use the information from it may perform substantially better at the recall task than the shadowing task, even under high load demands. This finding would be expected even if the operator was instructed that the two tasks had equal performance priority. It might be hypothesizd that if the recall task was given higher priority than the monitoring/shadowing task that this performance discrepancy under load would be even more greatly enhanced. Whether the reverse would be true and if shadowing could be more highly prioritized than encoding is an empirical question.

It is possible that the reason that disrupted shadowing performance failed to predict recall failures is that the two processes operate completely independently of each other. A more plausible notion is that the two operate from a common resource pool with differential demands on central processing capacity. Recall that subjects were instructed to both shadow and encode for recall simultaneously and that only one of these two simultaneous processes was disrupted in the schizophrenic patients. It is possible that shadowing is more resource demanding than encoding and as a result this task was more affected by the effort involved in ignoring the irrevelant distractor story. It could also be that prioritization processes themselves are affected by distraction in schizophrenics, so that they could not effectively split their effort and perform two simultaneous processes without problems. It turned out that all subjects were better at shadowing random than organized passages and that all subjects were better at recalling organized passages. Conceivably the optimal level of textual coherence differs depending on whether text is to be recalled or only shadowed. Possibly shadowing is most effectively done on a sentence by sentence basis, with higher level organization information leading only to interference with the process. In contrast, the presence of higher level organizational features has already been demonstrated to enhance the process of recalling textual information. Viewing shadowing and recall tasks as a dual-task method may be the most productive way to further clarify the state of knowledge in this area.

Across these two studies, however, we have seen that schizophrenic information processors do not differ qualitatively from normals. We have also seen that it may be possible to draw inferences about high-level overload in normals by comparison of their performance with those of a population of subjects whose information-processing capabilities are qualitatively similar to normals but impaired in certain capacity-related ways. The use of other information-processing impaired populations may be an effective modality to generate hypotheses about abnormal or special mental states in normal subjects.

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Table 1

Total Performance in the

Digit Span Task

Trial Length	Group					
	Schizophrenic		Manic		Normal	
	M	SD	M	SD	M	SD
4	.83	.27	.92	.17	1.00	.00
6	.65	.23	.82	.12	.93	.05
8	.49	.19	.67	.20	.85	.05
10	.42	.17	.52	.19	.78	.09

Table 2

Between Group Differences in

Serial Position Performance[a]

Serial Position	Length 8	Length 10
1	n=m>s	n>m>s
2	n=m>s	n>m>s
3	n>m>s	n>m=s
4	n>m>s	n>m>s
5	n>m>s	n>m=s
6	n>m=s	n>m=s
7	n>m=s	n>m=s
8	n=m=s	n>m=s
9	---	n>m=s
10	---	n>m=s

[a] n = normal
m = manic
s = schizophrenic

Table 3

Shadowing Performance and Error Measures

	Ear	Schizophrenics								Manics								Normals							
		Organized				Random				Organized				Random				Organized				Random			
		ND		D		ND		D		ND		D		ND		D		ND		D		ND		D	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Percent Correct	R	86.6	10.95	75.05	27.95	89.4	20.65	79.3	24.8	85.88	19,88	80.31	21.1	86.06	18.04	80.5	18.74	86.5	24.67	84.50	25.57	89.00	23.8	87.5	24.6
	L	87.6	20.18	73.25	24.27	84.55	24.98	79.35	22.57	81.19	19.74	76.44	22.7	81.44	22.92	76.38	23.71	86.13	29.07	83.94	26.24	87.75	26.41	84.56	27.63
Number of Concepts	R	8.90	2.25	8.20	2.65	9.15	2.23	8.50	2.63	8.75	1.95	9.13	1.45	9.00	1.26	8.63	1.71	9.00	2.28	8.81	2.23	9.00	2.22	8.94	2.38
	L	8.90	2.22	8.35	2.32	8.80	2.44	8.15	2.37	8.44	1.90	8.56	1.93	8.44	2.28	8.38	1.89	8.94	2.59	8.63	3.03	8.94	2.62	8.81	2.54
Level of Organization	R	6.35	1.57	5.20	2.21	1.00	0	1.00	0	6.19	1.64	6.06	1.84	1.00	0	1.00	0	6.25	1.88	6.13	2.03	1.00	0	1.00	0
	L	6.45	1.47	5.45	1.93	1.00	0	1.00	0	6.06	1.24	5.44	2.10	1.00	0	1.00	0	6.19	2.04	6.19	2.04	1.00	0	1.00	0

Table 4

Recall Performance Measures

	Ear	Schizophrenics								Manics								Normals							
		Organized				Random				Organized				Random				Organized				Random			
		ND		D		ND		D		ND		D		ND		D		ND		D		ND		D	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Number of Concepts	R	3.80	2.40	4.35	1.87	2.70	1.59	2.65	2.03	4.00	2.53	4.56	2.68	3.31	2.27	3.31	1.92	6.00	1.97	7.00	1.71	5.06	1.24	4.13	1.67
	L	3.80	2.48	4.40	2.33	2.90	1.62	2.45	1.64	4.44	1.82	4.63	2.87	3.00	1.71	2.50	1.10	5.75	2.14	6.69	1.45	5.00	1.83	4.63	1.82
Words Used	R	45.05	22.23	50.50	23.33	41.75	18.96	46.10	27.59	73.19	37.83	73.63	48.74	69.31	38.70	69.25	41.41	63.94	16.85	66.13	19.53	56.13	17.93	57.88	17.78
	L	45.95	23.74	48.85	28.59	40.10	22.96	41.55	22.45	76.19	53.83	73.50	41.56	75.13	56.58	75.31	68.24	60.75	23.46	68.44	16.44	59.56	19.51	58.00	22.89
Level of Organization	R	2.55	1.32	3.05	1.90	1.20	.62	1.40	.99	3.19	1.64	3.00	1.63	1.50	.89	1.13	.34	4.13	2.36	4.44	1.79	1.00	0	1.19	.54
	L	3.30	2.18	2.60	1.47	1.20	.62	1.10	.31	2.63	1.67	2.75	1.84	1.56	1.55	1.56	1.21	3.56	2.03	5.00	2.03	1.00	0	1.50	1.32

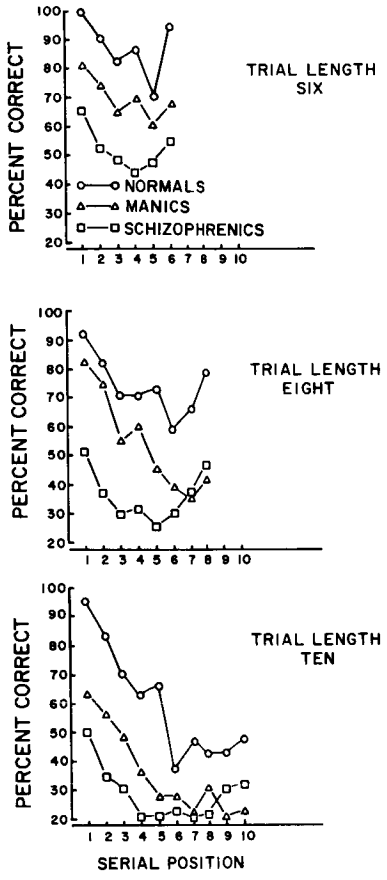

Figure 1. Serial Recall Performance Across the Varied Trial Lengths