71-26,546

DEPUE, Richard Allen, 1945-
GROUPING IN CHRONIC SCHIZOPHRENICS.

The University of Oklahoma, Ph.D., 1971
Psychology, clinical

University Microfilms, A XEROX Company, Ann Arbor, Michigan

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

GROUPING IN CHRONIC SCHIZOPHRENICS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

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Norman, Oklahoma

1971

GROUPING IN CHRONIC SCHIZOPHRENICS

APPROVED BY

DISSERTATION COMMITTEE

ACKNOWLEDGMENTS

The author is greatly indebted to Dr. Don C. Fowles, Committee Chairman, for his valuable suggestions and criticisms in the preparation of this dissertation. Appreciation is also expressed to the other committee members, Drs. Robert F. Weiss, N. Jack Kanak, and Lawrence E. Toothaker.

In addition, the author is grateful to Drs. Mark L. Isaacs and Elaine Jarmen, and Lois Allen, all of Spring Grove State Hospital, Catonsville, Maryland, for their aid in obtaining and selecting patients. Similar thanks is extended to Dr. Jerry Whitmarsh, Director of Research, Shephard-Pratt Hospital, Towson, Maryland.

Finally, appreciation is expressed to all the patients who made the studies herein possible through their cooperation.

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INTRODUCTION

The finding that heightened arousal is correlated with reduced range of cue utilization or narrowed attention in normal Ss is now well established (Callaway, 1959; Callaway & Thompson, 1953; Easterbrook, 1959). In addition, schizophrenics, and in particular chronic nonparanoids, due to their heightened level of arousal (Broen, 1968; Lang & Buss, 1965; Pfeiffer, Goldstein, Murphree,,& Sugarman, 1965; Zahn, 1964), have been subject to much investigation concerning attention processes. Not surprisingly, such patients exhibit attentional behaviors similar to aroused normals, both on tasks requiring the scanning of external information (i.e., physical displays; Broen, 1968; Hamilton, 1963; Venables, 1963, 1964; Weckowicz, 1957, 1958) as well as those using internal information (i.e., memory, meaning hierarchies; Ashman, 1959; Chapman, Chapman, & Miller, 1964; Zahn, Rosenthal, & Shakow, 1963).

In an attempt to integrate these findings in a more theoretical manner, Callaway and Stone (1960) re-evaluated Callaway's previous research in terms of Broadbent's (1958) model of attention processes. In so doing, they stated that increased arousal leads to : (1) increased filtering (or narrowed attention); (2) reduced probabilistic coding (i.e., increased overall uncertainty with regard to the stimulus complex under consideration); and (3) a reduction in the size of the stimulus complex, accomplished by means of grouping. Taken together, these variables would result in a reduced stimulus complex where all stimuli are considered more nearly equally probable. This would, in turn, imply a reduced set of response possibilities all more nearly equally ready for expression. As Callaway and Stone noted, the resulting situation is analogous to that predicted by the Hullian concept that increased drive elevates competing responses nearer to threshold.

In discussing his model of schizophrenic deficit in terms of Broadbent's theory, Broen (1968) stressed most of the variables noted by Callaway and Stone, yet indicated specifically that the deficit lies with that of reduced probabilistic coding. Employing the Hullian concept noted above, Broen has hypothesized and demonstrated (Broen & Storms, 1961, 1966) that schizophrenics are subject to greater response competition (resulting from schizophrenic's lower response strength ceiling) than normals, and that increased arousal interacts with this deficit to further aggravate the competition. It is this extreme response competition in schizophrenics which yields their output so unintelligible and their environment so disorganized and aversive.

In light of these findings, Broen (1968) felt that a distinction between range of scanning and the organization of response tendencies that are evoked by the multiple stimuli that have been scanned is most important in accounting for schizophrenics' deteriorated performance. The range of scanning is directly affected by degree of filtering, while the organization of response tendencies is subject to the variable of probabilistic coding.

It is unfortunate that Broen (1968) has not dealt with the coding variable of grouping noted by Callaway and Stone, since it would seem to be a significant factor in the organization of information already scanned and would most likely be affected by degree of probabilistic coding as well as filtering. One might expect the latter two variables to adversely affect grouping under chronic conditions of arousal (as found in chronic nonparanoid schizophrenics) since grouping would be carried out under conditions of reduced information and knowledge of relevancy (i.e., increased filtering), and where all elements of the remaining limited stimulus complex are treated as if they had more nearly equal importance or probability of occurrence (reduced probabilistic coding leading to response competition) (Callaway & Stone, 1960).

Recently employing Broadbent's model, McGhie (1970) has indicated that schizophrenics are unable to process incoming verbal materials (e.g., speech) in meaningful relationship to each other as part of an organized pattern. This deficit was seen as due mainly to a deficiency in the screening out of redundant information, as normals do (Goldman-Eisler, 1961; Miller, 1963; Shannon, 1951), and to an inability to organize the incoming verbal data in an economical way. In terms of Broadbent's model, these factors would seem to coincide with filtering and grouping, respectively.

As a preliminary test of the above hypothesis, Lawson, McGhie, and Chapman (1964) presented schizophrenics and controls with passages of English prose of different degrees of internal organization (Miller & Sulfridge, 1950), varying from collections of random unrelated words (zero constraint) to standard English text. Results indicated that, although schizophrenics were able to perceive and recall sentences of low contextual constraint as well as controls, they did poorly in comparison with non-schizophrenics in dealing with sentences of higher constraint. This was viewed as suggesting an inability on the part of schizophrenics "to utilize the transitional bonds between words which normally facilitate perception of the passage as an organized whole (McGhie, 1970, p. 13)."

Although these findings were independently replicated by Nidorf (1964), other investigators using the same task (Lewinsohn & Elwood, 1961; Raeburn & Tong, 1968) have failed to substantiate some of the findings, pointing out that both speed of writing the response in recall and verbal ability (both uncontrolled in the Lawson et al., 1964, study) are related to the recall of contextually constrained passages. These authors noted that with these variables controlled, the deficit found by Lawson et al. disappeared. However, as Venables (1964) noted, verbal ability measured in terms of vocabulary performance as above, insofar as it is the selection of a verbal description of a word while keeping that word in the forefront of attention, might very well be contaminated by the mechanism of narrowed temporal scanning. In addition, the above studies have looked only at total recall without independently measuring the organization of material recalled. Thus, it remains to be demonstrated that chronic schizophrenics are unable to code information through grouping.

The purpose of this research is to analyze grouping in chronic nonparanoid schizophrenics on a verbal learning task originated to investigate Miller's (1956) hypothesis concerning a process of organizing or grouping input information into familiar units or chunks. Both Miller's chunk hypothesis and the efficacy of the task have been well demonstrated using normal Ss (Bousefield, 1953; Bousefield & Cohen, 1956; Cohen, 1963; Dallett, 1964; Mathews, 1954), the general findings indicating that words falling into categories, presented in a randomized order for free recall, are recalled in clusters according to category membership and that recall of such a category-organized list is better than recall of a randomly selected set of words. Of particular interest for this paper is that greatest recall and clustering in recall resulted in 4-category lists, especially in Blocked order (where all members within a given category were contiguous) as opposed to Random order (where no word of a category followed a word from the same category) (Dallett, 1964).

The task would seem sensitive to extreme filtering since measures such as number of categories and number of words per category represented in recall are easily obtainable and would necessarily be affected by narrowed spatial as well as temporal scanning. In addition, if non-exhaustive categories (where list words only partially exhaust the pool of words belonging to a category, Cohen, 1963) are employed, it might be assumed that associated words of the category in question, not included in the list, would be natural intrusions and simulate the response competition resulting from reduced probabilistic coding so pervasive in schizophrenia (Broen, 1968). This assumption is supported by research which indicates that intrusions do occur greatly in the recall of schizophrenics on verbal learning tasks relative to normals (Kausler, Lair, & Matsumoto, 1964; Lang & Luoto, 1962) and that intrusions are associative in nature.

rather than completely unrelated (Busstein, 1961). Most important, proficiency of grouping on the task is measurable directly through cluster analysis and indirectly through total recall, since recall increases with greater degrees of category organization of the lists.

Finally, since arousal level is a key factor in determining degree of filtering and probabilistic coding, it was varied in two ways: (1) naturally; and (2) experimentally. The natural variation of arousal was accomplished by selecting chronic nonparanoid Ss who differ in arousal level under non-stimulating conditions. Venables (1960, 1963; Venables & Wing, 1962), through the use of rating scale (Venables, 1957), has dichotomized chronics into active and withdrawn and found the latter to be of greater level of arousal. As might be expected, withdrawns exhibited greated narrowing of attention than actives and normals (Venables, 1963). Furthermore, in keeping with Broen's model where arousal is not the deficit per se but is only an interacting variables, it was felt that the most appropriate controls would be psychiatric patients who also exhibit an over-aroused pattern. This should allow for an evaluation of schizophrenic deficit independent of arousal level and arousal differences represented by the activity--withdrawal dichotomy. Therefore, since neurotics have been found to be over-aroused (Lader & Wing, 1966), they were selected as controls and dichotomized on the Venables scale.

The experimental manipulation of arousal was accomplished by having Ss maintain grip pressure on a hand dynamometer.

The present paper presents two studies designed to investigate: (1) grouping in schizophrenics; and (2) the effects of reduced probabilistic coding (response competition) and increased arousal upon grouping.

Experiment I

The first experiment involves a direct test of grouping or chunking in schizophrenics byyemploying three serial lists of increasing inherent "chunkability." The predictions are:

1. Schizophrenics will not be aided by the increasing inherent chunkability of the lists and thus will not reveal increased recall as lists increase in chunkability, nor will they demonstrate clustering in recall, relative to controls.

2. Schizophrenics will reveal increased filtering in terms of reduced number of categories recalled, number of words per category recalled, or both, relative to controls.

3. Schizophrenics will reveal greater response competition in terms of total number of intrusions in list recall relative to controls.

Method

Subjects

Seventy-five females, including 15 withdrawn chronic nonparanoid schizophrenics (WS), 15 active chronic nonparanoid schizophrenics (AS), 15 withdrawn chronic neurotics (WN), 15 active chronic neurotics (AN), and 15 normals (N), served as Ss. The psychiatric inpatients were obtained from a state mental hospital, while normals consisted of introductory psychology students. Patients scoring 30 or less on Venables' (1957) Activity--Withdrawal Scale were classified as withdrawn; those scoring 31 or more were classified as active. The neurotics were also dichotomized in order to assess the activity-withdrawal variable independently of schizophrenic deficit. Patients were considered chronic if diagnosed as such in staffing, were in the hospital at least 6 months on their current admission, and had a history of at least 2 previous hospitalizations, the first being at least 3 years prior to the current admission. The latter criterion is in keeping with the 2-year criterion suggested by Brown's (1960) findings and with Johannsen and O'Connell's (1965) evidence that perceptual decrement is related to the duration of the basic illness (defined as time since initial hospitalization) and not related to percentage of time spent in the hospital since the initial diagnosis. However, any effects due to institutionalization per se were controlled through the use of chronic patient controls (i.e., neurotics). Schizophrenics with the diagnosis of paranoid-type or found delusional in an initial interview were not used. Moreover, none of the patients had a history of brain pathology, alcoholism, mental retardation, electro-convulsive or insulin therapy, although patients were on medication. Patient groups were matched on age, education, length of current hospitalization, and time since first hospitalization. Patients were of middle or higher socio-economic level, and all had completed at least 11 grades of schooling.

Apparatus and Materials

Three lists of 20 words each were made up using the materials presented by Cohen (1963). His lists consisted of words given by Ss as associates to category names (Cohen, Bousefield, & Whitmarsh, 1957). Thus, for each item the frequency with which the item was given in response to its category name was known. These category-membership norms (taxonomic frequency) as well as frequencies of usage from the Thorndike-Lorge (1944) "G" count were used to construct lists which were equated as nearly as possible for (a) mean taxonomic frequency per word, and (b) mean frequency of usage. The pool of words selected were already categorized with points (a) and (b) controlled and may be found in Cohen (1963). Two of the lists used contain words that are capable of being chunked into categories. Only the order of presentation was different: in one, the order was random; in the other, it was blocked, as defined above (Dallett, 1964). The third list (Non-Grp) contained words of the same G-count as those of the other 2 lists, but the words were not capable of being chunked into categories. This list was used to equate groups on list learning and recall ability and thus served as a control list. Eight categories (Cohen, 1963) were used: 4 for the Random list (cloth, furniture, fish, landscape features) and 4 for the Blocked list (trees, animals, vehicles, bodily parts). Each category contained 5 words. Words were presented for a 2-sec. duration on a Lafayette memory drum apparatus.

Procedure

Patients were brought to the testing room for purposes of habituation to the experimental situation, apparatus, and experimenter. The room was located off the ward and was relatively free of distracting noise. Later the same day, the patient returned to the room. Following instructions, lists were then presented in counterbalanced order for 1 exposure each. A 1-minute verbal free recall was recorded following each list, with an average inter-list interval of approximately 2 minutes elapsing.

Instructions

Upon being seated, all Ss were told:

"This is a study in verbal learning. A list of words will appear in this window (indicating the memory drum window). One word will appear at a time, every 2 sec. Say each word aloud as it appears and when the list is finished, I will ask you to tell me as many words as you remember in any order. They do not have to be remembered in the order presented. You will see the list only once."

After recall of the first list, Ss were then told:

"Now a list will appear in this window. You are to do exactly as you did on the first list" (a re-statement of the original instructions was then read).

The same procedure was followed for the third list.

Results

Analyses of the comparison data for the 5 groups are summarized in Table 1. Inspection of the table indicates that patient groups did not differ on variables of education, age, length of current admission, time since first admission, and total recall[1] on the control list (list Non-Grp). Similarly, normals did not did not differ from patient groups in terms of education or total recall on the control list; however, they were younger than patients[2] and all of college potential, which is not likely true of all patients. Withdrawn groups differed from active groups on the Venables (1957) Activity--Withdrawal Scale, yet neither of the withdrawn nor active schizophrenic groups differed from their respective neurotic control groups. Inter-rater reliability on the Venables scale was .85 ($p < .01$; $N = 20$). Thus, all groups would seem well matched and of similar ability in terms of list memorization and recall.

Insert Table 1 about here

For each S, a recall score was calculated on each of the 3 lists and analyzed for groups × lists differences in a repeated measures design. Results are summarized in Table 2. The main effects for the groups and for the lists[3] are significant beyond the .01 level, as is the Groups × Lists interaction. More specific analysis of the significant lists effect revealed that while the neurotic and normal controls increased in total recall as lists increased in inherent chunkability, WSs did not. ASs showed no difference between lists Non-Grp and Random but did exhibit increased recall on the Blocked list over the latter two lists. These results may be seen in Figure 1.

Insert Table 2 and Figure 1 about here

The effect for groups was not significant for list Non-Grp but was evident on the other lists. On the Random list, WS and AS patients showed less recall than controls yet did not differ from each other. The 3 control groups also did not differ from one another. On the Blocked list, WS and AS groups again revealed less recall than controls, yet actives showed greater recall than withdrawns. Though the neurotic groups did not differ from one another, they did show less recall than normals on the Blocked list.

Thus, since the recall of schizophrenics is not increased by the inherent chunkability of lists while the recall of neurotics and normals is increased, part of prediction 1 would seem well supported.

Clustering or grouping of material recalled was analyzed next. Clustering was measured by use of the C index recently put forward by Dalrymple-Alford (1970). The index is most appropriate for this study since it yields an estimate of clustering uncontaminated by differences in total recall. Inspection of Table 3 indicates that the main effects for groups and for lists are significant beyond the .01 level, while the interaction is not significant ($p > .05$). More specific analysis indicated that all groups showed significantly greater clustering on the Blocked list relative to the Random list. However, comparisocn of groups on the individual lists revealed basic differences. WS and AS groups showed significantly less clustering on both the Random and Blocked lists relative to all control groups. WSs showed reliably less clustering on the Random list than ASs, although no differences occurred between WSs and ASs on the Blocked list. There were no differences between WN and AN Ss on either list. Neurotics showed less clustering than normals on the Random list but not on the Blocked list. Thus, the second part of prediction 1 was supported in that both active and withdrawn schizophrenics showed less clustering in recall than controls.

Insert Table 3 about here

Two additional measures were obtained for each S to enable an analysis of the effects of filtering or narrowed temporal attention on recall: (1) the number of categories (NC) represented in recall; and (2) the number of words per category (W/C). Analyses of these variables may be found in Tables 4 and 5.

Insert Tables 4 and 5 about here

Inspection of Table 4 indicates that the main effect for groups is significant beyond the .05 level, while both the main effect for lists and the Lists X Groups interaction are not significant ($p > .05$). More specific analysis indicated that none of the groups increased reliably in NC in recall on the Bloked list relative to the Random. On the Random list, there were no significant group differences in NC, while on the Blocked list, ASs showed significantly less NC than normals. No other group comparisons were significantly different.

Concerning W/C, inspection of Table 5 indicates that the main effects for groups and for lists are significant beyond the .01 level, but that the Lists X Groups interaction is not significant ($p > .05$). More specific analysis revealed a significant increase in W/C in recall on the Blocked list relative to the Random for all groups. WSs revealed the least W/C, differing reliably from ANs and normals on the Random list and from all groups on the Blocked list. ASs, on the other hand, did not differ on W/C from any of the control groups, while none of the control groups differed from one another.

Thus, prediction 2 cannot be generally supported. It becomes necessary to indicate to which variable (NC or W/C) and also to which schizophrenic group one is referring. The most reliable result is that WSs show less W/C than the other groups.

Prediction 3 was partially supported in that WSs revealed the greatest number of intrusions, differing from all other groups, while ASs did not differ from controls. None of the controls differed from each other.

Discussion

The results of experiment I have well supported prediction 1 and indicate that both active and withdrawn schizophrenics' recall is less aided by the degree of inherent organization of material, and that they group or cluster processed material less efficiently than controls. However, these findings should not be taken to mean that schizophrenics are unaware of the organizational structure of input information or of the possivilities for grouping the information into meaningful units. It should be noted that while the increase in recall of schizophrenics acrees lists was not always significant, there was nevertheless an increase, significantly so for ASs on the Blocked list relative to lists Non-Grp and Random. Similarly, though clustering was inferior for WSs relative to controls, these Ss did cluster 49% and 85% of their recall on the Random and Blocked lists, respectively, and obviously increased clustering on the Blocked list relative to the Random. The same was true for ASs. It would seem that schizophrenics reveal a deficit in benefiting from and organizing material of differing degrees of structure, rather than a complete inability to do so as McGhie (1970) has suggested. Moreover, this grouping deficit would not appear to be due to less list memorization and recall ability or rate of processing information (Yates, 1966) since schizophrenics did not differ on the control list from the control groups. Moreover, the deficit would seem to be somewhat independent of Broen's probabilistic coding deficit, since ASs did not differ significantly from controls in terms of number of intrusion errors but did reveal less clustering and list recall. However, the interaction between arousal and cognitive deficit noted by Broen (1968) seems to hold also for grouping deficit. The more aroused WSs not only revealed less efficient clustering on the Random list, but also a greater reduction in probabilistic coding (more intrusion errors) and more extreme filtering (less W/C) than ASs on both lists. That increased arousal is not sufficient in reducing grouping is indicated by the efficient clustering of the withdrawn neurotic controls who are of similar level of arousal as WSs.

In general, then, the first study indicates a cognitive deficit of some sort in schizophrenics which is revealed in the inefficient grouping of information. In addition, more aroused schizophrenics (WSs) exhibit more extreme filtering (less W/C) and reduced probabilistic coding (greater intrusion errors) than less aroused Ss (ASs).

Finally, since Broen (1968) has emphasized the deleterious effects of arousal and reduced probabilistic coding upon schizophrenic performance, a second study was designed to assess their effects upon grouping somewhat more independently than in experiment I and under more extreme conditions.

Experiment II

The second experiment was designed to assess the differential effects of non-arousing and arousing conditions upon grouping in a task fostering high response competition. This will allow an analysis of the effects of response competition upon grouping independently of heightened arousal (non-arousing condition), plus the effects of an interaction between arousal and response competition (arousal condition). In other words, the question being asked here is: does the normal use of category names as mediators for recalling words in clusters disorganize under conditions of high response competition, increased arousal, or an interaction between the two? This analysis will hopefully illuminate what occurs to the grouping process in schizophrenics under disorganizing circumstances. The predictions are:

1. Schizophrenics will not group (as shown by cluster analysis and total recall) either under non-arousing or arousal conditions while controls will.

2. Schizophrenics will show reduced total recall, number of categories, and number of words per category in recall under the arousal condition relative to the non-arousal condition. Controls will exhibit the same pattern but to less a degree.

3. Schizophrenics will exhibit a greater frequency of intrusions than controls, showing the greatest in the arousal condition.

4. Withdrawn schizophrenics, due to their greater susceptibility to response competition, will reveal the greatest deficit

on the measures of hypotheses 1, 2, and 3, relative to the other groups.

Method

Subjects

One-hundred and fifty females, including 30 WS, 30 AS, 30 WN, 30 AN, and 30 N, served as Ss. The Ss were obtained from the same sources, were classified in identical fashion, and met identical criteria as in experiment I. One-half of the Ss in each group was randomly assigned to the arousal condition, while the other half was assigned to the non-arousal condition.

Apparatus and Materials

Response competition was induced through the use of a proactive inhibition (PI) design. Two category lists (designated I and II, consisting of 12 and 16 words, respectively) were made up again by using the materials presented by Cohen (1963). The lists have different words yet identical non-exhaustive categories (clothes, animals, furniture, bodily parts) which number 4 (list I=3 words per category; list II=4) and are in blocked order. The blocked order and 4-category lists should maximize the potentiality for clustering in recall (Dallett, 1964), while the identical categories yet different words within those categories should maximize the possibility of intrusions due to PI. Both maximizations are desirable for the present experiment. Presentation of words was identical to that of experiment I.

Arousal was induced by S maintaining grip pressure on a

Stoelting Co. hand dynamometer (Pinneo, 1961). The dynamometer was on the table to the right of S and in a mount which allowed for easy handling. The dynamometer was wired to a dim light mounted on the top right side of the memory drum which lit if grip pressure deviated 1 kilogram above or below a specified level. One-half of the maximum grip pressure obtained by S was used to induce arousal during the task.

Procedure

Patients were habituated as in experiment I. Each S was then shown the control list, list Non-Grp used in the first experiment, to equate groups of Ss on list learning and recall ability. Maximum grip pressure was then ascertained for Ss randomly assigned to the arousal condition, this being followed by a 30-sec. practice session in keeping the light off by maintaining a constant ½ maximum grip pressure. A 5-minute rest period followed to allow the induced tension to subside. The Ss were then instructed to learn list I to 2 perfect recalls, a 1-minute verbal free recall period following each presentation. Following this, Ss in the arousal condition were required to place their right hand on the dynamometer without squeezing, to observe list II for 1 presentation, then to squeeze the dynamometer ½ maximum grip, wait 10 sec, and then to verbally free recall list II while still squeezing the dynamometer. Recall of list II lasted 1 minute. The Ss in the non-arousing condition were required to place their right hand on the dynamometer during both list II presentation and recall but were not required to squeeze. These Ss were also required to wait 10 sec. before recalling list II.

Instructions

Upon being seated, all Ss were given the control list, and identical instructions as those in experiment I were read. Next, the dynamometer procedure was carried out followed by repetition of the above instructions for the next list, list I. Here it was added that the list will be repeated until all of the words are learned well (i.e., 2 perfect recalls). Next, Ss were asked to put their right hand on the dynamometer and were told the following, with the phrases enclosed in parentheses added for Ss in the arousal condition:

"Now a list will appear in this window, but only once. Again, say each word aloud and when the list is finished and I tell you to begin, (squeeze the dynamometer $\frac{1}{2}$ grip, hold it there keeping the light out, and) tell me as many words as you remember in any order (while still squeezing)."

Results

Analyses of the comparison data for groups of the non-arousal (NA) and arousal (A) conditions are summarized in Table 6. There were no differences between groups of the NA condition and groups of the A condition. Thus, Table 6 shows differences between groups within a specific arousal condition. Inspection of the table indicates that patient groups did not differ on variables of education, age, time since first admission, and total recall on the control list. Group WN differed from WS in length of current admission by 9 months on the average, however, no other differences occurred between any other group combinations. Normals did not differ from patient groups in terms of education or total recall on the control list, but were younger than patients. Whithdrawn groups differed from active groups on the Venables scale, yet neither WSs nor ASs differed from their respective neurotic control groups. Thus, all groups would seem well matched and of similar ability in terms of list memorization and recall, both within and across arousal conditions.

Insert Table 6 about here

For each S, a recall score was calculated on list II and analyzed for groups $\times$ arousal condition differences. Results are summarized in Table 7. The main effects for the groups and for arousal conditions are significant beyond the .01 level, but the Groups $\times$ Arousal Condition interaction is not significant ($p > .05$). More specific analysis of the significant arousal condition effect revealed that increased arousal resulted in significantly reduced total recall for all group types except AS.

The effect for groups was analyzed and results showed that, within the NA condition, both WS and AS showed less total recall than all control groups but did not differ from each other. Controls also did not differ from one another. Within the A condition, WS differed from all groups, including AS who did not differ from controls. Again, controls did not differ from one another.

Insert Table 7 about here

Thus, prediction 1 was supported for the most part in that schizophrenics revealed less recall on list II than controls within the NA condition. For the A condition, prediction 1 was supported only by WSs since ASs did not differ from controls.

Clustering or grouping of material was analyzed next, and the results may be found in Table 8. Inspection of the table indicates that the main effect for arousal conditions is not significant ($p > .05$), but the effect for groups is significant beyond the .01 level, as is the Groups X Arousal Condition interaction. More specific analysis of the significant groups effect indicated that while both WS and AS revealed less clustering within the NA condition relative to controls, only WS clustered less within the A condition. The only significant effect of arousal upon group type was increased clustering for ASs in the A condition relative to the NA condition.

Insert Table 8 about here

Thus, the second part of prediction 1 was partially confirmed in that schizophrenics revealed less clustering than controls in the NA condition, and also in the A condition but only for WSs. ASs did not differ from controls in the A condition and, in fact, were the only group to show significant increase in clustering with increased arousal.

Measures of NC and W/C were obtained to enable an analysis of the effects of filtering on recall. Analyses of these variables may be found in Tables 9 and 10, respectively. Inspection of Table 9 indicates that the main effects for arousal conditions and for groups is significant beyond the .05 level, as is the Groups X Arousal Condition interaction. More specific results indicated that there were no differences between groups in NC in the NA condition, that WS showed significantly less NC than all other groups in the A condition, and that WS exhibited the only significant decrease in NC across arousal conditions. ASs and controls did not differ among themselves in either condition.

Insert Tables 9 and 10 about here

Concerning the W/C analysis, inspection of Table 10 indicates that the main effects for arousal conditions and for groups is significant beyond the .01 level, but that the Groups X Arousal condition interaction is not significant ($p > .05$). More specific analysis revealed that WS and AS showed less W/C than all other groups in NA condition but did not differ from each other. In the A condition, WS revealed less W/C than all other groups, ASs not differing from controls. Through all group types showed reductions in W/C in the A condition relative to the NA condition, only WN revealed significant reductions.

Prediction 2 was supported by WSs on all points, but by ASs only in the NA condition. In the A condition, ASs revealed no differences in NC or W/C relative to controls.

Prediction 3 was partially supported and results may be found in Table 11. Inspection of the table indicates that the main effect for groups is significant beyond the .01 level, but that both the main effect for arousal conditions and the GroupsX Arousal Condition interaction are not significant ($p > .05$). More specific analysis of the significant group main effect showed that WS revealed more intrusions than all groups in both arousal conditions except AS in the NA condition. AS did not differ from controls in any condition, and controls did not differ among themselves. The effect of increased arousal upon group types was to increase intrusions, but the increase did not reach significance for any group ($p < .10$).

Insert Table 11 about here

Prediction 4 was supported in that WSs consistently revealed the poorest performance, especially in the A condition, in terms of total recall, clustering, NC, W/C, and number of intrusions in recall.

It was noted while investigating intrusion errors that intrusions were associative in nature; i.e., they were members of the categories represented in list II. Most of these intrusions were words from list I. Due to the greater number of intrusions in schizophrenics' recall, it was felt of interest to re-analyze clustering for these Ss, including associative intrusions. These results may be found in Table 12. Clustering with intrusions would appear to be a better index of grouping per se, independent of task proficiency. It was found that both WS and AS showed significantly increased clustering with intrusions included compared to clustering without intrusions included. In addition, both groups revealed increased clustering in the A condition relative to the NA condition, with ASs showing the most clustering in the A condition and WSs the most in the NA condition. However, neither group significantly approached the level of clustering of controls in the NA condition, and the same holds in the A condition for WSs. ASs, on the other hand, did not differ from controls in the A condition.

Insert Table 12 about here

Discussion

Predictions of experiment II have been supported for the most part, although several qualifications are necessary in order to gain greater understanding of the results. All predictions were fully supported in the NA condition in that both active and withdrawn schizophrenics revealed less recall, clustering, and W/C on list II relative to controls, and WS consistently performed at the lowest level, though not always significantly so. Prediction 3, that schizophrenics would show a greater number of intrusions, was only supported by group WS.

Thus, the results of the NA condition confirm the results found in experiment I. However, the NA condition differed from the first experiment in that high response competition was fostered, and any differences between performance levels of the two studies might illuminate the effect of this variable upon recall and grouping. Inasmuch as the two studies can be qualitatively compared, it is of interest to note that while control list means differ little between studies, total recall and clustering is inferior for all groups in the second study relative to the first. This becomes more striking when one considers the fact that lists of the first experiment were longer than list II of the second study. It would thus appear that response competition has deleterious effects upon recall and clustering for all Ss, and given WSs' greater susceptibility to the effects of this variable, it would seem to be an important factor in determining their less efficient information processing than controls. However, again the grouping deficit seems somewhat independent of the probabilistic coding deficit since ASs did not differ significantly in total intrusion errors from controls, yet showed less recall and clustering.

Although increased arousal was predicted to further deteriorate schizophrenics' performance, results here were less consistent. Concerning WSs, all predictions were confirmed in the A condition in that withdrawns again showed less recall, clustering, NC, W/C, and a greater number of intrusions relative to all other groups. Moreover, as predicted, the performance of WSs was adversely affected by the increase in arousal relative to the NA condition, as was performance for all groups except AS.

Group AS did not confirm the predictions concerning arousal and, in fact, showed the opposite trends. In the A condition, ASs did not differ significantly from controls in terms of total recall, clustering, NC, W/C, and number of intrusions. Furthermore, whereas all other groups showed less proficient performance with an increase in arousal, ASs did not reveal significant decreases in either total recall or clustering relative to the non-arousing conditions. It would thus appear that the non-proficient performance of ASs relative to controls is enhanced by increased arousal to the point where they are statistically indistinguishable from controls.

Taken together, the two studies presented here yield one reliable generalization: both active and withdrawn schizophrenics are subject to some sort of cognitive deficit which is revealed in their less efficient grouping relative to controls. Further generalizations become difficult since it appears that actives and withdrawns are distinctly different types of schizophrenics. Since withdrawns exhibit probabilistic coding deficit and show increased deterioration and filtering with correlated increases in arousal, they would represent most closely the classic type of schizophrenic Broen (1968) and others have described. Actives, on the other hand, show neither the probabilistic coding deficit nor increased deterioration with increased arousal. In fact, the proficiency of their performance is increased with heightened arousal, suggesting that these Ss function normally at a sub-optimal level.

In an attempt to interpret these differences, it is hypothesized that the effect of increased arousal is apparently to narrow ASs' temporal attention to irrelevant stimuli (in this case words of list I held in memory) to an optimal point in which irrelevant stimuli are reduced, leaving stimuli relevant to the task enhanced. That increases in task proficiency can be correlated with increased arousal has been well demonstrated, with a similar interpretation forwarded (Easterbrook, 1959). On the other hand, withdrawns, given their higher level of arousal and attentional narrowing, have apparently passed this optimal point of narrowing, and further increases in arousal only reduce relevant cues, and thereby probabilistic coding, so that irrelevant intrusions and relevant stimuli become more indistinguishable in terms of probability of occurrence and importance for the task at hand. The effect of this condition upon grouping of task specific material is most profound in that WSs clustered only 24% of the material recalled in the arousal condition. However, it must be realized that the actual process of grouping did not deteriorate completely evenunder these disorganizing conditions. The analysis of clustering with associative intrusions included showed significantly superior performance for withdrawns, as well as actives, relative to clustering without intrusions included.

In considering alternative interpretations of the results, Yates' (1966) suggestion of a reduced rate of processing input information would not seem to account for the present results by itself in light of the equation of groups on list memorization and recall ability. In addition, stimulus exposure was relatively long in the studies presented here compared to most verbal learning studies. However, with decreased exposure time, a slower rate of processing input might well be evidenced in schizophrenics and would not be surprising since reduced probabilistic coding results in increased overall uncertainty with regard to the stimulus ensemble under consideration (Callaway & Stone, 1960). That this uncertainty would lead to decreased rates of processing is quite tenable, and one might expect the uncertainty effects accompanying reduced probabilistic coding to increase with task complexity. It is of direct interest that Yates and Korboot (1970) found that slowness of processing material is an increasing function of the complexity of that material. Inview of the fact that heightened arousal increases the reduction of probabilistic coding, it is of interest that Yates and Korboot

(1970) also found generally greater slowness of processing information in chronic nonparanoid schizophrenics relative to acute nonparanoids, especially since the latter group has been thought by some to be less aroused than chronics (Venables, 1964, 1966). From results found in the studies presented here, one would predict WSs to reveal slower rates of processing than ASs.

The results would also not seem accounted for by the withdrawal--activity distinction alone, since the over-aroused withdrawn and active neurotics failed to reveal diverging performance patterns between themselves or performance similar to their respective schizophrenic groups. Thus, the activity--withdrawal distinction does not hold up in the absence of schizophrenic grouping deficit, and the clearest interpretation of results would be in terms of an interaction between that deficit and arousal.

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FOOTNOTES

[1]Recall scores do not include intrusion errors.

[2]All a posteriori multiple comparisons were analyzed by use of Tukey's (1953) HSD test at the .05 level as described in Kirk (1968, pp. 88, 268). Differences mentioned are significant unless noted otherwise.

[3]The Geisser and Greenhouse (1958) correction for unequal covariance matrices was employed, and the lists main effect was significant on the conservative test (i.e., the null was rejected).

Table 1

Comparison Data for Groups of Experiment I

Variable	Withdrawn Schizo-phrenics M	Withdrawn Schizo-phrenics SD	Active Schizo-phrenics M	Active Schizo-phrenics SD	Withdrawn Neurotics M	Withdrawn Neurotics SD	Active Neurotics M	Active Neurotics SD	Normals M	Normals SD	F
Age (in yr.)	31.3	9.3	35.9	10.5	30.3	9.1	32.7	10.5	18.2	.68	7.4643**
Education (in yr.)	12.2	.68	12.5	.83	12.4	1.4	12.6	.91	12.3	.46	0.4052
Control List[a]	9.3	1.16	9.7	2.4	9.3	1.9	9.2	2.1	9.5	1.96	0.1613
Current Admission (in yr.)	1.75	1.71	1.2	.70	1.2	1.1	1.1	.68			0.8204
Since First Admission (in yr.)	8.8	5.07	9.5	7.58	5.2	3.47	6.9	6.89			1.2921
Withdrawal--Activity[b]	20.1	2.61	43.4	2.6	21.7	3.1	40.2	2.0			258.4289**

a Numbers indicate total words recalled (minus intrusions)

b Higher scores indicate more active

* $p < .05$

** $p < .01$

Table 2

Analysis of Variance of list Recall For Experiment I

Source	df	M S	F	p
Groups	4	43.6888	4.0841	$<.01$
Error (a)	70	10.6971		
Lists	2	393.4044	188.1032	$<.01$
Lists X Groups	8	18.7155	8.9486	$<.01$
Error (b)	140	2.0914		

Table 3

Analysis of Variance of Clustering For Experiment I

Source	df	M S	F	p
Groups	4	1207.5068	3.8357	<.01
Error (a)	70	314.8009		
Lists	1	30845.3398	83.5380	<.01
Lists X Groups	4	526.1400	1.4249	>.05
Error (b)	70	369.2371		

Table 4

Analysis of Variance of Number of
Categories in Recall For Experiment I

Source	df	M S	F	p
Groups	4	1.2766	3.3180	< .05
Error (a)	70	0.3847		
Lists	1	0.0599	0.2519	>.05
Lists X Groups	4	0.4433	1.8620	>.05
Error (b)	70	0.2380		

Table 5

Analysis of Variance of Number of Words
Per Category in Recall For Experiment I

Source	df	M S	F	p
Groups	4	4.0910	9.5177	<.01
Error (a)	70	0.4298		
Lists	1	20.3651	67.4434	<.01
Lists X Groups	4	0.2877	0.9529	>.05
Error (b)	70	0.3019		

Table 6

Comparison Data For Groups of Experiment II

Arousal Condition	Variable	WS		AS		WN		AN		N		F[c]
		M	SD	M	SD	M	SD	M	SD	M	SD	
	Age (in yr.)	41.1	6.2	36.5	9.2	35.8	9.7	33.3	9.9	19.1	1.3	29.233**
	Education (in yr.)	12.1	.74	12.3	.80	12.3	1.0	12.3	.70	12.2	,41	0.374
Non-Arousal	Control List[a]	9.5	1.25	9.4	1.88	9.7	2.29	9.6	2.2	9.7	1.84	0.084
	Current Admission (in yr.)	1.9	1.3	1.4	.80	1.0	.75	1.3	.64			4.37*
	Since First Admission (in yr.)	10.4	5.1	12.5	7.4	9.3	5.95	9.07	5.5			1.204
	Withdrawal--Activity[b]	20.0	2.45	43.1	2.6	22.6	3.2	41.3	3.4			205.3305**

a Numbers indicate total words recalled (minus intrusions).

b Higher score indicates more active

c F indicates test between groups within an arousal condition. There were no differences within a group across arousal conditions. See text.

* $p < .05$

** $p < .01$

Table 6 (Continued)

Comparison Data For Groups of Experiment II

Arousal Condition	Variable	WS M	WS SD	AS M	AS SD	WN M	WN SD	AN M	AN SD	N M	N SD	F[c]
	Age (in yr.)	37.3	6.7	39.0	7.6	33.5	9.98	35.9	9.2	20.1	5.3	29.233**
	Education (in yr.)	12.1	.70	12.3	1.2	12.2	.68	12.4	.91	12.2	.41	0.374
Arousal	Control List[a]	9.4	1.88	9.7	2.29	9.6	2.2	9.7	2.05	9.8	2.01	0.084
	Current Admission (in yr.)	1.8	1.4	1.4	.78	1.67	.58	1.0	.77			4.37*
	Since First Admission (in yr.)	9.9	4.9	11.4	5.9	10.1	5.8	9.6	5.3			1.204
	Withdrawal--Activity[b]	20.9	1.8	42.5	2.9	23.7	2.96	41.7	3.7			184.0183**

a Numbers indicate total words recalled (minus intrusions).

b Higher score indicates more active

c F indicates test between groups within an arousal condition. There were no differences within a group across arousal conditions. See text.

* $p < .05$

** $p < .01$

Table 7

Analysis of Variance of List II Recall

Source	df	M S	F	p
Arousal Condition	1	102.51	16.605	$<.01$
Groups	4	66.04	19.27	$<.01$
Arousal X Groups	4	6.17	1.80	$>.05$
Error	140	3.4266		

Table 8

Analysis of Variance of Clustering
By All Groups Without Intrusions Included

Source	df	M S	F	p
Arousal Condition	1	9680.1211	5.1981	$>.05$
Groups	4	17620.1719	38.4047	$<.01$
Arousal X Groups	4	1861.6911	4.0577	$<.01$
Error	140	458.8014		

Table 9

Analysis of Variance of Number of Categories in List II Recall

Source	df	M S	F	p
Arousal Condition	1	8.167	9.42	$<.05$
Groups	4	1.000	3.76	$<.01$
Arousal X Groups	4	0.867	3.26	$<.01$
Error	140	0.266		

Table 10

Analysis of Variance of Number of Words Per Category in List II Recall

Source	df	M S	F	p
Arousal Condition	1	1.58	7.564	$<.01$
Groups	4	3.43	14.14	$<.01$
Arousal X Groups	4	0.21	0.85	$>.05$
Error	140	0.24		

Table 11

Analysis of Variance of Number of Intrusions in List II Recall

Source	df	M S	F	p
Arousal Condition	1	5.227	3.9389	>.05
Groups	4	22.967	14.686	<.01
Arousal X Groups	4	1.327	0.848	>.05
Error	140	1.564		

Table 12

Analysis of Variance of Clustering By Schizophrenics With and Without Intrusions Included

Source	df	M S	F	p
Arousal Condition	1	24538.7998	44.1157	$<.01$
Groups	1	4489.6334	8.0714	$<.01$
Arousal X Groups	1	8068.8001	14.5060	$<.01$
Error (a)	56	556.2369		
Clustering	1	18154.7998	60.8776	$<.01$
Arousal X Clustering	1	1484.0339	4.9763	$<.05$
Groups X Clustering	1	2803.3334	9.4002	$<.01$
Arousal X Groups X Clustering	1	625.6328	2.0979	$>.05$
Error (b)	56	298.2178		

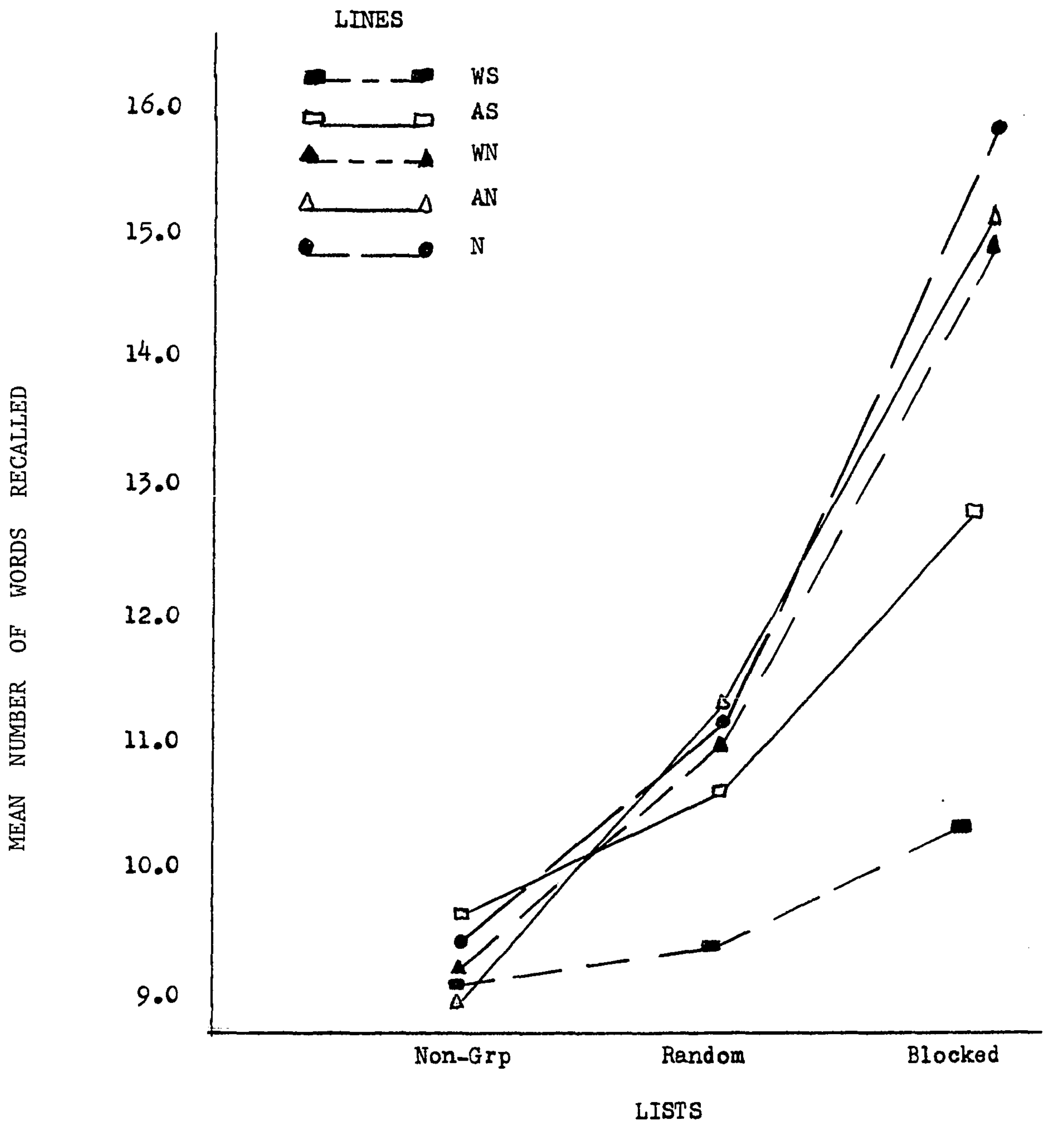

Fig. 1. Recall as a function of inherent chunkability of the lists.

APPENDIX A

PROSPECTUS

PROSPECTUS

CHAPTER I

INTRODUCTION

Attention processes have become one of the main focuses of research investigations in the past fifteen years. Of special interest has been the concept of range or breadth of cue utilization, defined by Easterbrook (1959) as the "total number of environmental cues in any situation that an organism observes, maintains an orientation towards, responds to, or associates with a response (p. 183)." Probably the most sound generalization that may be made at this point concerning this concept is that arousal (drive, emotion) acts consistently to reduce the range of cues that an organism uses, be it due to temporary phasic emotional states or to longer-term cortical-subcortical disarrangements that are manifest in mental disorders (Easterbrook, 1959; Venables, 1964). The latter arousal condition and its effect upon attention in schizophrenia has been studied extensively (Broen, 1968; McGhie, 1970; Venables, 1964) and constitutes the topic of this research. However, an initial examination of salent findings on normal Ss is valuable insofar as it may enable insight to be gained which will be helpful in interpreting experiments with schizophrenic Ss.

Normal Literature

Of the investigations using normal Ss, probably the most relevant are a series of studies by Callaway and his associates which researched the span of attention on perceptual tasks through the employment of several manipulations which induced arousal. In several studies (Callaway, 1959; Callaway & Dembo, 1958; Callaway & Thompson, 1953), pharmacological induction of arousal and its effect on size constancy was investigated. Here increased sympathetic activity was expected to decrease the general awareness of gradients (peripheral cues) by which the shrunken retinal image of distant objects is corrected. Objects would then be perceived as smaller than their true size and would seem to approach a size more nearly proportional to their retinal image size.

The size-constancy experiment involved the adjustment of the size of a projected rectangular patch of light 200 cm away from the S to match the size of a rectangular card held in the hand. Use of amyl nitrate, as well as a cold pressor test, evoked a reduction in size constancy in comparison to that obtained under non-stimulating conditions (Callaway & Thompson, 1953). Moreover, the same results were found using other stimulant drugs (Callaway, 1959; Callaway & Dembo, 1958) on the size-constancy task as well as on other tasks which are interpretable in terms of extent of attention, such as the Stroop test (1935) and a binary choice game (Hake & Hyman, 1953). Of interest is that in the latter task, "the central focus of attention will be held alternately by the current guess and the current answer...Since past answers are continually peripheral to current guesses, guess frequency response to answer frequency change reflects the influence of peripheral factors upon behavior (Callaway, 1959)." What apparently are on the periphery here are memory traces, not true sensory input, suggesting a temporal narrowing as opposed to a spatial narrowing represented by the size-constancy task.

It is noteworthy that all of the arousal manipulations have a common factor in that they all result in an alert EEG (Callaway, 1959). A corrollary of these findings would suggest that a drug which produces the opposite of EEG arousal should produce "broadness of attention." Such was found to be the case on the Stroop using atropine (Callaway & Band, 1958) and amobarbital (Callaway, 1959).

Other arousal manipulations yielding reduced range of cue utilization have included threatening conditions (presence of high-voltage sparks in the testing room) (Kohn, 1954), direct threat of shock and induction of feelings of failure (Agnew & Agnew, 1963), prolonged fatiguing performance causing irritability (Drew, 1963), bonus incentives (Bahrick, Fitts, & Rankin, 1954), use of anxious Ss as determined by questionnaire (Lucas, 1952) or diagnosis of neurosis (Clarke, 1955; Cohen, 1952; Lewinski, 1945), and social (Lucas, 1952; Moldawsky & Moldawsky, 1952) or surgical threat (Wright, 1954). However, less consistent is the effect of narrowed attention on the proficiency of task performance. As has been shown above, performance on the Stroop became more proficient under conditions of reduced cue utilization, whereas the opposite was true for the size-constancy task. What seems to be the basic formula in understanding the interaction between reduced cue utilization and task proficiency is that the use of peripheral (occasionally or partially relevant) cues has been reduced, while the use of central and immediately relevant cues has been maintained (Easterbrook, 1959). Assuming that proficiency is a function of the number of cues in use and that simultaneous use of task-relevant and task-irrelevant cues reduces the effectiveness of response, then the reduction in range will reduce the proportion of irrelevant (peripheral) cues employed and so improve performance. These points were illustrated nicely by Bahrick, Fitts, and Rankin's (1954) use of pursuit-rotor tracking as the central task and reporting of light and dial measures on the periphery of the display as the peripheral task. As predicted, the performance of Ss administered bonuses for high tracking scores (central task) was superior to the low motivation group, while performance on the peripheral tasks was inferior under high motivation, despite the fact that they too were more rewarded. "Thus, the benefits attributable to motivation were obtained on the central task at the cost of proficiency on the broader (central peripheral) tasks (Easterbrook, 1959, p. 185)."

It should be noted that where peripheral cues are relevant (e.g., size constancy, latent learning) or where task complexity is high (thus more cues in the situation become relevant), one would predict less proficient performance associated with reduced range. Support exists for both the former (Bruner, Matter, & Papanek, 1955; Callaway & Thompson, 1953) and the latter (Cohen, 1952; Porteus, 1961; Wright, 1954) cue conditions. In addition, when all irrelevant cues have been excluded, further reduction in the number of cues employed (i.e., greater reduction in range) can only affect relevant cues, and proficiency would be predicted to fall (Easterbrook, 1959).

Broen (1968) has similarly stressed task complexity as an important variable in predicting proficiency of performance under reduced cue conditions. However, he questioned the direct causative effects of arousal on reduced attention and cited theory (Callaway & Stone, 1960) and research (e.g., Broen & Storms, 1961, 1966) which indicates a mediating variable of response competition. Briefly, it is felt that sympathetic and cortical arousal may, in some situations, increase response competition, and it is this response competition that human beings react to by reducing their range of observation. Broen further stated that unless a situation evokes concurrent competing responses, and increase in arousal will not tend to lead to response disorganization and thus no restriction of cues will result. Support for this notion comes from a study similar to the Bahrick et al.'s (1954) experiment cited above. Thus, Bursill (1958) found the usual reduced attention in terms of performance proficiency to the peripheral task during complex pursuit tracking, but not during less demanding tracking conditions. However, Easterbrook's (1959) alternative interpretation that the less demanding task having less relevant cues allows irrelevant or periphery cues to be utilized within the reduced cue span is just as viable. Therefore, the causative chain still remains unclear. However, Broen (1968) has appropriately drawn attention to a previously neglected, yet significant, variable of response competition.

In light of Broen's (1968) argument, his further distinction between actual scanning of the stimuli (which greatly determines the range of cue utilization) and the organization of response tendencies that are evoked by the multiple stimuli that have been scanned seems worth making, especially when dealing with schizophrenic Ss. Not only do schizophrenics exhibit the same effects of reduced cue utilization as do normals, but also are subject to intrusions of associated ideas (response competition) which Broen (1968) has emphasized as disorganizing. Furthermore, these attentional anomalies are exaggerated in schizophrenics due to their chronic heightened level of autonomic (Broen, 1968; Lang & Buss, 1965; Goldstein & Acker, 1967), neuromuscular (Malmo, Shagass, & Smith, 1951; Petursson, 1962; Whatmore & Ellis, 1958) and electrocortical (Jones, Blacker, Callaway, & Layne, 1965; Salamon & Post, 1965) indices of arousal. Review of studies of attention using schizophrenic Ss would now seem appropriate.

Schizophrenia Literature

There have been three recent reviews of attention processes in schizophrenia (Broen,1968; McGhie, 1970; Venables, 1964), and a brief synthesis of their material and conclusions follows. The most reliable finding is that while acute schizophrenics exhibit broadened attention (greater range of cue utilization than normals), chronics show narrowed attention, as would be expected of over-aroused individuals. The evidence for these results comes from studies of attention processes dealing either with external information (physical displays) or internal information (memory, meaning hierarchies).

External Information

The bulk of studies included under external information has employed the size-constancy task. The overwhelming conclusion to be drawn from these investigations is that chronic schizophrenics exhibit under-constancy (narrowed attention or cue utilization) under both cue (Hamilton, 1963; Weckowicz, 1957, 1958) and cueless (Hamilton, 1963) conditions. Less size constancy has similarly been reported for schizophrenics in poor contact (probably chronic) than for those in good contact or for normals (Lovinger, 1956). Since thought disorder is probably related to degree of contact, it is of interest that Weckowicz and Blewett (1959) supported Lovinger's (1956) results in that patients of high thought disorder (impaired abstract thinking) showed poor size constancy, while paranoids (much less disordered) exhibited well-maintained constancy.

The size-constancy results have been similarly found for distance constancy, chronics underestimating distance relative to controls (Hamilton, 1963; Weckowicz, Sommer, & Hall, 1958). In addition, Hamilton (1963) observed that paranoids markedly overestimate distance. Results divergent from those found for chronic non-paranoids were reported by Nelson and Caldwell (1962) in that acutes gave no indication of an inaccuracy of depth perception, and in fact, tended to be more accurate than normals, indicating some degree of overconstancy for these Ss. Since schizophrenics who yield a higher estimation of the size of distant objects exhibit a significant rise in blood pressure after a mecholyl injection (Weckowicz, 1958), Weckowicz (1958) suggested a parasympathetic imbalance in these Ss, usually those in the acute phase. Acutes have similarly shown tendency toward under-arousal on several other indicators (Venables, 1966).

It is not surprising that chronics have yielded little rise in blood pressure after mecholyl injection since they tend toward underconstancy, suggesting sympathetic imbalance (Weckowicz, 1958). This latter suggestion is not uncommon, as noted above.

Narrowed attention has been examined using many other tasks. Thus, on a card sorting task which yielded greater proficiency the more irrelevant material was disregarded, Venables (1963a) found greater narrowed attention in chronic nonparanoids who were rated as withdrawn (Ss who exhibit high cortical activation; Venables & Wing, 1962) relative to those rated as active. Moreover, a lack of relation between withdrawal and reduced cue utilization found for paranoids (Venables, 1963a) is in line with the previously reported differences between these patients and other schizophrenics.

Incidental learning tasks have also supported the narrowed attention hypothesis, with chronics showing the least proficiency (Greenberg, 1953; Topping & O'Connor, 1960). However, again the findings did not hold for paranoids or acutes (Greenberg, 1953).

Finally, Dragùns (1963) found that chronic nonparanoids stopped viewing blurred drawings earlier than normals, even though they did not have sufficient information to identify the object. Acutes held an intermediate position between chronics and normals, differing significantly from neither group.

Internal Information

Reaction-time (RT) tasks are of a kind in which information from previous events affects performance. When the preparatory interval (PI-- the interval between "ready" and "go" signals) varies, maximal readiness should be obtained by scanning past PIs held in memory, noting the length of PI when the probability of the "go" signal begins to climb sharply, and beginning to sharpen readiness when that interval has passed since the "ready" signal. Recent events would be dominant in memory and, if any reduction in cue utilization occurs, more remote events will be more likely to be ignored. Thus, the pattern of readiness preparation should be over-determined by the length of the immediately preceding preparatory interval (PPI). In a task where the length of PIs varies, if the PPI has been longer than average, on the present trial the point at which readiness will begin to be high should often be late. If memory scanning is more restricted in chronic schizophrenics than in normals, chronics should show a closer relationship between reaction time and length of the dominant PI in memory, the PPI.

Zahn, Rosenthal, and Shakow (1963) found exactly this. Though both groups' readiness was over-determined by the PPI (indicating that early scanning of the PPI is the dominant scanning response for both groups), chronics' was more so. Thus, in chronic schizophrenics, the length of the PPI was a larger part of the available information about length of preparatory intervals, and RT was more closely related to PPI.

Zahn, Rosenthal, and Shakow (1961) also found that if a series of regular PIs were presented followed by trials with a shorter PI, chronics were more influenced by the prominent (previous) PI length than were normals. As Broen (1968) noted, "this seems to be a case of inability to adapt because of overfocus on more remote information that has become prominent through repetition (p. 144)."

The way in which words are used should also reflect the degree to which internal information is scanned. For instance, since chronic schizophrenics stop scanning temporally sooner than do normals, then it would be expected that they would stop scanning meanings of multi-meaning words sooner and thus be over-determined by the dominant meaning of a word. This is, of course, exactly what Chapman, Chapman, and Miller (1964) have found in a series of studies using long-term chronic schizophrenics. Moreover, not only are chronics over-dtermined by the dominant meaning, but also are less capable of recognizing unusual meanings of words (Willner, 1965).

One study by Ashman (1959), using chronic nonparanoids, found temporal narrowing on a task requiring perception of statistical structure, similar to the binary choice guessing task cited above (Callaway, 1959). Ashman noted that patients were not able to utilize prior probability learning on responding appropriately to later patterns. They tend to perseverate to a reinforced response inappropriate and after the cessation of a reinforcement renders the response inappropriate in terms of a different pattern of events.

Finally, effects of anchor stimuli (Boardman, Goldstone, Reiner, & Fathouer, 1962; Salzinger, 1957; Weinstein, Goldstone, & Boardman, 1958) upon later judgments seem minimal in chronics (narrowed attention), while acutes still have in their broadened attention the impression left by the previous anchor gimen.

Thus, in a number of experiments that require the scanning of internal information, chronics seem to have a limited breadth of scanning. In scanning memory (Zahn et al., 1961, 1963) chronics seem to base their readiness in RT tasks abnormally on prominent information-- the length of the prior PIs or the length of regularly repeated PIs. Chronics also appear to focus too much on recent anchor stimuli (Weinstein et al., 1958) if given shortly before the task and prominent meanings of words, tending to neglect less prominent meanings (Chapman et al., 1964; Willner, 1965).

On the other hand, acutes seem to show opposite tendencies than chronics, though the evidence is sparce. However, evidence cited by Payne (1962) and Payne and Friedlander (1962) on over-inclusion suggests excessive broadness of attention in acutes, yet not in chronics.

In summary, then, the concept of reduced cue utilization or narrowed attention seems well demonstrated in both normals and chronics. At this point, most needed is a model of attention processes that will integrate these findings, in general, and also include tenets which will account for the prominent response competition found in schizophrenia (Bleuler, 1950; Broen & Storms, 1961, 1966). One relevant model is the model of attention processes proposed by Broadbent (1958), which is based on a great amount of research on attention in normals.

Using the Broadbent Model

In Broadbent's (1958) model, "a nervous system acts to some extent as a single communication channel, so that it is meaningful to regard it as having a limited capacity (p. 297)." This capacity is defined in terms of the amount of information contained in the sensory events being processed. Sensory events do not enter this channel directly; rather, after being registered by sensory receptors, they are held in a short-term store, where they decay rapidly if not selected by a selective filter to enter the limited capacity information-processing channel. "The selection is not completely random, and the probability of a particular class of events being selected is increased by certain properties of the events (e.g., intensity) and states of the organism (drives) (p. 297)."

Once signals have been selected from short-term store, the conditional probabilities concerning sequences of signals that have been experienced are held in a separate long-term (relatively slowly decaying) store. These conditional probabilities have two functions. They are used to predict redundancy in series of signals and thereby reduce the information load in a series of signals, enabling more other signals to be selected to enter the information-processing channel. Also, when an organism is motivated in a certain direction, it enables behaior to "...vary in such a way that it receives that ordered series of stimuli which, from a count of past conditional probabilities, has the highest probability of terminating in the primary reinforcement for that drive (p. 298)." Thus, the store of conditional probabilities of past events not only enables more signals to be processed, but also seems to act on the filter to aid the selection of relevant classes of signals from short-term store. It also seems to enable the person to orient himself so as to be more likely to have relevant information register at the senses and enter the short-term store.

Callaway and Stone (1960) reinterpreted Callaway's research cited above on arousal and attention in terms of Broadbent's model and have included the concept of response competition so necessary in making predictions with schizophrenic Ss. The following characteristics of Broadbent's model were viewed by Callaway and Stone as most important in re-interpreting their results:

1. Information loading imposed by stimuli is a function of the size of the ensemble from which stimuli are expected to be drawn.

2. The greater the overall information load, the slower are adaptive responses.

3. Incoming sensory data can be filtered to reject certain classes of stimuli

4. In addition to filtering, various other forms of coding can be used to reduce the overall information load. Thus: (a) Stimulus classes can be grouped and a whole set of stimulus possibilities can be lumped into one class. (b) A second inportant coding device might be called probabilistic coding. In conventional information theory, an ensemble of possible input classes imposes maximal information load if all classes are considered equally probable. When the classes can be considered in some hierarchy as to the probability of occurrence, then the information load is reduced.

From these characteristics, Callaway and Stone (1960) state that "our best prediction is that arousal will lead to: (1) reduced probabilistic coding (i.e., increased overall uncertainty with regard to the stimulus ensemble under consideration); (2) increased filtering (as in our previous concept of narrowed attention); and (3) reduced size of the stimulus ensemble under consideration, accomplished by means of grouping (p. 395)." Together, these points would yield "a reduced ensemble of possible stimuli all considered more nearly equally probable than previously implying a reduced ensemble of response possibilities all more nearly equally ready for expression than previously. This statement is analogous to the Hullian concept that increased drive elevates competing responses nearer to threshold (p. 395)," which leads to response competition as emphasized by Broen (1968) in his interpretation of schizophrenic thought disorder.

In line with his distinction between scanning range and the organization of information already scanned, Broen (1968) sees the reduction in probabilistic coding (leading to response competition) as affecting the organization of information already scanned. He has also emphasized increased filtering or, as he labeled it, reduced range of scanning in chronic schizophrenics. However, another important coding device pointed out by Callaway and Stone (1960) as characteristic of information processing is that of grouping. It is strange that Broen has not dealt with this variable since it affects the organization of information already scanned, and, in turn, must be affected by the other variables of probabilistic coding and filtering. One might expect the latter two variables to adversely affect grouping under extreme conditions of arousal (as found in chronic schizophrenia), since grouping would be carried out under conditions of reduced information and knowledge of relevancy (increased filtering or narrowed range of cue utilization) and where all elements of the remaining information are treated as if they were more nearly equal in importance or probability of occurrence (reduced probabilistic coding), leading to response competition of possibly disorganizing proportions. One might find that the normal use of group names as mediators for recalling elements of information in clusters disorganizes due to response competition, filtering or both concurrently.

Recently using Broadbent's model, McGhie (1970), noting the inability of schizophrenics to exclude irrelevant information (Lawson, McGhie, & Chapman, 1966; McGhie, Chapman & Lawson, 1965), indicated that in schizophrenia the normal filtering process has broken down so that the patients are less able to attend selectively and to process only relevant information. This deficit is seen as less obvious in situations requiring a response to simple predictable stimuli, yet is blatantly obvious in tasks demanding the monitoring of a range of stimuli involving more complex decision making. Broen (1968) has made the same distinction, suggesting that response competition is increased by the complex task.

In addition, McGhie (1970) noted schizophrenic's inability to process incoming verbal materials (e.g., speech) in meaningful relationships to each other as part of an organized pattern. He suggested that this was due mainly to a deficiency in the screening out of redundant information, as normals do (Goldman-Eisler, 1961; Miller, 1963; Shannon, 1951), and to an inability to organize the incoming verbal data in an economical way. In terms of Broadbent's model, these two factors coincide with filtering and grouping, respectively. Thus, McGhie (1970) has emphasized, though not explicitly, the coding variable neglected by Broen (1968), namely grouping.

As a preliminary test of this hypotheses, Lawson, McGhie, and Chapman (1964) presented schizophrenics, patients suffering from other psychiatric conditions, and normal Ss with passages of English prose of different degrees of internal organization (Miller & Selfridge, 1950). These varied from collections of random unrelated words (zero constraint) to standard English text. The intervening passages were graded according to the degree of contextual constraint involved in their structure. The results clearly indicated that, althogh the schizophrenics were able to perceive and recall sentences of low contextual constraint as well as the controls, they fared badly in comparison with non-schizophrenics in dealing with sentences of higher constraint. "In other words, the schizophrenic seems unable to utilize the transitional bonds between words which normally facilitate perception of the passage as an organized whole (McGhie, 1970, p. 13)."

Although these findings were independently replicated by Nidorf (1964), a more recent study by Raeburn and Tong (1968) failed to substantiate some of the findings. Raeburn and Tong's results indicated that both speed of writing the response down in recall and verbal ability (both uncontrolled in the Lawson et al. study) are related to the recall of contextually constrained passages and that the effect observed by Lawson et al. (1964) is confined to certain schizophrenics. Furthermore, Lewinsohn and Elwood (1961) using the same task found that while only chronics were unable to make use of the contextual constraints of language relative to acutes, non-schizophrenic patients, and normals, the difference between chronics and the rest disappeared when the vocabulary level was controlled. However, as Venables (1964) noted, verbal ability measured in terms of vocabulary performance, insofar as it is the selection of a verbal description of a word while keeping that word in the forefront of attention, might very well be contaminated by the mechanism of narrowed attention. If this is valid, then the language experiments tend to support the general notion that the selection of the immediate response which is in the foreground of attention is not helped in chronic schizophrenics by the pattern or structure of the words or letters normally surrounding it. In other words, grouping information into meaningful units may be adversely affected by extreme filtering (narrowed attention) through the elimination of relevant cues necessary for grouping.

It would seem, then, that a clean investigation of grouping in schizophrenics has yet to be undertaken. The purpose of the present research is to analyze grouping in chronic schizophrenics in a well established task measuring statistically the amount of grouping exhibited. Further, the task is sensitive to effects of increased filtering and also to reduced probabilistic coding. These three variables will be analyzed under conditions of normal and increased arousal, and under conditions designed specifically to increase response competition.

The task to be used originated from a paper by Miller (1956). Miller hypothesized a process of organizing or grouping input information into familiar units, dimensions, or chunks. He states that the number of chunks of information is constant for the span of immediate memory but that the span seems to be almost independent of the number of items of information per chunk. Most input is given in a code that contains many chunks with few items per chunk. To increase one's transmission of information, the input is recoded into another code that contains fewer chunks with more items per chunk. At time of output, the chunks are recalled and decoded into their respective items.

Miller's chunk hypothesis has been well supported in studies using normal Ss (e.g., Bousefield, 1953; Bousefield & Cohen, 1956; Cohen, 1963; Dallett, 1964; Mathews, 1954) through the use of a verbal learning task. Bousefield, Cohen, and Whitmarsh (1958) made up lists consisting of words given by Ss as associates to category names. Thus, for each item the frequency with which the item is given in response to its category name is known. These category-membership norms (Taxonomic Frequency) as well as frequencies of usage from the Thorndike-Lorge (1944) L count were used to construct lists which were equated as nearly as possible for (a) mean taxonomic frequency per word, and (b) mean frequency of usage.

It was found that words falling into categories presented in a randomized order for free recall, are recalled in clusters according to category membership and that recall of such a category-organized list is better than recall of a randomly selected set of words (Bousefield, 1953; Bousefield & Cohen, 1956; Cohen, 1963; Dallett, 1964; Mathews, 1954).

More specific findings of import for the present paper are that: (1) both nonexhaustive categories (NE) (list words only partially exhausted the pool of words belonging to a category) and exhaustive categories (E) (list words exhausted, or nearly so, the entire pool of words belonging to the category) were equally represented in recall in clusters, however, there was a significantly greater number of words recalled in E categories (Cohen, 1963). This was believed to be due to the greater inter-item associative strength of E as opposed to NE words. (2) Greatest recall and clustering in recall resulted in 4-category lists, especially in blocked order (where all members within a given category were contiguous) as opposed to random order (where no word of a category followed a word from the same category) (Dallett, 1964). Dallett explained the interaction between category number (NC) and clustering by postulating that as NC decreases from about 12, not only does the number of category names decrease, making them easier to remember, but also the number of members of each category increases, making the categories easier to identify. This analysis suggests that not only those associative linkages which relate category members to one another should be considered, but also those which relate category members to category names.

These studies have well supported Miller's chunk hypothesis and indicate the efficacy of the task employed as a measure of chunking or grouping. Thus, the task seems well suited for analyzing grouping in schizophrenics. In addition, the task would seem sensitive to extreme filtering or reduced scanning since measures such as total recall, number of categories, and number of words per category represented in recall are easily obtainable and would necessarily be affected by narrowed spatial scanning as well as reduced temporal scanning of memory. Moreover, if NE categories are employed, then it might be assumed that associated words of the category in question, not included in the list, would be natural intrusions and simulate the response competition so pervasive in schizophrenia (Broen, 11968). This assumption is supported by research which indicates that intrusions do occur greatly in the recall of schizophrenics on verbal learning tasks relative to normals (Kausler, Lair, & Matsumoto, 1964; Lang & Luoto, 1962) and that intrusions are associative in nature rather than completely irrelevant (Burstein, 1961).

Thus, the task allows the investigation of grouping in schizophrenia as well as the effects of increased filtering and response competition upon it. Since arousal level is a key factor in determining degree of filtering and response competition (Broen, 1968), treatment of this concept as an independent variable would seem most valuable. Therefore, chronic nonparanoid schizophrenics will be selected who differ in arousal level under non-stimulating conditions. Venables and his colleagues (Venables, 1960, 1963a; Venables & Wing, 1962), through the use of a rating scale (Venables, 1957), have dichotomized chronic nonparanoids into active and withdrawn and found the latter to be of greater level of arousal. In addition, as might be expected, withdrawns show greater narrowing of attention (Venables, 1963a). The use of withdrawn and active schizophrenics on a task of cognitive, information-processing will , in addition, illuminate this patient distinction since to date only motor (Tizard & Venables, 1957; Venables & O'Connor, 1959; Venables & Tizard, 1956, 1958), attention (Venables, 1963a), and arousal (Venables, 1963b; Venables & Wing, 1962) functioning have been assessed in these Ss.

A further manipulation of arousal will be employed, that of maintaining grip pressure on a hand dynamometer. Pinneo,(1961) has demonstrated increased neuromuscular, autonomic, and electrocortical indices of arousal with dynamometer induced arousal. Moreover, dynamometer induced arousal results in increased response competition (Broen, Storms, & Goldberg, 1963) as well as increased total recall (Bourne, 1955).

The present paper presents two studies designed to investigate: (1) grouping in chronic nonparanoid schizophrenics; and (2) the effects of reduced probabilistic coding (response competition) and increased filtering upon grouping.

CHAPTER II

METHOD

EXPERIMENT I

The first experiment involves a direct test of grouping or chunking in schizophrenics employing three serial lists of increasing inherent "chunkability." The hypotheses are:

1. Schizophrenics will not be aided by the increasing inherent chunkability of the lists and thus will not reveal increased recall as lists increase in chunkability, nor will they demonstrate clustering in recall, relative to controls.

2. Schizophrenics will reveal increased filtering in terms of reduced number of categories recalled, number of words per category recalled, or both, relative to controls.

3. Schizophrenics will reveal greater response competition in terms of total number of intrusions in list recall relative to controls.

4. Withdrawn schizophrenics, given their higher level of arousal, should reveal greater deficit on the measures of hypotheses 1, 2, and 3, relative to the other groups.

Method

Subjects

Seventy-five females, including 15 withdrawn chronic nonparanoid schizophrenics (WS), 15 active chronic nonparanoid schizophrenics (AS), 15 withdrawn chronic neurotics (WN), 15 active chronic neurotics (AN), and 15 normals (N), will serve as Ss. The psychiatric inpatients will be obtained from a state mental hospital, while normals will consist of introductory psychology students. Patients scoring 30 or less on Venables' (1957) Activity--Withdrawal Scale will be classified as withdrawn; those scoring 31 or more will be classified as active. The neurotics will also be dichotomized in order to assess the activity-withdrawal variable independently of schizophrenic deficit. Patients to be considered chronic will need to have been diagnosed as such in staffing, have been in the hospital at least 6 months on their current admission, have had a history of at least 2 previous hospitalizations, the first of which being at least 3 years prior to the current admission. The latter criterion is in keeping with the 2-year criterion suggested by Brown's (1960) findings, and with Johannsen and O'Connell's (1965) evidence that perceptual decrement is related to the duration of the basic illness (defined as time since initial hospitalization) and not related to percentage of time spent in the hospital since the initial diagnosis. However, any effects due to institutionalization per se will be controlled through the use of chronic patient controls (i.e., neurotics). Schizophrenics having the diagnosis of paranoid-type or found delusional in an initial interview will not be used. Moreover, none of the patients will have a history of brain pathology, alcoholism, mental retardation, electroconvulsive or insulin therapy.

Patient groups will be matched on age, education, length of current hospitalization, and time since first hospitalization. Patients will need to have completed 11 grades of schooling.

Apparatus and Materials

Three lists of 20 words each were made up using the materials presented by Cohen (1963). His lists consisted of words given by Ss as associates to category names (Cohen, Bousefield, & Whitmarsh, 1957). Thus, for each item the frequency with which the item is given in response to its category name is known. These category-membership norms (taxonomic frequency) as well as frequencies of usage from the Thorndike-Lorge (1944) G count were used to construct lists which were equated as nearly as possible for (a) mean taxonomic frequency per word, and (b) mean frequency of usage. The pool of words selected were already categorized with points (a) and (b) controlled and may be found in Cohen (1963). Two of the lists to be used contain words that are capable of being chunked into categories. Only the order of presentation is different: in one the words are random; in the other they are blocked, as defined above (Dallett, 1964). The third list (Non-Grp) contains words of the same G-count as those of the other 2 lists, however, the words are not capable of being chunked into categories. This list will be used to equate groups on list learning and recall ability. Eight categories (Cohen, 1963) were used: 4 for the random list (cloth, furniture, fish, landscape features) and 4 for the blocked list (trees, animals, vehicles, bodily parts). Each category contained 5 words. Words will be presented for a 2-sec. duration on a Lafayette memory drum aparatus.

Procedure

Patients will be brought to the testing room for purposes of habituation to the experimental situation, apparatus, and experimenter. The room will be located off the ward and relatively free of distracting noise. Later the same day, the patient will return to the room. Following instructions, lists will be then presented, in counterbalanced order, for 1 exposure each. A 1-minute verbal free recall will be recorded following each list, with an average inter-list interval of approximately 2 minutes elapsing.

Instructions

Upon being seated, all Ss will be told:

"This is a study in verbal learning. A list of words will appear in this window (indicating the memory drum window). One word will appear at a time, every 2 sec. Say each word aloud as it appears and when the list is finished, I will ask you to tell me as many words as you remember in any order. They do not have to be remembered in the order presented. You will see the list only once."

After recall of the first list, Ss will then be told:

"Now a list will appear in this window. You are to do exactly as you did on the first list" (a restatement of the original instructions will then be read).

The same procedure will be followed for the third list.

EXPERIMENT II

The second experiment was designed to assess the differential effects of non-arousing and arousing condition upon grouping in a task fostering high response competition. This will allow an analysis of the effects of response competition upon grouping independently of heightened arousal and extreme filtering (non-arousal condition), plus the effects of an interaction between arousal, filtering, and response competition (arousal condition). In other words, the question being asked here is: does the normal use of category names as mediators for recalling words in clusters disorganize under conditons of high response competition, filtering and arousal, or all three concurrently? It is this analysis which will hopefully answer the question of what occurs to the grouping process in schizophrenics under disorganizing circumstances. The hypotheses are:

1. Schizophrenics will not group (as shown by cluster analysis) either under non-arousal or arousal conditions while controls will.

2. Schizophrenics will show reduced total recall, number of categories, and number of words per category in recall under the arousal condition relative to the non-arousal condition. Controls will exhibit the same pattern but to less a degree.

3. Schizophrenics will exhibit a greater frequency of intrusions than controls, showing the greatest in the arousal condition.

4. Withdrawn schizophrenics will reveal the greatest deficit on the measures of hypotheses 1, 2, and 3, relative to the other groups.

Method

Subjects

One-hundred and fifty females, including 30 WS, 30 AS, 30

WN, 30 AN, and 30 N, will serve as Ss. The Ss will be obtained from the same sources, will be classified in identical fashion, and will meet identical criteriaias in experiment I. One-half of the Ss in each group will be randomly assigned to the arousal condition, while the other half will be assigned to the non-arousal condition.

Apparatus and Materials

Response competition will be induced through the use of a proactive inhibition (PI) design. Two category lists (designated I and II, consisting of 12 and 16 words respectively), were made up again by using the materials presented by Cohen (1963). The lists have different words yet identical non-exhaustive categories (clothes, animals, furniture, bodily parts) which number 4 (list I=3 word per category; list II=4) and are in blocked order. The blocked order and 4-category lists should maximize the potentiality for clustering in recall (Dallett, 1964), while the identical categories yet different words within those categories should maximize the possibility of intrusions due to PI. Both maximizations are desirable for the present experiment. Presentation of words will be identical to that of experiment I.

Arousal will be induced by S maintaining grip pressure on a Stoelting Co. hand dynamometer (Pinneo, 1961). The dynamometer will be on the table to the right of S and in a mount which will allow for easy handling. The dynamometer will be wired to a dim light to be mounted on the top right side of the memory drum which will light if grip pressure deviates 1 kilogram above or below a specified level. One-half of the maximum grip pressure obtained by S will be used to induce arousal during the task.

Procedure

Patients will be habituated as in experiment I. Each S will then be shown the control list, list Non-Grp used in the first experiment, which will be used to equate groups of Ss on list learning and recall ability. Maximum grip pressure will then be ascertained for Ss randomly assigned to the arousal condition, this being followed by a 30-sec. practice session in keeping the light off by maintaining a constant $\frac{1}{2}$ maximum grip pressure. A 5-minute rest period will follow to allow the induced tension to subside. The Ss will then be instructed to learn list I to 2 perfect recalls, a 1-minute verbal free recall period following each presentation. Following this, Ss in the arousal condition will be required to place their right hand on the dynamometer without squeezing, to observe list II for 1 presentation, then to squeeze the dynamometer $\frac{1}{2}$ maximum grip, wait 10 sec., and then to verbally free recall list II while still squeezing the dynamometer. Recall of list II will last 1 minute. The Ss in the non-arousing condition will be required to place their right hand on the dynamometer during both list II presentation and recall but will not be required to squeeze.

Instructions

Upon being seated, all Ss will be given the control list and identical instructions as those in experiment I. Next, the dynamometer procedure will be carried out, followed by repetition of the above instructions for the next list, list I. Here it will be added that the list will be repeated until all of the words are learned well (i.e., 2 perfect recalls). Next Ss will be asked to put their right hand on the dynamometer and will be told the following, with the phreases enclosed in parentheses added for Ss in the arousal condition:

"Now a list will appear in this window, but only once. Again, say each word aloud and when the list is finished and I tell you to begin, (squeeze the dynamometer $\frac{1}{2}$ grip, hold it there keeping the light out, and) tell me as many words as you remember in any order (while still squeezing)."

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APPENDIX B

MATERIALS

WORD LISTS USED IN EXPERIMENT I

NON-GRP	RANDOM	BLOCKED
ARMY	SARDINE	OAK
VEGETABLE	COTTON	MAPLE
FORK	CHAIR	ELM
BLACK	STREAM	SPRUCE
NORTH	DESK	PINE
QUEEN	LINEN	BEAR
VIOLIN	MINNOW	CAT
INCH	HILL	SHEEP
DINNER	COUCH	DOG
MINISTER	VALLEY	HORSE
HOTEL	PERCH	TRAIN
ADDITION	SILK	CAR
ROOF	RIVER	BOAT
FOG	VELVET	TAXI
QUARTER	TABLE	PLANE
SPRING	TROUT	LEG
PIPE	MOUNTAIN	HEAD
JUMP	SATIN	FOOT
SPARK	SALMON	ARM
PEARL	BED	FINGER

WORD LISTS USED IN EXPERIMENT II

I	II
SKIRT	SHIRT
TIE	SHOE
PANTS	BELT
DOG	COAT
PIG	CAT
HORSE	SHEEP
SOFA	GOAT
CHAIR	COW
LAMP	COUCH
FOOT	TABLE
HAND	BED
EAR	DESK
	TOE
	LEG
	FINGER
	EYE

APPENDIX C

MEANS AND STANDARD DEVIATIONS FOR EXPERIMENT I

RECALL ON LISTS

		WS	AS	WN	AN	N
NON-GRP	M	9.27	9.73	9.33	9.20	9.53
	SD	1.16	2.40	1.88	2.11	1.96
RANDOM	M	9.53	10.80	11.20	11.33	11.27
	SD	1.13	2.27	2.37	2.55	2.05
BLOCKED	M	10.40	13.13	15.00	15.13	15.80
	SD	2.38	3.20	2.45	2.77	1.74

CLUSTERING ON LISTS

		WS	AS	WN	AN	N
RANDOM	M	0.49	0.54	0.67	0.64	0.74
	SD	0.25	0.22	0.27	0.26	0.20
BLOCKED	M	0.85	0.92	0.92	0.89	0.92
	SD	0.12	0.08	0.07	0.11	0.08

CATEGORIES ON LISTS

		WS	AS	WN	AN	N
RANDOM	M	3.73	3.27	3.60	3.53	3.67
	SD	0.46	0.70	0.63	0.64	0.49
BLOCKED	M	3.40	3.20	3.73	3.80	3.87
	SD	0.74	0.56	0.46	0.41	0.35

WORDS PER CATEGORY ON LISTS

		WS	AS	WN	AN	N
RANDOM	M	2.60	3.39	2.13	3.26	3.16
	SD	0.52	0.74	0.63	0.76	0.74
BLOCKED	M	3.05	4.08	4.02	3.97	4.11
	SD	0.49	0.58	0.51	0.53	0.46

INTRUSIONS ON LISTS

	WS	AS	WN	AN	N
M	1.18	1.07	0.44	0.38	0.29
SD	1.66	2.50	0.72	0.68	0.55

APPENDIX D

MEANS AND STANDARD DEVIATIONS FOR EXPERIMENT II

RECALL ON LIST II

		WS	AS	WN	AN	N
NON-AROUSAL	M	7.53	7.93	10.00	10.13	10.40
	SD	0.99	1.87	2.24	2.10	1.99
AROUSAL	M	4.60	7.53	8.13	8.53	8.93
	SD	1.64	1.73	1.81	2.13	1.71

CLUSTERING ON LIST II

		WS	AS	WN	AN	N
NON-AROUSAL	M	0.22	0.23	0.68	0.70	0.69
	SD	0.19	0.22	0.21	0.20	0.21
AROUSAL	M	0.24	0.66	0.83	0.80	0.81
	SD	0.33	0.19	0.18	0.19	0.19

CATEGORIES ON LIST II

		WS	AS	WN	AN	N
NON-AROUSAL	M	3.80	3.80	3.80	3.73	3.67
	SD	0.41	0.42	0.41	0.46	0.35
AROUSAL	M	2.73	3.47	3.53	3.33	3.60
	SD	0.80	0.52	0.51	0.62	0.52

WORDS PER CATEGORY ON LIST II

		WS	AS	WN	AN	N
NON-AROUSAL	M	2.01	2.10	2.66	2.77	2.70
	SD	0.38	0.49	0.65	0.74	0.49
AROUSAL	M	1.71	2.17	2.29	2.58	2.46
	SD	0.42	0.34	0.38	0.48	0.41

INTRUSIONS ON LIST II

		WS	AS	WN	AN	N
NON-AROUSAL	M	2.33	1.80	1.00	0.80	0.80
	SD	1.80	1.15	1.00	1.15	1.01
AROUSAL	M	3.40	2.13	1.20	1.13	0.73
	SD	1.88	1.25	0.94	0.83	1.03