effect of DDT upon Group 50 contributed to significantly less nursing activity than in Groups 0 and 100. Also, Group 100, rather than being hyperexcitable, was prostrated by the DDT and thus remained in the nest and nursed.

Further evidence for the hyperexcitability-prostration interpretation is provided by the rejection data. Poor mothering by the animals in Group 50 led to the death of significantly more pups than expected based on the proportion of pups in Group 50 to the total number of pups. The switching of pups across litters renders an alternate interpretation of degree of pup DDT content as an explanation of pup consumption untenable. It should be mentioned that while many of the pups in Group 50 were allowed by the mothers to expire via nonnursing and nonretrieval, cannibalism of healthy pups was also observed.

In conclusion, the data of the present experiment would appear to support the hypothesis that poor maternal behavior, and not only direct ingestion of DDT, may cause harm to neonates.

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Anagram solution times, word length, and type of accessory clue

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Previous research on long-term memory has shown that the number of items retrieved is a power function of the number presented. An application of this power law to the prediction of anagram solution times as a function of word length was, in general, successful. It was also found that giving semantic cues decreased solution time more than did giving graphemic cues.

Studies on the retrieval of items such as words or pictures have shown, that, if P items are presented, and R are retrieved, then

$$R = k\,P^{m} \qquad (1)$$

where k and m are parameters to be found empirically (Standing, 1973; Murray, in press). The question asked in the present work was whether a similar formula could be applied in determining how long it takes to solve an anagram. It seems likely that in solving an anagram the subject processes a number of permutations of the letters of the anagram until he eventually finds a

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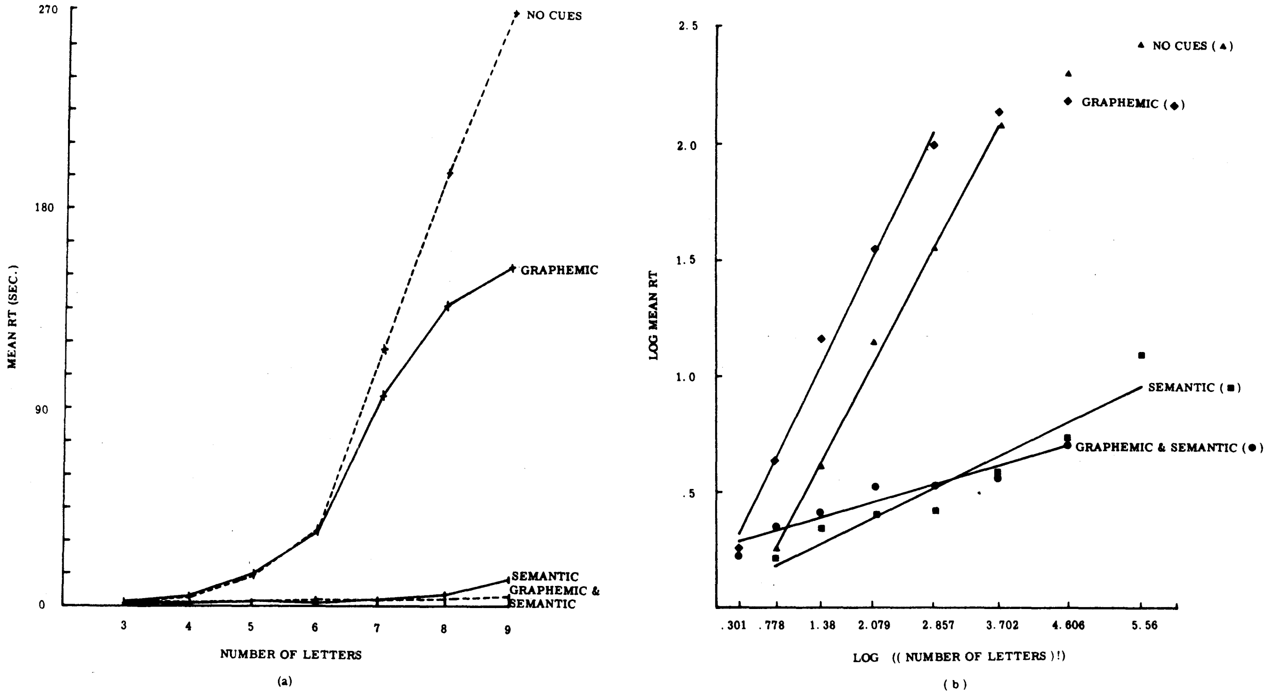

Figure 1. (a) Mean solution time as a function of word length and cue type. (b) The same data replotted in the light of Equation 2 (see text).

permutation corresponding to the solution. Since the number of permutations of a word n letters long is n!, and if we assume that it takes a constant amount of time to find and check a permutation, it might be speculated that the solution time T to solve an anagram of n letters long might be

$$T = k\,(n!)^m \qquad (2)$$

Kaplan and Carvellas (1968) have shown that anagram solution time does indeed increase in a nonlinear fashion with n but did not investigate the above expression because a power law of retrieval was not known at the time. It should be observed that, instead of treating anagrams as simple puzzles in their own right, we are here treating them as retrieval cues: the solution is a word presumably known to the subject and what he must do is unscramble the letters of the anagram until he finds a solution corresponding to that word. Since solution time will probably be facilitated by giving him another retrieval cue besides the anagram—for example, the first letter of the solution, or a clue as to the meaning of the solution—another question of interest in the present study was how giving such an extra cue might reduce the number of permutations through which the subject searchs. Such a facilitation would be expressed in Equation 2 by a reduction in the parameter m: the smaller m is, the smaller the subset of permutations of n! searched through.

METHOD

Materials

The first task of the experiment consisted in finding words of lengths 3 to 9 letters, all of which were approximately equally accessible given a certain meaningful cue. Choosing such words was facilitated by the use of the Battig and Montague category norms (1969), which give the relative frequencies of responses to cues such as "animal' or some other category of words. Five words of each word length were chosen from these norms in such a way that 35 categories were represented, there being 7 word lengths. In order of increasing length the words are: bed, car, cow, leg, red; coal, coat, hour, milk, roof; horse, maple, meter, rabbi, waltz; cancer, church, cotton, cousin, pepper; emerald, general, tornado, trumpet, whiskey; aluminum, cardinal, football, mosquito, mountain; adjective, chemistry, destroyer, newspaper, president. Each of these words was turned into an anagram, using random number tables to determine the order of the letters in the anagram. Four sets of 35 slides, with one anagram per slide, were then prepared. On the "no cue" slides, just the anagram was shown. On the "semantic cue" set, an anagram was shown with a meaningful cue just beneath it. For example, the slides whose solution was "cancer' showed:

NRACEC
Type of disease

The cue in question was the category name from the Battig and Montague list. On the "graphemic cue" set, the anagram was shown along with the first letter of the solution. On the "graphemic plus semantic cue" set, the anagram was shown along with a meaningful cue plus the first letter of the solution.

Subjects and Procedure

Four groups of subjects, with 10 subjects in each, were chosen

Table 1
Estimated Mean Time in Milliseconds to Process a Single Permutation, Derived from Inserting the Appropriate Numerical Values in Equation 2

	Word Length						
	3	4	5	6	7	8	9
No Cues	976	931	1174	972	964		
Graphemic Cues	874	994	1306	1040	875		
Semantic Cues	1077	1162	1028	791	939	846	1354
Graphemic + Semantic Cues	871	1033	1053	1176	981	894	1009

from volunteers from introductory psychology classes at Queen's University. Each group was assigned its own set of slides, thus making cue type a between-subjects variable and word length a within-subjects variable. Each subject sat about 5 ft from the screen on which the slides were projected; each subject was tested individually. Before each trial the experimenter said "ready,' then a single slide was flashed on. The slide stayed on while the subject tried to solve the anagram (using pen and paper is desired). When he thought he had the correct solution he spoke the solution aloud and a voice-key apparatus recorded the time between slide onset and the subject's response. If he did not have a solution after 5 min the trial was terminated and he was given a score of 300 sec as his solution time. Three practice trials were given at the start of the session. The order in which the words of various lengths were examined were random with respect to the 35 slides seen by each subject.

RESULTS AND DISCUSSION

Taking the mean reaction time to solve an anagram as a measure of T, we find the results shown in Figure 1. On the left are shown the raw data before transformation. If a power function holds, as Equation 2 suggests, then plotting the same data on log-log axes, and plotting $(n!)$ instead of n, should yield linear functions. In Figure 1b, this transformation is shown, though it should be noted that for graphemic cue conditons, since the first letter is already given to the subject, the appropriate plot is against $\log [(n-1)!]$ rather than $\log (n!)$. It is obvious that for no cues and for graphemic cues, the data are not linear beyond 7 letters. Kaplan and Carvellas obtained a similar result, but it should be recognized that in the present experiment it is possible that cutting off the solution time at 5 min may have artificially depressed the values for 8 or 9 letter items. With semantic and graphemic plus semantic cues, however, the relationship between T and $n!$ appears to hold systematically even for these longer word lengths. The straight lines in Figure 2 were fitted by least squares; r values for the 4 lines are as follows: no cues, $r = .998$; graphemic cues, $r = .994$; semantic cues, $r = .956$; graphemic plus semantic cues, $r = .959$. All these r values are highly significant. When m and k were calculated, the following values were found: no cues, $m = .622$, $k = .607$; graphemic cues, $m = .673$, $k = 1.324$; semantic cues, $m = .162$, $k = 1.143$; graphemic plus semantic cues, $m = .095$, $k = 1.828$. In general, the m values decrease, the easier the cue (semantic cues obviously being more helpful than graphemic cues): this is consistent with the speculation made in the first paragraph.

However, Equation 2 is only valid given that a constant amount of time is presumably spent on each permutation during the solution process. It is possible to solve Equation 2 numerically, for each condition, and arrive at the estimated time per permutation under each condition. These values are shown in Table 1. The mean time taken to process a permutation was 1009 msec; this value did not change significantly with the type of retrieval cue given (analysis of variance on the first 5 columns of Table 1 gave $F = .099$, $df = 3,16$). This is a slow rate of processing, compared with other values of processing time such as those found by Sternberg (1966) for memory scanning; it is likely that the second or so taken to process a permutation includes rapid subconscious search for a permutation likely to be valid given the constraints of the English language, followed by a check against the anagram to verify that all letters are accounted for. It is possible that the "permutations" searched given a semantic cue are themselves words, associates to the cue, with each word being matched against the anagram; given no cues or graphemic cues only, it is more likely that permutations of the anagram itself are perused, with the check made against one's lexicon of English words. Further experimentation will be necessary to evaluate this hypothesis. For the moment, we may conclude that, since an equation derived from memory studies was successful in predicting anagram solution time, then anagrams themselves can be seen as retrieval cues of a rather special kind.

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