space/animal and number of animals/cage during development seem to alter social behavior.

The reliability of qualitative ratings in this study were less than ideal, and the number of pairs observed was not large. Despite these limitations, differences were observed in social behavior resulting from different levels of crowding during development, even after a 6-month period of individual laboratory housing. The alterations which were observed seem to have been adaptations to population density that would tend to reduce aggressiveness in crowded living conditions.

Studies conducted by Latané and his students clearly indicate that housing conditions immediately prior to observation have an effect upon open-field social behaviors in the rat. They found little effect of number of animals/cage or density of cagemates on social behaviors. Perhaps the limited range of housing conditions accounts for the difference between our results and theirs. The present study shows that, under extreme conditions of space/animal or number of animals/cage, social effects are observed.

This study also emphasizes the importance of controlling developmental housing conditions, particularly if adult social behaviors are the object of study.

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Retrieval of categorized items increases without guessing

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Without any feedback to distinguish correct recall from intrusions, spontaneous retrieval (without further presentation after initial recall of each item) of a list of 20 animals increased rapidly during free recall verbal learning. Intrusions, elicited by requiring forced recall of 20 items on each trial, decreased as correct recall increased. List items were recalled with great consistency once they were spontaneously retrieved; total recall was limited more by the initial difficulty of retrieving an item from long-term storage for the first time. Since these results show that subjects know which items belong to the list, they indicated that spontaneous retrieval of items from the same category does show retention and retrieval, rather than guessing. Forced recall increases retrieval even more than extended recall does, not through guessing but by encouraging further search in long-term storage for recovery of more items, which are correctly discriminated when found.

Spontaneous retrieval from long-term storage during verbal learning has recently been shown by repeated retrieval without further presentation of each item after it has been recalled just once (Buschke, 1973, 1974). In free recall list learning of unrelated items, there is no question that such spontaneous retrieval without further presentation shows previous storage and subsequent retention. However, in spontaneous retrieval of related items from the *same category* (such as a list of animals), it is possible that at least some spontaneous recall might represent guessing rather than true retrieval from long-term storage. This could mean that some items in such lists were not really learned at the time of their initial recall and retained for later spontaneous retrieval, but were learned later when a lucky guess was confirmed as correct recall of a list item. This study shows that spontaneous recall of related items that might be guessed does represent true retrieval rather than guessing, by withholding any feedback during learning that might either confirm guesses or correct intrusions.

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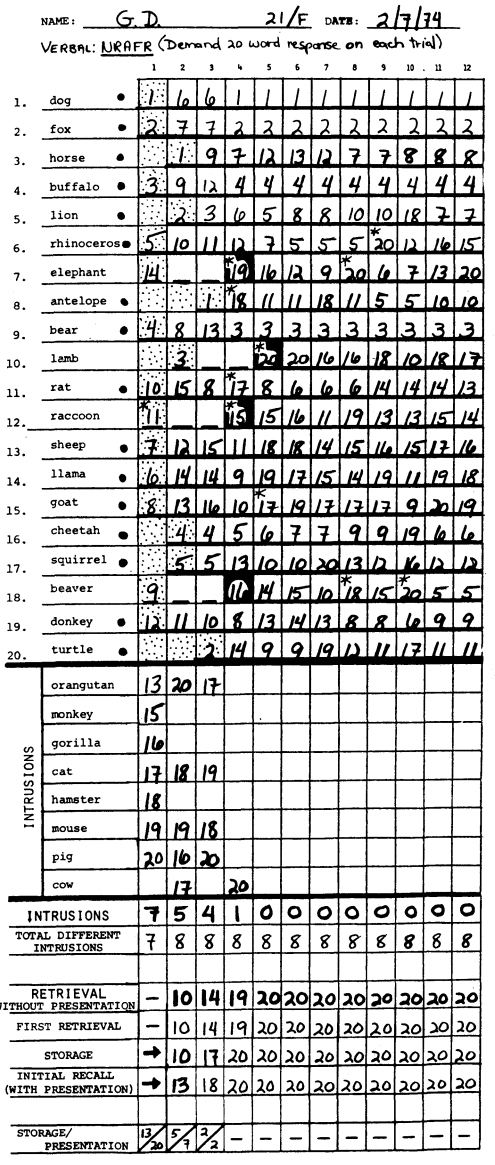
METHOD

Each subject was tested individually, by reading aloud a list of 20 animals at a 2-sec rate for free recall in any order immediately after presentation. After an initial presentation of the entire list, only those items which had not yet been recalled at all were presented again, so that each item was presented only until it had been recalled just once. Since all items were recalled at least once by the third trial, there were no presentations at all on any of the last nine trials. However, the subjects tried to recall *all* of



NAME: G.D. 21/F DATE: 2/7/74

VERBAL: UNAFR (Demand 20 word response on each trial)

		1	2	3	4	5	6	7	8	9	10	11	12
1.	dog •	1	6	6	1	1	1	1	1	1	1	1	1
2.	fox •	2	7	7	2	2	2	2	2	2	2	2	2
3.	horse •		1	9	7	12	13	12	7	7	8	8	8
4.	buffalo •	3	9	12	4	4	4	4	4	4	4	4	4
5.	lion •		2	3	6	5	8	8	10	10	18	7	7
6.	rhinoceros •	5	10	11	12	7	5	5	5	*20	12	16	15
7.	elephant	14	_	_	*19	16	12	9	*20	6	7	13	20
8.	antelope •			1	*18	11	11	18	11	5	5	10	10
9.	bear •	4	8	13	3	3	3	3	3	3	3	3	3
10.	lamb		3	_	_	*20	20	16	16	18	10	18	17
11.	rat •	10	15	8	*17	8	16	16	6	14	14	14	13
12.	raccoon	*11	_	_	*15	15	16	11	19	13	13	15	14
13.	sheep •	7	12	15	11	18	18	14	15	16	15	17	16
14.	llama •	16	14	14	9	19	17	15	14	19	11	19	18
15.	goat •	8	13	16	10	*17	19	17	17	17	9	20	19
16.	cheetah •		4	4	5	6	7	7	9	9	19	6	6
17.	squirrel •		5	5	13	10	10	20	13	12	16	12	12
18.	beaver	9	_	_	*18	14	15	10	*18	15	*20	5	5
19.	donkey •	12	11	10	8	13	14	13	8	8	16	9	9
20.	turtle •			2	14	9	9	19	12	11	17	11	11
INTRUSIONS	orangutan	13	20	17									
	monkey	15											
	gorilla	16											
	cat	17	18	19									
	hamster	18											
	mouse	19	19	18									
	pig	20	16	20									
	cow		17		20								
INTRUSIONS		7	5	4	1	0	0	0	0	0	0	0	0
TOTAL DIFFERENT INTRUSIONS		7	8	8	8	8	8	8	8	8	8	8	8
RETRIEVAL WITHOUT PRESENTATION		–	10	14	19	20	20	20	20	20	20	20	20
FIRST RETRIEVAL		–	10	14	19	20	20	20	20	20	20	20	20
STORAGE		→	10	17	20	20	20	20	20	20	20	20	20
INITIAL RECALL (WITH PRESENTATION)		→	13	18	20	20	20	20	20	20	20	20	20
STORAGE/ PRESENTATION		13/20	5/7	3/2	–	–	–	–	–	–	–	–	–

Figure 1. Free recall verbal learning without further presentation of items recalled once, using forced and extended recall on each trial to show increasing spontaneous retrieval without confirmation of correct recall or correction of intrusions.

the items in the entire list on each of the 12 trials.

The subjects' verbal recall was recorded by the examiner, who gave absolutely no feedback to confirm correct recall of list items or to correct intrusions. The subjects were allowed as much time as they wished for recall, and were urged to extend their recall even after it became difficult, in order to obtain the maximum retrieval necessary for accurate evaluation of storage and retention. In order to elicit intrusions, as well as to maximize retrieval, these subjects were required to recall 20 items on each trial.

The subjects were 10 young adults, who were paid for their voluntary participation in this experiment. The list of animals used is shown in Figure 1, which illustrates the procedure of free recall learning with restricted reminding.

INDIVIDUAL RESULTS AND DISCUSSION

Figure 1 shows such free recall learning by an individual subject. The stippled cells show which items were presented on each trial. The numbers in each column show the order in which items were recalled; if there is no number in a cell, it means that item was not recalled on that trial. Numbers in stippled cells show recall with presentation. Numbers in cells without stippling show recall without presentation, after interference by the presentation and recall of other items, which identifies true retrieval from long-term storage (Buschke, 1973; 1974). The asterisks indicate late retreival by very extended recall after a long pause in recall.

Retrieval from long-term storage also demonstrates initial storage and subsequent retention. If an item is retrieved spontaneously without further presentation and without confirmation of correct recall or correction of intrusions, that item must have been stored on (or before) its last presentation, and must have been retained in long-term storage despite any recall failures. For example, the first item (dog) must have been stored on its initial presentation on Trial 1 because it was retrieved from long-term storage on Trial 2. The seventh item (elephant) also must have been stored on Trial 1, even though it was not retrieved from long-term storage until Trial 4. Since this subject received no feedback to confirm the recall of this item (elephant) on Trial 4 as correct recall of a list item, (information about) this item must have been retained in long-term storage from Trial 1.

Retention in long-term storage is shown by the heavy underlining, beginning with the last presentation of those items which are retrieved spontaneously from long-term storage. Since, as Figure 1 shows, items remain in long-term storage after their initial encoding (Buschke, 1974), this underlining is continued over all trials after initial storage. The unbroken underlining indicates consistent retrieval from long-term storage on every subsequent trial, while the dashed underlining indicates long-term storage with inconsistent or random retrieval. A distinction is made between (storage appropriate for) random retrieval from long-term storage and consistent retrieval from long-term storage because these different kinds of empirically observed retrieval appear to indicate two different stages of (*item* and *list*) learning (Buschke, in press; Kintsch & Morris, 1965; Restle, 1965).

There is a remarkable amount of consistent retrieval in free recall list learning. The black dots indicate 16 items which were consistently retrieved from their initial recall onward; 9 of these 16 items were retrieved consistently on all subsequent attempts from the very first trial onward. The remaining four items also were retrieved consistently after they were retrieved spontaneously, so that all 20 items in this list were retrieved consistently after their first (spontaneous) retrieval from long-term storage.

The increase in this subject's spontaneous retrieval, and her consistent retrieval after she had spontaneously retrieved each item, without confirmation of correct recall, indicates that she knew which items belonged to this list and was not guessing. Because she was required to recall 20 items on each trial, she produced eight different intrusions, which she subsequently dropped from her recall spontaneously, without correction of such intrusions. As the summary at the bottom of Figure 1 indicates, this subject maintained consistent retrieval of all items which she had retrieved spontaneously, although it took a few trials before she was able to retrieve spontaneously all of the items retained in storage.

GENERAL RESULTS AND DISCUSSION

Figure 2 shows the increasing retrieval of related items from the same category by the entire group of subjects. Retrieval from long-term storage is shown directly by recall without (further) presentation. Storage is shown as the (minimum) number of items available in long-term storage *before* each recall attempt, so that the relative effectiveness of retrieval can be evaluated. The curve labeled "first retrieval" shows the (cumulative) number of items spontaneously retrieved from long-term storage at least once, so that the difficulty of the first spontaneous retrieval and the maintenance of recall after first retrieval can be appreciated.

The minimal presentation of each item only until its initial recall resulted in storage of nearly all 20 items on or before their initial recall. The first retrieval of items from long-term storage, which shows previous storage and subsequent retention in long-term storage, continued to occur as late as the 12th trial. Retrieval of list items increased spontaneously and the number of intrusions decreased. Decreasing intrusions as the total number of different intrusions increased shows that these subjects did not persist in recalling intrusions. They did persist in retrieving list items.

Increasing total retrieval involves finding items for their first retrieval from long-term storage, and then maintaining the recall of those items which have been retrieved from long-term storage at least once. Although the recall of most items was maintained after their first spontaneous retrieval, it took many trials before all of the items retained in long-term storage were retrieved at least once. Total retrieval was limited more by the difficulty of retrieving items from long-term storage for the first time than by difficulty in their retrieval thereafter.

Retrieval by this group of subjects (heavy line), who did not receive any feedback, was greater than retrieval by another group of 10 similar subjects (dotted line) who did receive feedback by correcting intrusions immediately after extended recall on each trial, but who were *not* required to recall 20 items on each trial. The greater retrieval without feedback, when retrieval was forced by requiring recall of 20 items on each trial, indicates that feedback to correct intrusions or confirm recall of list items is not necessary to increase spontaneous retrieval from long-term storage, and that even extended recall can be further increased by requiring recall of the specific number of items on the list. Even though forced retrieval elicited intrusions, it was not necessary to correct such intrusions. This indicates that subjects know which items belong to the list. The difficulty in retrieval appears to be difficulty in recovering items from long-term storage; when subjects have found an item not previously retrieved, they recognize it correctly as a list item. This would be expected, since Ritter and Buschke (in press) have shown that forced recall of items from the same category (boys' names) can increase correct retrieval without increasing guesses.

These results show that the spontaneous retrieval of related items from the same category does not depend on guessing, because it does not require feedback to distinguish correctly recalled list items from intrusions. It is not necessary to continue presenting all items before each recall attempt throughout learning (Buschke, 1973) to confirm (or reinforce) correct recall or to delete intrusions, since such feedback apparently is not needed to increase retrieval during verbal list learning. The finding that forcing retrieval by requiring recall of the specific number of items on the list can increase even extended recall, suggests that such forced retrieval should perhaps be used more generally, to obtain the maximum retrieval from long-term storage necessary for accurate evaluation of storage, retention, and retrieval in verbal learning.

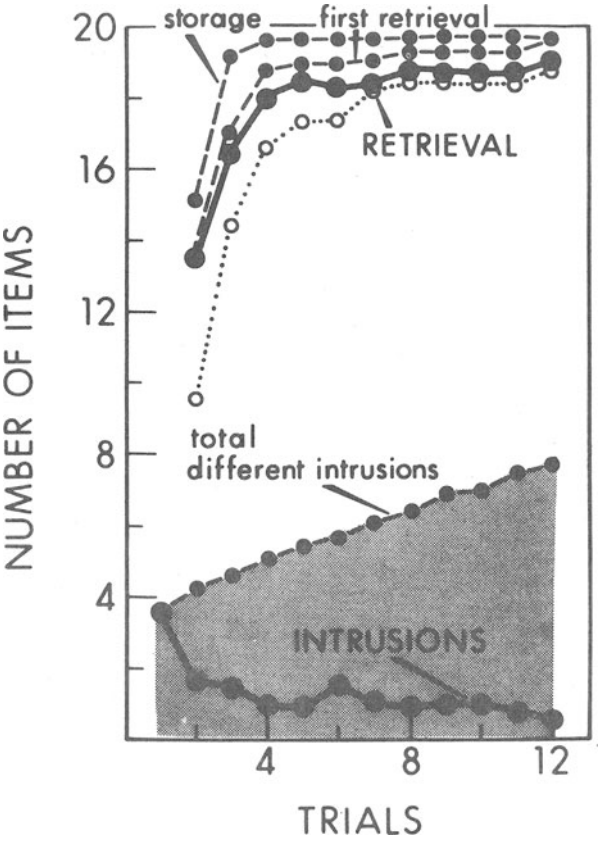


Figure 2. Increasing recall of items from the same category (animals) in free recall verbal learning, without any feedback to distinguish correct recall fron intrusions in spontaneous retrieval from long-term storage.

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