were spotted on the same filter strip in two experiments and on separate ones in three others.

The relative flow rate of *Onoclea* antheridiogen was between 0.8 and 0.9 (much closer to the latter value), and that of *Pteridium* antheridiogen was approximately 0.2. The results were the same whether the two antheridiogens were spotted on the same filter strip or on different ones. Clearly, the antheridiogens derived from *O. sensibilus* and *P. aquilinum* are not identical. In another experiment, *Onoclea* antheridiogen was tested for antheridium-inducing activity in *Anemia phyllitidis, Lygodium japonicum,* and *Onoclea sensibilis* (Table 1). The *Onoclea* preparation was active to a dilution of 1/100 in *O. sensibilis* but inactive even at the highest concentration in *A. phyllitidis* and *L. japonicum.* The antheridiogen of *Onoclea sensibilis* differs not only from the native antheridiogen of *P. aquilinum* but also from those of *A. phyllitidis* and of *L. japonicum.* In addition the relative flow rate of the *Onoclea* antheridiogen reported here differs from those reported for *Anemia* and *Lygodium* antheridiogens with the same solvent system (*5*).

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Alcohol and Recall: State-Dependent Effects in Man

Abstract. *Male volunteers performed four memory tasks either while sober or under effects of alcohol. Twenty-four hours later they were tested under the same or different conditions. In tasks measuring recall and interference, learning transfer was better when the subject was intoxicated during both sessions than when he was intoxicated only during the learning session. In a task measuring recognition, transfer was not significantly affected by changing state. Thus, alcohol appears to produce "dissociated" or state-dependent effects in man, but not all forms of memory are equally sensitive to the phenomenon.*

Animals trained in a drugged state may "remember" their training better if tested in a comparable drugged state than in a nondrugged state (*1*). Similarly, learning acquired in a nondrugged state transfers better to the same state than to a drugged state. This "dissociation of learning" has been demonstrated primarily with anesthetic agents (*2*). Given in sufficient quantities these drugs impair performance, and it could be expected that animals would manifest learned responses better in a nondrugged state than when drugged. The observation, however, that performance may actually improve in a drugged state, provided that original learning was in the same state, cannot be attributed to the drug's depressant effect on acquisition, retention, or performance. Thus, to some extent, learning is apparently state-dependent, that is, it depends for optimum expression on restoration of the original condition in which learning was acquired.

That alcohol produces dissociation has been demonstrated in animals (*3*) and in man (*4*). In studying this phenomenon in man we used a higher dosage of alcohol than was previously used and a wider range of learning tasks to determine whether interaction effects are more evident in some tasks than in others.

Forty-eight male medical students, paid to participate in a training session (day 1) and a testing session (day 2) separated by 24 hours, were randomly assigned to four groups of 12 subjects each (Table 1). One group (SS) was sober both days. A second group (AA) was intoxicated both days. A third group (AS) was intoxicated on day 1 and sober on day 2. The fourth group (SA) was sober on day 1 and intoxicated on day 2. Intoxicated subjects, depending on body weight, consumed between 8 and 10 ounces (250 and 300 ml) of 80-proof vodka, diluted in a soft drink, over 1 hour, after which testing began. Concentrations of alcohol in blood, as determined by breath analyses (*5*), varied from 80 to 140 mg/100 ml, with a mean of 111 mg/100 ml. All subjects drinking this amount showed signs of intoxication. Equivalent amounts of the soft drink were given to nondrinkers. Subjects knew in advance that they might receive alcohol, but had no other knowledge of the experiment.

Tests were administered in the same order to all subjects over a 40-minute period. They included an avoidance task to measure interference and latency of response, a verbal rote-learning task to measure recall, a word-association test to measure recall of "self-generated" learning, and a picture task to measure recognition. A motor task with a pursuit rotor also was used, but proved so easy to master, regardless of state, that the resultant data were unusable.

In the avoidance task, four patterns of lights were randomly presented. Each pattern could be extinguished by a specific switch that could be controlled by hands or feet. An incorrect response or failure to respond resulted in presentation of a noxious tone. Criterion was 20 correct responses, with number of errors to reach criterion taken as the measure of performance. The task was identical on both days, except that on day 2 the pattern-switch relation was altered. Thus, performance of day 2 was assumed to reflect interference; that is, the greater the number of errors on day 2, the greater the degree of interference (*6*). Latency of response also was recorded.

The rote-learning task involved memorizing four five-word "sentences" of varying meaningfulness (normal sentence, anomalous sentence, anagram, and word list) (*7*). On day 2 subjects were asked to recall the sentences memorized on day 1, after which a relearning session was conducted. Performance was measured in terms of errors of sequence and omission.

For the word-association test, ten words of low association value (*8*) were presented. Subjects were instructed to respond to the stimulus words with

Table 1. Mean errors on memory tasks for the four groups of either sober or intoxicated subjects. The first letter in group designations refers to condition on day 1; the second letter, condition on day 2; A, alcohol; S, no alcohol. Each group had 12 subjects, with the following exceptions: In the avoidance task, AA and SS had eight, AS had six, and SA had seven subjects. In the rote-learning task, all groups had ten subjects (*13*). No measure of day 1 errors was possible for the word-association and picture-recognition tasks.

Group	Avoidance* (measuring interference)		Rote-learning		Word association	Picture recognition	
	Day 1	Day 2	Day 1	Day 2		Neutral	Emotional
AA	8.28 ± 1.15	9.12 ± 1.41	16.96 ± 5.14	16.45 ± 6.35	2.50 ± 1.57	5.08 ± 1.73	3.67 ± 1.88
SS	6.91 ± 1.98	8.13 ± 1.79	12.05 ± 5.90	13.75 ± 7.09	1.25 ± 1.14	4.92 ± 2.55	1.67 ± 1.45
AS	8.99 ± .67	7.15 ± 1.34	20.56 ± 5.12	24.55 ± 6.90	4.58 ± 2.13	5.00 ± 2.09	4.25 ± 2.07
SA	6.02 ± 1.04	7.20 ± 2.12	12.29 ± 5.02	15.10 ± 7.94	2.25 ± 1.43	5.08 ± 2.19	2.50 ± 1.51

* Square root transformations were used to achieve homogeneity of variance (*10*).

the first word that came to mind. On day 2 the stimulus words were repeated and subjects were asked to recall their responses on day 1. Performance was measured in terms of errors made in day 2 recall.

In the picture recognition task, subjects were shown 20 pictures on day 1. On day 2 they were asked to select from 40 pictures those seen on day 1. Half of the pictures, showing mail-order catalog models, were designated as "neutral"; half were chosen from nudist magazines and were designated as "emotional."

The means and standard deviations of performance on the four tasks are presented in Table 1. For the avoidance and rote-learning tasks, performance measures were available for both day 1 and day 2, whereas scores for the other two tasks were limited to performance on day 2.

On day 1 performance was significantly better in the sober groups (SS and SA) than in the alcohol groups (AA and AS) for both the avoidance and rote learning ($t = 2.58$, $P < .01$, and $t = 3.78$, $P < .01$, respectively) —the expected depressant effect of alcohol on performance.

Since dissociation or effect of changing state could best be reflected by an interaction effect, the measures of performance on day 2 were subjected to 2 by 2 factorial analyses of variance (Table 2). Preliminary testing with the $F_{\max}$ test (*9*) indicated homogeneity of variance for all data except that obtained from the avoidance task. For the latter, homogeneity was achieved through use of the square-root transformation (*10*), normalizing distribution of the data.

Table 2 presents the *F* values obtained from the analyses of variance. The data indicated a significant A by B interaction (state-change effect) for the avoidance, rote-memory, and word-association tasks: Changes in alcohol state from day 1 to day 2 were associated with changes in test performance. Analyses of simple main effects were conducted to assess the source of the interaction effects (Table 1).

In the avoidance task, compared to subjects remaining in the same state those in changed states made significantly fewer errors (were subject to less interference from original learning). This difference was primarily due to more errors being committed by the AA group, but the SS group also made more errors than the changed groups, although this difference was not significant.

In both the rote-learning and word-association tasks, the interaction effect was largely due to the fact that the AS group made significantly more recall errors than the AA or SS groups. In neither task did the SA group differ significantly from the same-state groups, although in both tasks the SA group made more errors than the SS group (*11*).

Latency of response in the avoidance task was not influenced by state change. Nor was there a significant interaction effect in the picture-recognition task, although in the case of "emotional" pictures, a trend toward dissociation was evident.

These results tend to substantiate Storm's finding (*4*) that learning which the subject acquires while he is intoxicated may be more available to him while he is intoxicated than when he is sober. Conversely, but to a lesser and more variable extent, learning acquired while sober may be more available which sober than when intoxicated. Overton (*2*) has observed that training often appears to transfer less completely in the direction of drug to nondrug state than in the reverse direction. This asymmetry also was apparent in our findings.

Furthermore certain types of memory appear more sensitive to dissociation than others. The data indicate that simple recall and interference were most clearly influenced by state change, especially where original learning was in the alcohol condition. Picture recognition and latency of response were relatively uninfluenced by state change.

Table 2. *F* values for analysis of variance of errors on memory tasks on day 2. A, effect on errors on day 2 of being intoxicated on day 1; B, effect on errors on day 2 of being intoxicated on day 2; and the A by B interaction, effect of changed state.

Task	A	B	A × B
Avoidance task	0.56	0.68	5.33*
Rote learning	7.34*	2.27	4.44*
Word association	15.05†	1.37	11.14†
Picture recognition			
Neutral	0.00	0.00	0.00
Emotional	14.09†	0.00	2.01

* $P < .05$. † $P < .01$.

There is evidence that recall of single experiences, where massed practice or "overlearning" is not a factor, may be particularly vulnerable to state change. For example, in Storm's study, subjects were trained to criterion on learning and relearning days. When he used the first relearning trial as a measure of recall, Storm found no tendency for alcohol to enhance recall when original learning was in the alcohol condition. This finding, contrary to ours, may have been due to the overlearning inherent in a training-to-criterion paradigm. Our data suggest that the word-association task, measuring single-trial, "self-generated" learning, may be particularly useful in studying dissociation.

That drinking may facilitate recall of experiences which occurred while previously drinking has support from certain clinical observations. In one study (*12*), alcoholics frequently reported hiding liquor or money while drinking with no recall of the event until intoxicated again. They also reported difficulty in spontaneously recalling events that happened during a drinking episode and having a return of memory when told about the event. The latter is consistent with our finding that subjects who learned material while intoxicated had difficulty recalling it spontaneously when sober, but, after one relearning trial, performed as well as the other subjects. This suggests that the memory deficit associated with changed state may reflect an impairment of retrieval rather than of registration and retention.

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13. Reduced numbers of observations resulted from mechanical difficulty and subjects becoming too intoxicated to perform the tasks.
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Fossil Hominid Taxonomy

Although the editors of *Science* cannot check on every detail of every report, it still seems as though some process of review should exist which could eliminate the more unfortunate blunders. I refer to the creation of yet another level of confusion in the recent report by Leakey, Protsch, and Berger (*1*). Information on the date of Bed V at Olduvai Gorge, Tanzania, is valuable and welcome, but the chart on page 559 represents the addition of one more set of undocumented claims to an area which continues to suffer from such.

Homo habilis appears at two levels on the chart even though the questions concerning the validity of even one such application (*2*) have never received a satisfactory answer. To this already disputed area Leakey now adds yet a new taxon, *Homo leakeyi*, without citation, justification, or discernible reason (*3*).

This appears to be just one more example of unwarranted name-giving indulged in by students of the hominid fossil record in the absence of definitive study, adequate information, or objective criteria. The chaos which this creates in phylogenetic studies has been specifically recognized (*4*). Informed editing should have removed such sources of confusion, leaving the genuine contribution to stand alone.

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3. What is apparently being referred to is Olduvai hominid 9 which G. Heberer [*Z. Morphol. Anthropol.* **53**, 171 (1963)] has tentatively called either *Homo leakeyi* n. sp. or *Homo erectus leakeyi* n. subsp., noting that a decision concerning which name it is to be given cannot yet be made. Even if there were reason to believe that the specimen represented a new taxon, which is doubtful, Heberer's procedure would appear to be at variance with both Article 72(b) and Recommendation 15 of Appendix E of the *International Code of Zoological Nomenclature* [N. R. Stoll *et al.*, Eds. (International Trust for Zoological Nomenclature, London, 1961)].
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Brace has expressed concern about terminology used in our correlation chart listing various names that have been used for hominids found at Olduvai Gorge (*1*). We took these names from Oakley's *Frameworks for Dating Fossil Man* where they appear in a compilation at the end of the book which contains the various names brought into play over the years for the same find (*2*). This publication has seen wide distribution among interested scientists and must have been known to Brace.

Table 1. Correlation of hominids, strata, and dates at Olduvai Gorge (*4*).

Bed	Geological sequence	Absolute age (yr)
VI	Recent	
Caliche	Recent	
V	End of Upper Pleistocene	10,400 ± 600 *
	Major find: *Homo sapiens sapiens*	
Va	Upper Pleistocene	
IV	Upper to Middle Pleistocene	
	Major find: *Homo sp., indet.*	
III	Middle Pleistocene	
II	End Villafranchian	
	Major find: *Homo habilis; Australopithecus (Zinjanthropus) boisei; Pithecanthropus sp.*	
I	Villafranchian	$2.03 \pm 0.28 \times 10^6$ † 1.75×10^6 ‡
	Major find: *Australopithecus (Zinjanthropus) boisei; Homo habilis*	
Lava	Pliocene	4×10^6‡
Tuffs		

* Radiocarbon dating (*1*). † Fission track dating (*5*). ‡ Potassium-argon dating (*6*).

It goes without saying that we prefer certain names to others, and the problem of nomenclature is only too familiar to those concerned with the subtleties of taxonomic considerations in the face of statistics involving small numbers. Our own choice is indicated in Table 1. With respect to the validity of *Homo habilis* and Brace's allegation that "criticism of *Homo habilis* has never received a satisfactory answer" we refer to two papers which appeared some time ago. They should go a long way to answer any challenge (*3*).

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