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Free-listed Items are Effective Cues for Eliciting Additional Items in Semantic Domains

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SUMMARY

This study tested a cueing procedure for enhancing recall in semantic domains based on associative processes inferred from semantic clustering. Participants first free listed items exhaustively from a semantic domain (fruits or drugs). Then, to aid recall of additional items from the domain, participants received either the items they free listed as semantic cues (to trigger semantically similar items) or alphabetic cues (to trigger items beginning with a particular letter). Participants' strong semantic clustering and weak alphabetic clustering in free listing confirmed previous research on associative processes. By several measures, free-listed items as semantic cues elicited moderately more additional items than alphabetic cues. Semantic cues elicited an appreciable proportion of items that would not have been identified at the aggregate level through free listing alone. These results indicate that using free-listed items as semantic cues can be a useful adjunct for ethnographic applications of free listing. Copyright © 2002 John Wiley & Sons, Ltd.

When people free list[1] items from a semantic domain, such as the names of trees, diseases, or occupations, they are usually unable to recall all items they actually know in the domain. Several observations indicate this inability to list exhaustively all the items one knows in a domain. First, after listing as many items in a domain as they can, individuals often comment that they know other items but just cannot recall them, even with concerted effort. Second, on repeated interviewing, research participants list some items they did not mention in the initial interview (a phenomenon called reminiscence) (e.g. Bellezza, 1984, 1987; Brown, 1923; Greenwald *et al.*, 1988; Lazar and Buschke, 1972). Third, individuals routinely recognize far more items in a domain than they free list (e.g. Hutchinson, 1983).

The inability of people to free list completely all items they know in a domain presents a practical problem and a scientific opportunity. The practical problem concerns ethnographic applications of free listing (e.g. Weller and Romney, 1988). In such cases, the

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[1]Free listing is also called free emission, free retrieval, unconstrained free recall, and production, among other terms.

researcher seeks to identify items in a semantic domain as a first step in describing cultural knowledge or belief on a topic among some set of people (who are often culturally different from the researcher). Thus, in ethnographic applications of free listing, the researcher does not necessarily know which items belong to the domain under study. When individuals share a reasonable degree of knowledge about a domain, twenty to thirty informants (ethnographic research participants) are usually required to identify a coherent set of items. Additional informants typically add no more than a few items not previously identified (although this is less true when the level of shared knowledge among informants about the domain is only modest).

In many ethnographic field situations, interviewing dozens of informants can be very time- and labour-intensive. In other circumstances, there may not be dozens of informants to interview, as there may only be a handful of knowledgeable informants (perhaps due to some vanishing cultural tradition or concentration of expertise in a small number of individuals). If researchers could enhance informants' recall in free listing interviews (i.e. aid informants in listing more of the items they know but otherwise would forget to mention), then they could extract more information from each informant. This would allow ethnographic research to be more efficient and complete.

To illustrate, some ethnographers seek to document the full range of folk illnesses, illness symptoms, and treatments (e.g. Garro, 1986; Wilson *et al.*, 1995) familiar to traditional healers in a particular cultural group. In such a case, it may be difficult to interview a large number of informants for the reasons mentioned earlier. Interviewing methods that could help informants to remember all the illnesses, symptoms, and treatments they knew would facilitate as complete a description of these domains as possible.

Testing ways to enhance recall from semantic domains not only would address these practical problems in ethnographic research, but would contribute to assessing the organization of semantic memory. Traditionally, psychologists have studied the organization of memory by investigating semantic clustering. Semantic clustering refers to a tendency to mention semantically similar items adjacently, or successively, in free recall/free listing tasks. Researchers have observed semantic clustering in free listing at the individual and aggregate levels (Baron and Galizio, 1978; Bousfield and Sedgewick, 1944; Graesser and Mandler, 1978; Henley, 1969; Katz, unpublished master's thesis, 1976, cited in Friendly, 1979; Rubin and Olson, 1980), and have inferred semantic clustering from the pattern of inter-response times for adjacently listed items (Fitzgerald, 1983; Gruenewald and Lockhead, 1980). Semantic clustering constitutes strong, but observational, evidence of the associative processes in free listing (or free recall). Controlled experiments allow further evaluation of semantic similarity as the primary associative factor in free listing/recall.

Few prior studies have tested techniques for increasing the number of items elicited in free-listing tasks. Previously examined techniques include giving individuals 'reminder' lists of items in a domain to study before free listing (Brown, 1968; Buschke *et al.*, 1973; Gronlund and Shiffrin, 1986) and providing individuals with taxonomic and related cues during free listing (Glidden and Mar, 1978). To implement these procedures, researchers must have extensive prior knowledge of the semantic domain under study. However, no previous research has proposed or demonstrated a method for increasing the number of items elicited without such prior knowledge.

We believe that forgetting often is the result of retrieval failures and that items forgotten in free listing may be recalled if the appropriate cues are provided (cf. Tulving, 1974). Thus, the goal of our research was to determine precisely what the appropriate cues are and thereby also identify the specific causal factor(s) in associative recall processes. In our experiment we tested the effectiveness of cues in eliciting additional items after participants had free listed as many items as they could. Based on the semantic clustering literature, we hypothesized that semantic cues would be the most effective. The challenge was to develop semantic cues that tap the associative process we think underlies semantic clustering. At the same time, to be useful in ethnographic applications, no prior knowledge of the domain under study must be required for an interviewer to discover and administer the cues.

We think that free listing proceeds according to a semantically-driven associative process modeled formally by Romney *et al.* (1993). From this perspective, an individual associates from one item to the next in a probabilistic fashion based on how similar items are to each other semantically. Therefore, to imitate this process, we reasoned that the key to eliciting additional items after free listing exhaustively was to have participants associate from specific cue items to other semantically similar items and list those they had not already mentioned. To satisfy the requirement of no prior domain knowledge on the part of the interviewer, we used the items a participant free listed as the specific cue items.

We used the letters of the alphabet as control cues. Although it has not been measured in free listing tasks, clustering of items by first letter is very weak in episodic free recall tasks (Lauer and Battig, 1972). Based on this lack of alphabetical clustering and the inhibiting effects of alphabetic retrieval strategies in free listing (Gronlund and Shiffrin, 1986), we thought that providing alphabetic cues after free listing would be relatively ineffective but allow control participants approximately the same number of cues as experimental participants who received the free listed items as semantic cues. Indeed, Lauer and Battig (1972) found that in cued recall of lists of items that belonged to eight different semantic categories and also began with one of eight letters, taxonomic cues produced 51% greater recall than first-letter cues.

After describing the methods of our experiment, we report formal, individual level measures of semantic and alphabetic clustering in free listing to see whether our assumptions about the greater strength of semantic clustering, and hence the likely effectiveness of the different cues, are justified. Then we present the results from a comprehensive evaluation of the effectiveness of the different sets of cues in eliciting additional items. In the discussion, we draw implications for models of associative recall processes and ethnographic applications of free listing, and consider alternative approaches to eliciting additional items.

METHOD

Participants

Participants were a subset of adults involved in a larger study of memory for sexual and drug injection partners (Brewer *et al.*, 1999). For this experiment, participants responded for one of two domains (street or recreational drugs and fruits people eat). Participants who were recruited to the larger study from an epidemiological study of drug injectors (Hagan *et al.*, 1999) free listed different types of drugs. Participants recruited from an HIV testing clinic (who generally were not drug injectors) and an outreach services project for drug injectors free listed types of fruit.

The mean and median age of the 43 participants who free listed drugs was 41 (range 27–65). Thirty-four (79%) were male. Eighty-four per cent had graduated high school or earned a general equivalency degree, but only 21% were employed and 33% considered themselves homeless. Sixty-nine per cent were white, 21% black, and 10% were of some other or mixed ethnic/racial background. Ninety-one per cent of these participants had injected drugs (primarily heroin, cocaine, and/or methamphetamine) recently.

The mean age of the 33 participants who free listed fruits was 33 (median = 34; range 19–57). Twenty-eight (85%) were male. All had graduated high school or earned a general equivalency degree, 70% were employed, and only 6% considered themselves homeless. Eighty-five per cent were white, 9% black, and 6% were of some other or mixed ethnic/racial background. Only 6 (18%) of these participants had injected drugs recently.

Design

We chose the fruit domain because it is one that has been studied repeatedly in laboratory-based psychological research with undergraduate research participants. Our sample for the fruit domain included a somewhat more diverse sample of adults. We chose to study the drug domain with drug injectors to represent the more common ethnographic situation in which researchers interview members of a particular (sub)culture to elicit knowledge especially relevant to their (sub)culture. Our goal was to evaluate the effectiveness of the semantic and alphabetic cues *across* different samples of participants responding to different domains. This approach reflects the nature of ethnographic research, which is typically focused on domains specific to a given (sub)culture.

For each domain, we randomly assigned participants to receive either semantic or alphabetic cues after free listing, based on their order of enrollment into the Brewer *et al.* (1999) study. In the fruit domain, 17 of the 33 participants received semantic cues. In the drug domain, 20 of the 43 participants received semantic cues. The slightly unequal numbers of participants in the two conditions are due to haphazard procedural factors described below.

Procedure

Participants performed the tasks in this experiment at the end of their second and final interview in the Brewer *et al.* (1999) study. In the main part of the interview, none of the questions related to fruits, and the only question related to different types of drugs was ‘What drug do you shoot up most often?’ (asked of drug injectors only in the early part of the interview). To eliminate time constraints on participants’ full motivation to participate in the experiment, we involved only those participants for whom there was ample time left remaining within the scheduled duration of the interview. Each participant was interviewed individually and privately by one of three interviewers.

Free listing

Participants first free listed aloud items from a domain as exhaustively as possible. Interviewers audiotaped the interviews and wrote participants’ responses on paper. When participants claimed they could not recall any more items, the interviewer prompted them nonspecifically to list other items (e.g. ‘What other kinds of fruits/drugs are there?’). Interviewers prompted in this way until a participant insisted she or he could not remember any more items. This non-specific prompting gave participants every opportunity to list more items and indicated the importance of recalling as exhaustively as possible (participants were not informed they would later be presented with cues to aid recall further).

For the fruit domain, the free listing instructions were:

> Think of all the different kinds of fruit people eat. Tell me the names of all the kinds of fruit you can remember. Please keep trying to recall if you think there are more kinds of fruit you might be able to remember.

For the drug domain, the free listing instructions were:

> Think of all the different kinds of drugs or substances people use to get high, feel good, or think and feel differently. These drugs are sometimes called recreational drugs or street drugs. Tell me the names of all the kinds of these drugs you can remember. Please keep trying to recall if you think there are more kinds of drugs you might be able to remember.

Alphabetic and semantic cues

When a participant said he or she could not list any more items after the non-specific prompting, the interviewer administered either alphabetic or semantic cues. For the alphabetic cues, the interviewer instructed the participant that they would go through the letters of the alphabet as cues. The interviewer then said 'Think of all the kinds of fruits/drugs that begin with the letter A. Try to remember all the types of fruits/drugs that begin with the letter A and tell me any new ones that you haven't already said.' After the participant finished listing all the additional items she or he could in response to the letter cue (whether the response item(s) began with that letter or not) or said she or he could not remember any additional items in response to that letter cue, the interviewer repeated the process with the next letter until all 26 letter cues had been presented.

For the semantic cues, the interviewer instructed the participant that they would go through the list of items he or she had recalled earlier as cues. Then the interviewer said 'Think of all the kinds of fruits/drugs that are similar to or like [the first item the participant free listed]. Try to remember other types of fruits/drugs that are like [the first item the participant free listed] and tell me any new ones that you haven't already said.' After the participant finished listing all the additional items she or he could in response to the semantic cue (whether the response item(s) was similar to the cue item or not) or said she or he could not remember any additional items in response to that cue item, the interviewer repeated the process with the next free listed item until all free listed items had been presented as semantic cues. After the interview was finished, the interviewer rated the participant on various characteristics, including motivation to answer questions fully.

Reference lists of items and semantic similarity data

We created a standardized reference list of items in each domain to determine whether free listed and cue elicited items truly represent distinct items at the same basic level of contrast (Rosch, 1978) in the cultural/subcultural lexicon and not merely synonyms or idiosyncratic terms. In creating the reference list, we first excluded free-listed or cue-elicited items mentioned by only one participant, unless they were included in standard dictionary or lexical sources. We then standardized the spelling of all remaining items according to these sources. Next, we removed subdomain category terms that were obviously in between the superordinate and basic levels of contrast (e.g. berry for fruits and opiates for drugs) (cf. Rosch, 1978). Examples of items at the basic level of contrast are strawberry for fruits and heroin for drugs.

In the second step of creating the reference list, we collected several types of judgements from separate samples of participants to identify synonyms and determine items at the basic level of contrast more precisely. These data also allowed us to measure semantic clustering in our primary participants' free lists. For the judgements related to fruits, we recruited 20 participants from among the first two authors' coworkers and acquaintances. For the judgements related to drugs, we recruited 20 additional participants from the epidemiological study of drug injectors (Hagan *et al.*, 1999). Both sets of these participants were very similar in demographic terms to the corresponding sets of free listing participants.

For each domain, we wrote the terms already identified on 3" × 5" notecards. The interviewer randomly shuffled the cards and then handed them to a participant. The interviewer asked the participant to go through the cards and remove those terms with which they were unfamiliar. Next, the participant indicated which items he or she thought were synonyms and which were kinds of another. Then, the interviewer asked the participant to judge the similarity of all the items he or she recognized. Participants were asked to put drugs that are similar or alike into the same pile, and they were free to make as many or as few piles as they wanted (cf. Weller and Romney, 1988).

We used these participants' judgements of which items were synonyms or kinds of another to produce the final reference lists, which included 77 fruit items and 113 drug items. Visit http://faculty.washington.edu/ddbrewer/smeappendix.htm for a full description of how the reference lists were created. Unless otherwise noted, all analyses were based on the items listed by participants that were on the reference lists; items not on these lists were not counted or considered.

RESULTS

Number of items free listed

Table 1 shows the number of items participants free listed by domain and experimental condition. Participants who free listed fruits took a mean of 233 s to free list exhaustively (median = 211 s, range = 82 s to 610 s), while participants who free listed drugs took a mean of 154 s (median = 117 s, range = 42 s to 662 s). The differences between cue conditions in the number of items free listed are fairly small and non-significant. As with previous research on free listing (Fitzgerald, 1983; Graesser and Mandler, 1978; Gruenewald and Lockhead, 1980), our participants produced a very low level of

Table 1. Number of items free listed by domain and cue condition

Domain and condition	*n*	Mean	Median	SD	Range
Fruits					
Semantic	17	20.47	21	5.84	12–31
Alphabetic	16	24.25	24	7.87	12–44
Drugs					
Semantic	20	15.25	14.5	7.35	6–32
Alphabetic	23	11.17	9	6.83	3–32

repetitions and we excluded any item a participant repeated in free listing or in response to cues from all analyses except where otherwise noted.

Motivation

The number of items free listed reflects, to a certain degree, level of knowledge in the domain (Brewer, 1995). The number free listed may also indicate a participant's level of motivation and differences in interviewers' ability to elicit items (e.g. skill in non-specific prompting). Each of these factors could influence the number of additional items available to be elicited by cues, although this should not vary by experimental condition (because of random assignment). Participants displayed high levels of interviewer-rated motivation (88% of the participants in the fruit domain and 84% of those in the drug domain received the highest motivation rating ['very motivated'] on a 3-point scale). In addition, neither type of cue appears to be inherently more engaging or motivating.

Our participants also tended to free list more items than did undergraduates for related domains in other studies. Seventeen undergraduates in one study (Trotter *et al.*, 1997) free listed 'things people use to get high', a somewhat broader domain than drugs only. They free listed a mean of 11.9 items (based on all responses), which is less than the mean number of drugs our participants free listed (mean = 15.1, based on all responses [excluding repetitions] prior to creating the reference list). In another set of studies (Bellezza, 1984, 1987; Greenwald *et al.*, 1988), undergraduates free listed fruits for three minutes. Bellezza (1987, p. 407) remarked that this was sufficient enough time that '. . . subjects reported that they usually could retrieve no further relevant information'. (As noted earlier, our participants took a little less than 4 minutes to free list fruits, on average.) Participants in these other studies free listed between 17.2 and 18.9 fruit items, on average, which is less than the number of fruits our participants free listed in the first three minutes (mean = 20.7). In sum, our participants were quite motivated to participate in the experiment, contrary to stereotypes about drug injectors and other types of persons involved in our study.

Semantic and alphabetic clustering

Semantic clustering occurs in a participant's free list to the extent that adjacently listed pairs of items are semantically more similar than non-adjacently listed pairs of items. Alphabetic clustering occurs to the extent that adjacently listed pairs of items are more likely to have the same first letter than non-adjacent pairs. Both types of clustering can be measured with the same analytic approach.

Roenker *et al.* (1971) introduced the Adjusted Ratio of Clustering (ARC), which has become the standard measure of clustering in recall by a single variable for an individual participant. The ARC equals $(o - e) / (m - e)$, where o is the observed clustering score, e is the expected (by chance) clustering score, and m is the maximum possible clustering score for a given participant. The ARC takes a value of 1 when clustering is maximal, a value of 0 when clustering is at the level expected by chance, and negative values when clustering is less than expected. The ARC is easily computed when the variable on which clustering is measured is binary and categorical (as in letter of the alphabet, with 26 mutually exclusive categories).

However, it is much more difficult to compute the ARC when attempting to measure clustering by a variable that is not categorical (as in the case of semantic similarity in our study). First, for a non-categorical variable, a square hypothesized associative structure matrix must be constructed that contains the hypothesized associative strengths (in our case, semantic similarities) between each pair of free listed/recalled items. The observed clustering score, *o*, is the sum of the hypothesized associative strengths for the adjacently listed pairs of items. The expected clustering score, *e*, is the mean off-diagonal cell value (hypothesized associative strength) multiplied by the number of items listed minus one. This score represents the mean sum of associative strengths for adjacent pairs of items across all possible permutations of the items a participant listed.

The difficulty in computing the ARC for a non-categorical variable is in calculating the maximum clustering score, *m*. This score corresponds to the ordering of items that has the largest sum of associative strengths for adjacent pairs. The task of computing *m* is a case of the classic Traveling Salesman Problem (TSP) (Lawler *et al.*, 1985). In the TSP, the goal is to find the shortest route among a set of cities such that each city is visited exactly once. The TSP typically is discussed in graph theoretic terms, with cities referred to as nodes and the distances between pairs of cities as edge weights. In the clustering context, the hypothesized associative structure matrix may also be conceived of as a graph, with items as nodes and hypothesized associative strengths as edge weights. The goal in the TSP of finding the shortest Hamiltonian path (a path in which each node is visited exactly once) corresponds to the goal of finding the maximum clustering score, once similarity/proximity data have been appropriately converted to dissimilarities/distances.

When the number of items listed is few, all possible permutations of nodes (items in a participant's free list) can be enumerated and the shortest path (maximally clustered sequence of items) noted. When the number of nodes/items exceeds approximately 10 or greater, enumeration becomes infeasible (for 10 items, there are $10!/2 = 1{,}814{,}400$ permutations, excluding mirror images). We used Padberg and Rinaldi's (1991) branch-and-cut algorithm to obtain *provably* optimal solutions to the TSP and thus *m*. This algorithm produces optimal solutions even in cases with thousands of nodes and non-Euclidean distance data (see Padberg and Rinaldi, 1991, for details on the algorithm).

For measuring semantic clustering, we created for each participant a square matrix that contained the semantic similarities between all pairs of items she or he free listed. We measured the pairwise semantic similarities with proportions that represented the number of pile sort participants who put both items of a pair in the same pile divided by the number of participants who were familiar with both items in that pair (cf. Brewer and Yang, 1994). For measuring both alphabetic and semantic clustering, we reduced the value of *o* for a participant's free list with repetitions by the number of repetitions multiplied by the mean observed semantic similarity value for the adjacently listed pairs of items in that participant's free list (including the repetitions) (see Brewer and Yang, 1994, p. 354). For measuring alphabetic clustering, we used free lists based on all items participants mentioned, even if they were not on the reference lists.

Participants displayed substantial semantic clustering and almost negligible alphabetic clustering (see Table 2). That is, participants tended to list semantically similar items adjacently, but tended to list items with the same first letter adjacently at levels just slightly above that expected by chance. The means for the semantic ARCs are depressed slightly to moderately as a result of one outlier in the fruit domain and two in the drug domain with strongly negative ARCs (< -1.0). Such outliers are possible because the ARC has no lower bound. Nevertheless, these results validate our initial assumptions about participants' associative processes in free listing and warrant the comparisons between the semantic and alphabetic cues. In addition, the differences between domains in the

Table 2. Adjusted ratios of clustering for semantic and alphabetic clustering

Clustering type and domain	*n*	Mean	Median	% positive	SD	Range
Alphabetic—fruits	33	0.09	0.07	67	0.18	– 0.23–0.57
Alphabetic—drugs	41[a]	0.11	0.10	71	0.34	– 0.75–1.0
Semantic—fruits	33	0.44	0.49	97	0.33	– 1.15–0.83
Semantic—drugs	42	0.26	0.40	76	0.57	– 2.00–1.0

[a]Two participants did not list two or more drugs that began with the same letter.

degrees of semantic clustering and alphabetic clustering, respectively, are small and nonsignificant.

Cues' effectiveness in eliciting additional items

Individual level measures

All participants in both cue conditions and both domains listed one or more additional items in response to cues, except for two participants in the semantic condition in the drug domain. To gain a full understanding of the cues' impact, we used several related measures of effectiveness in eliciting additional items. The number of additional items elicited by the cues is a practical measure of effectiveness in absolute terms. The proportional increase in number of items elicited by the cues indicates the cues' practical effectiveness relative to the number of items free listed. The number of additional items elicited per cue measures the potency of cues of particular type, and reflects what might be called the intrinsic effectiveness of the cues. The final two measures, the proportion of cues that were successful in eliciting additional items and the number of additional items elicited per successful cue, indicate the two components that make up the number of additional items per cue measure. These measures shed light on what makes a set of cues potent.

Both types of cues elicited a noteworthy amount of additional items (see Table 3). Overall, the semantic cues elicited substantially more additional items than the alphabetic cues. In Table 3, the second, third, fifth, and sixth columns show the means for the semantic and alphabetic cue conditions in the fruit and drug domains, respectively, on the various measures. The fourth and seventh columns present the experimental effect point biserial correlation coefficients for each outcome measure. In computing these correlations, we coded the semantic condition as 2 and the alphabetic condition as 1. The experimental effect partial correlations control for the number of items free listed. By controlling for the number of items free listed, we eliminated as an explanation for any experimental effects the mild, nonsignificant differences between cue conditions on this variable. (Incidentally, the number of items elicited by cues is largely unrelated to the number of items free listed [semantic cues: $r = -.05$ for fruits, .23 for drugs; alphabetic cues: $r = -0.17$ for fruits, 0.30 for drugs]). The final column in Table 3 summarizes the results for the two domains with the mean experimental effect correlations, based on Fisher's z-transformations and weighted by sample size (Rosenthal, 1991).

In the fruit domain, the semantic cues were much more effective than alphabetic cues in eliciting additional items. Semantic cues elicited almost twice as many items in absolute numbers as the alphabetic cues. The proportional increase (over the number free listed) in the number of items elicited by semantic cues is more than twice as large as the increase for alphabetic cues. On a per cue basis, a semantic cue elicited almost three times as many items as an alphabetic cue, on average. This difference is due to the greater proportion of

Table 3. Effectiveness of semantic and alphabetic cues in eliciting additional items

Measure	Fruits			Drugs			Summary
	M (*SD*) semantic	*M* (*SD*) alphabetic	Exp. effect *r* (partial *r*)	*M* (*SD*) semantic	*M* (*SD*) alphabetic	Exp. effect *r* (partial *r*)	*M* exp. effect *r* (partial *r*)
# additional items	8.94 (4.59)	4.56 (2.61)	0.52 (0.49)	6.20 (4.57)	5.22 (2.47)	0.14 (0.09)	0.32 (0.27)
Prop. increase (# cue elicited / # free listed)	0.49 (0.37)	0.21 (0.13)	0.46 (0.39)	0.48 (0.48)	0.59 (0.40)	− 0.13 (− 0.01)	0.14(0.17)
# additional items per cue	0.48 (0.37)	0.18 (0.10)	0.49 (0.44)	0.42 (0.43)	0.20 (0.09)	0.35 (0.39)	0.41 (0.41)
Prop. cues successful	0.29 (0.11)	0.14 (0.07)	0.61 (0.57)	0.23 (0.16)	0.16 (0.07)	0.28 (0.32)	0.44 (0.44)
# additional items per successful cue	1.69 (0.57)	1.27 (0.30)	0.42 (0.39)	1.52 (0.93)	1.24 (0.35)	0.21 (0.21)	0.30 (0.29)

Notes: Experimental effect correlations are point biserial correlations, with the semantic condition coded as 2 and the alphabetic condition coded as 1. Partial correlations control for number of items free listed. All summary correlations are significant at the 0.01 level except for the proportional increase measure. The differences between domains in the magnitude of the correlations is non-significant ($p > 0.05$) for all measures except the proportional increase measure ($p < 0.01$).

semantic cues that were successful in eliciting one or more additional items and the larger number of additional items elicited per successful semantic cue, on average. Thus, even though there were fewer semantic cues (i.e., number of all items free listed by a participant even if not on the reference list; mean = 20.8, median = 22, range = 12 to 31) than alphabetic cues (26), semantic cues elicited more additional items, regardless of the effectiveness measure.

In the drug domain, semantic cues were also superior to alphabetic cues. In absolute numbers, the semantic cues elicited one additional item more than the alphabetic cues, on average. The proportional increase in items elicited actually is slightly higher for alphabetic than semantic cues. However, on a per cue basis, semantic cues elicited more than twice as many additional items as alphabetic cues. As with the fruit domain, this difference is due to the greater proportion of successful semantic cues and the larger number of additional items elicited by successful semantic cues. (We coded the two participants in the semantic condition who did not list additional items in response to the cues as having 0 additional items per successful cue.) Also like the fruit domain, there were fewer semantic cues (mean = 17.5, median = 16.5, range = 6 to 38) than alphabetic cues (26).

Across domains, the semantic cues were moderately and significantly more effective than the alphabetic cues for all effectiveness measures except proportional increase. The experimental effect correlations are higher in the fruit domain than in the drug domain, although the difference is statistically significant only for the proportional increase measure. For both domains, we observed very similar results in direction and magnitude when we counted all listed items as valid (i.e. regardless of whether they were on the reference list) and, for the semantic condition, when we eliminated all response items elicited by cue items not on the reference list. In addition, the results within conditions are similar for each interviewer.

Despite sizable differences between domains in the number of items free listed, there are striking similarities between domains in the means of the last three measures in Table 3 for participants receiving the same type of cues. This means that a particular type of cue elicited approximately the same number of items per cue in each domain, and that the proportion of successful cues and number of items elicited per successful cue were almost constant across domains for a given type of cue.

Participants responded to the cues as intended. For each participant who received alphabetic cues, we computed the proportion of all cue elicited items (including those not on the reference list) that were consistent (in terms of the first letter) with the alphabetic cue which elicited them. For both domains, the mean proportion is 0.87.

To assess the degree to which participants responded to semantic cues with semantically similar response items, we compared the semantic similarity values (based on the aggregated pile sort data) for adjacently free listed pairs of items and cue-response item pairs. The cue-response item pairs are those pairs formed by a cue item and each item listed in response to that cue. Because participants displayed reasonably strong semantic clustering, we reasoned that the semantic similarity values for adjacently free listed pairs of items represent a benchmark for assessing the strength of cue-response semantic associations. We computed for each participant a point biserial correlation between pairs' semantic similarity values and whether they were free listed adjacently (coded 2) or a cue-response pair (coded 1). For the fruit domain, the mean unweighted correlation (Rosenthal, 1991) is -0.16 (median = -0.25, range = -0.42 to 0.53). For the drug domain, the mean unweighted correlation is -0.43 (median = -0.25,

Table 4. Free list and items elicited by semantic cues for a representative participant in the fruit domain

apple
banana (cued: plantain)
orange (cued: tangelo, lemon, lime)
guava
watermelon
honeydew
cantaloupe
kiwi (cued: starfruit)
strawberry (cued: salmonberry)
blueberry
raspberry (cued: blackberry)
boysenberry
tomato
pineapple
tangerine
papaya
mango
pomegranate
grape
litchi (cued: elderberry)
satsuma
grapefruit (cued: cherry)
cranberry (cued: currant, lingonberry)
raisin
plum (cued: prune)
peach
nectarine

Note: The free list begins at the top and proceeds downward. Cue-elicited items are in parentheses next to their cue items.

range = -0.98 to 0.17). Therefore, on average, cue-response item pairs were somewhat more similar in semantic terms than adjacently free-listed item pairs. This difference in semantic similarity is not likely due to stronger semantic associations during cueing. Adjacently free-listed pairs include pairs that represent naturally occurring 'jumps' from one cluster of semantically related items to another. These pairs typically are not very similar in semantic terms. Such shifts are more probable when listing many items in succession rather than only one or a few items, as in responding to the semantic cues.

Table 4 shows the free list and cued responses for a representative participant (in terms of the cue effectiveness measures) who received semantic cues in the fruit domain. This case study illustrates both the semantic associations from cue to response items as well as semantic clustering in free listing.

Semantic cues' effectiveness in identifying additional items at the aggregate level

We also evaluated from an ethnographic perspective the practical impact of eliciting additional items with the semantic cues. Specifically, we treated the participants who received the semantic cues as if they were informants in an ethnographic study. For subsamples of informants of varying sizes, we assessed whether the semantic cues elicited items that had not otherwise been identified by other informants in that subsample. For each domain, we randomly sampled 1000 sets of 5, 10, and 15 informants, respectively, from our data. For each set we noted how many distinct items on the reference list were free listed by one or more informants. Then we also noted how many additional items on the reference list were listed by one or more informants in response to the semantic cues but were *not* free listed by any of the informants in the set. These additional items represent items identified only as a result of the semantic cues.

The semantic cues allow a substantial proportion of additional items to be identified. For the fruit domain, the percentage increases in the mean number of items identified by the semantic cues are 25%, 22%, and 19% for sets of 5, 10, and 15 informants, respectively. For the drug domain, the percentage increases are 31%, 26%, and 24% for sets of 5, 10, and 15 informants, respectively. Although the impact of the semantic cues in identifying additional items lessens slightly as the sample size increases, even with 15 informants the effect is still appreciable. For the purpose of identifying items, the semantic cues contribute as much information as adding free lists from approximately 5–6 more informants to the sample.

Free-listed and cue-elicited items' frequencies of mention

Since ethnographers often focus their research on items that are generally familiar to informants, it is also important to compare free-listed and cue-elicited items' frequencies of mention. For each participant who responded to semantic cues, we computed the mean frequencies of mention for free-listed items and cue-elicited items separately and then calculated means of these means across participants in a domain. (We based an item's frequency of mention on the number of participants in the semantic condition who mentioned the item in free listing or in response to semantic cues.) In the fruit domain, the mean frequencies of mention for free listed and cue elicited items are 12.49 and 9.48, respectively (out of a maximum possible of 17). In the drug domain, the mean frequencies of mention for free listed and cue elicited items are 11.49 and 7.38, respectively (out of a maximum possible of 20). Thus, cue elicited items tend to be reasonably familiar and are only modestly less frequently mentioned than free listed items.

In addition, most items participants free listed and mentioned in response to cues were on the reference lists. On average across participants, 98% of free listed fruits and 94% of cue-elicited fruits were on the reference list. For the drug domain, 87% of free-listed items and 77% of cue-elicited items, on average, were on the reference list. The mean percentages for items elicited by semantic cues and alphabetic cues within a domain are virtually identical. Our ethnographic experience with these domains indicates that essentially all items mentioned by participants that were not on the reference lists were genuine, but low salience, members of the domains (the standard references for these domains were not complete catalogues of all items in these domains).

DISCUSSION

Participants displayed a moderately strong degree of semantic clustering and only weak alphabetic clustering when they free listed items from a semantic domain. After free listing exhaustively, almost every participant listed additional items when presented with alphabetic cues or items they free listed as semantic cues. Overall, the cues enhanced recall by a fairly large amount. Even though there tended to be fewer semantic cues than alphabetic cues, semantic cues elicited substantially more additional items in absolute, proportional, and per cue terms than alphabetical cues. Proportionally more semantic cues were successful in eliciting additional items, and successful semantic cues elicited more additional items per cue than successful alphabetic cues. Participants responded to cues as intended, overwhelmingly listing response items consistent with letter cues in the alphabetic condition and response items semantically similar to cue items in the semantic condition. Across varying sample sizes of participants, semantic cues elicited a substantial proportion of items that would not have been identified at the aggregate level through free listing alone. Cue-elicited items are only modestly less frequently mentioned than free-listed items, indicating that cue-elicited items still are reasonably familiar to participants.

Building on the observational evidence from semantic clustering, our study provides experimental evidence consistent with a causal role for semantic similarity in associative recall processes. In particular, our results suggest that item to item semantic association may in fact be a primary specific mechanism in the free listing recall process (cf. Gruenewald and Lockhead, 1980).

Somewhat unexpectedly, alphabetic cues elicited a notable amount of additional items. Their moderate potency might be explained by a variety of factors. Alphabetic cues might sometimes facilitate acoustically based associations (e.g. the letter O, pronounced as a long vowel, is the first syllable of the word opium). Also, the widespread alphabetization of information in daily life (as in dictionaries, address books, filing systems, etc.) may carry over to some degree to individuals' knowledge and organization of a variety of semantic domains. Furthermore, people often make explicit associations between words and their first letters (e.g. A is for apple, B is for banana, etc.), that in some cases may trace back to when they learned how to read.

The semantic cues displayed greater practical effectiveness (i.e. number of additional items elicited in absolute and proportional terms) relative to the alphabetic cues in the fruit domain than in the drug domain. This is due to the fewer semantic cues in the drug domain than in the fruit domain. However, across domains, the semantic cues showed consistently greater potency on a per cue basis than the alphabetic cues. Furthermore, for a particular type of cue, the mean number of additional items elicited per cue, proportion of cues that were successful, and number of additional items elicited per successful cue were very similar across domains. If these results could be generalized to other domains, we would expect that semantic cues might elicit fewer additional items in absolute terms than alphabetic cues in domains where people tend to list few items (i.e. somewhat fewer than in the drug domain) because of the reduced number of semantic cue items.

Using free-listed items as semantic cues to enhance recall may be an effective and useful adjunct for ethnographic applications of free listing. Alphabetic cues, even though they are moderately (but less) effective in eliciting additional items, cannot be applied in all ethnographic field situations because some informants may not be literate or may speak languages that do not involve alphabets. Moreover, alphabetic cues would likely be ineffective in eliciting additional items when the items in a domain are not single words, but multi-word concepts or phrases (e.g., Brewer, 1992; Romney *et al.*, 1979).

Alternative procedures could be used to elicit additional items instead of using free listed items as semantic cues, although these other techniques involve major disadvantages. Multiple free listing trials for the same domain in an interview are one way to elicit additional items (Lazar and Buschke, 1972), although the increase in items elicited is not nearly as large as that from using free listed items as semantic cues. Furthermore, informants in ethnographic research (as opposed to participants in university-based research laboratories) would quite likely be highly irritated by repeated free listing trials for the same domain. Such a procedure is probably infeasible or at least costly in terms of damaged rapport in ethnographic settings. Multiple free listing trials also do not allow testing the underlying structure of memory.

In addition, it is possible that additional items can be elicited by simply insisting participants list more items or giving them a predetermined very long time period (e.g. 30 minutes) for free listing (cf. Gruenewald and Lockhead, 1980). In our study, prior to administering cues, we prompted nonspecifically and extensively to elicit other items and stopped prompting only when participants firmly said they could not recall any more items. The practice of insisting that participants free list more even when they believe they cannot, though, is likely less time efficient (in comparison to the semantic cueing procedure in our study) for eliciting the same number of additional items and would also likely harm rapport with informants in ethnographic field situations.

Still other elicitation procedures could be developed from experiential recall strategies that some individuals report using to identify contexts for searching memory when free listing (Vallee-Tourangeau *et al.*, 1998). However, these approaches would be specific to particular domains (and often particular individuals) and also require the interviewer to have prior domain knowledge, making them impractical for ethnographic applications of free listing.

In any event, additional research is required to test the robustness of our results in other domains and in other cultures, as our study is limited to two domains and two particular participant populations.

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REFERENCES

Baron A, Galizio M. 1978. Semantic representations of drug terms by industrial workers. *Journal of Clinical Psychology* **34**: 543–554.

Bellezza FS. 1984. Reliability of retrieval from semantic memory: Common categories. *Bulletin of the Psychonomic Society* **22**: 324–326.

Bellezza FS. 1987. Reliability of retrieving information from knowledge structures in memory: Self information. *Bulletin of the Psychonomic Society* **25**: 407–410.

Bousfield WA, Sedgewick CHW. 1944. An analysis of sequences of restricted associative responses. *Journal of General Psychology* **30**: 149–165.

Brewer DD. 1992. Hip Hop graffiti writers' evaluations of strategies to control illegal graffiti. *Human Organization* **51**: 188–196.

Brewer DD. 1995. Cognitive indicators of knowledge in semantic domains. *Journal of Quantitative Anthropology* **5**: 107–128.

Brewer DD, Garrett SB, Kulasingam S. 1999. Forgetting as a cause of incomplete reporting of sexual and drug injection partners. *Sexually Transmitted Diseases* **26**: 166–176.

Brewer DD, Yang BL. 1994. Patterns in the recall of persons in a religious community. *Social Networks* **16**: 347–379.

Brown J. 1968. Reciprocal facilitation and impairment of free recall. *Psychonomic Science* **10**: 41–42.

Brown W. 1923. To what extent is memory measured by a single recall? *Journal of Experimental Psychology* **6**: 377–382.
Buschke H, Goldberg PC, Lazar G. 1973. Reminding and retrieval from permanent storage. *Journal of Experimental Psychology* **101**: 132–138.
Fitzgerald JM. 1983. A developmental study of recall from natural categories. *Developmental Psychology* **19**: 9–14.
Friendly M. 1979. Methods for finding graphic representations of associative memory structures. In *Memory Organization and Structure*, Puff CR (ed.). Academic Press: New York; 85–129.
Garro LC. 1986. Intracultural variation in folk medical knowledge: A comparison between curers and noncurers. *American Anthropologist* **88**: 351–370.
Glidden LM, Mar HH. 1978. Availability and accessibility of information in the semantic memory of retarded and nonretarded adolescents. *Journal of Experimental Child Psychology* **25**: 33–40.
Graesser A II, Mandler G. 1978. Limited processing capacity constrains the storage of unrelated sets of words and retrieval from natural categories. *Journal of Experimental Psychology: Human Learning and Memory* **4**: 86–100.
Greenwald AG, Bellezza FS, Banaji MR. 1988. Is self-esteem a central ingredient of the self-concept? *Personality and Social Psychology Bulletin* **14**: 34–45.
Gronlund SD, Shiffrin RM. 1986. Retrieval strategies in recall of natural categories and categorized lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **12**: 550–561.
Gruenewald PJ, Lockhead GR. 1980. The free recall of category examples. *Journal of Experimental Psychology: Human Learning and Memory* **6**: 225–240.
Hagan H, McGough JP, Thiede H, Weiss NS, Hopkins S, Alexander ER. 1999. Syringe exchange and risk of infection with hepatitis B and C viruses. *American Journal of Epidemiology* **149**: 203–213.
Henley NM. 1969. A psychological study of the semantics of animal terms. *Journal of Verbal Learning and Verbal Behavior* **8**: 176–184.
Hutchinson JW. 1983. Expertise and the structure of free recall. In *Advances in Consumer Research*, Bagozzi RP, Tybout AM (eds). Association for Consumer Research: Ann Arbor, MI; 585–589.
Katz WA. 1976. *The Single Structure Hypothesis: A comparison of organizational structures derived from semantic and episodic memory*. Unpublished master's thesis, York University.
Lauer PA, Battig WF. 1972. Free recall of taxonomically and alphabetically organized word lists as a function of storage and retrieval cues. *Journal of Verbal Learning and Verbal Behavior* **11**: 333–342.
Lawler EL, Lenstra JK, Rinnooy Kan AHG, Shmoys DB (eds). 1985. *The Traveling Salesman Problem*. John Wiley: Chichester.
Lazar G, Buschke H. 1972. Successive retrieval from permanent storage. *Psychonomic Science* **29**: 388–390.
Padberg M, Rinaldi G. 1991. A branch-and-cut algorithm for the resolution of large-scale symmetric traveling salesman problems. *SIAM Review* **33**: 60–100.
Roenker DL, Thompson CP, Brown SC. 1971. Comparisons of measures for the estimation of clustering in free recall. *Psychological Bulletin* **76**: 45–48.
Romney AK, Brewer DD, Batchelder WH. 1993. Predicting clustering from semantic structure. *Psychological Science* **4**: 28–34.
Romney AK, Smith T, Freeman HE, Kagan J, Klein RE. 1979. Concepts of success and failure. *Social Science Research* **8**: 302–326.
Rosch E. 1978. Principles of categorization. In *Cognition and Categorization*, Rosch E, Lloyd BB (eds). Erlbaum: Hillsdale, NJ; 27–48.
Rosenthal R. 1991. *Meta-analytic Procedures for Social Research* (revised edition). Sage: Newbury Park, CA.
Rubin DC, Olson MJ. 1980. Recall of semantic domains. *Memory and Cognition* **8**: 354–366.
Trotter RT II, Rolf JE, Baldwin JA. 1997. Cultural models of inhalant abuse among Navajo youth. *Drugs and Society* **10**: 39–59.
Tulving E. 1974. Cue-dependent forgetting. *American Scientist* **62**: 74–82.
Vallee-Tourangeau F, Anthony SH, Austin NG. 1998. Strategies for generating multiple instances of common and ad hoc categories. *Memory* **6**: 555–592.
Weller SC, Romney AK. 1988. *Systematic Data Collection*. Sage: Newbury Park, CA.
Wilson RP, Shelley GA, Nxumalo M, Magonga B Jr. 1995. Pile sort analysis of siSwati terms for acute respiratory illness. *Journal of Quantitative Anthropology* **5**: 129–147.

