Research Article

Overcoming the Limitations of Single-Response Free Associations

Lance W. Hahn

Western Kentucky University

Address correspondence to Lance W. Hahn, Ph.D, *Department of Psychology, Western Kentucky University, 228 Tate-Page Hall, 1906 College Heights Blvd., #21030, Bowling Green, KY 42101-1030, e-mail: lance.hahn@wku.edu*

ABSTRACT: *Single-response free association has been the standard method for creating associates for a target word, but it has shortcomings when the objective is to create a broad set of associates. There are also some pragmatic challenges such as the preponderance of idiosyncratic responses and the lack of associate diversity when a strong associate is present. A multiple-response free association task with a new analytic approach is introduced. This new approach is compared with the traditional free association task in terms of response set size and associate strengths. While data from the two tasks are highly correlated, the new task generates broader associate sets and raises the possibility that response biases may influence single-response free association measurements. The new method also provides a mechanism by which individual differences could be studied.*

A fundamental part of human behavior is the association of meaning with an external stimulus. When we recognize a familiar face or hear a mockingbird sing we are associating semantic information stored in memory with an element of the real world. Within the context of word recognition, this task is reduced to the conversion of a symbolic stimulus (a word) into meaning without many of the salient perceptual features present in a more natural stimulus. By focusing on the semantic responses to a word, we may be able to tap into high-level semantic processes without substantial influence from the perceptual systems that are likely to critically constrain the processing of natural images.

Presumably, the semantic information associated with a word is formed through previous experiences with the stimulus, but it may also be constrained by the neural representation of the information. For instance, a representation based on the phonemic similarity of two words would produce very different associates than a representation based on the semantic similarity of two words. Meyer and Schvaneveldt (1971) provided support for a semantic-based representation of words when they showed that two semantically related words were recognized quicker than two semantically unrelated words. This finding initiated a wealth of research on how semantic information can facilitate word recognition (for a review, see McNamara, 2005).

One way to assess the shared semantic representation of two words is by using a Lexical Decision Task (LDT). In an LDT the recognition of one word (e.g., "NURSE") is faster when it is preceded by a related word (e.g., "DOCTOR") than when it is preceded by an unrelated word (e.g., "VASE"). This approach, however, assumes that there already exists a clear set of associated and unassociated words. So, LDT can be used to evaluate the impact of one word on the recognition of another word when the relationship between the two words is already known.

Creating a list of associated words has typically relied on a simple single-response free association task (e. g. Nelson, McEvoy and Dennis, 2000). Nelson, McEvoy and Schreiber (1998) have created a database of free association data with over 5000 cue words and the associative responses. This database has enabled researchers to create a list of associates for many

different words based on the responses of approximately 100 participants for each word. It is important to note, however, that there may be several processes underlying word recognition and the extent to which these processes overlap with the processes underlying free association is an empirical question. For example, the associates of a target word and the semantic neighbors of a target word are likely to have words in common, but the two sets of words will have some mutually exclusive words too. Perea & Rosa (2002) have suggested that the influence of semantic neighbors and associates may have different time profiles in the LDT.

Single-response free association (FA) norms have become a standard by which other methods are compared. Maki (2007) compared ratings of word relatedness to the associative strength measured by free association tasks and concluded that ratings systematically overestimate the associative strength of two words. Latent Semantic Analysis (LSA) is a method for deriving word associates based on the co-occurrence of words in text (Deerwester, Dumais, Furnas, Landauer, and Harshman, 1990). Steyvers, Shiffrin and Nelson (2004) compared associative networks derived from LSA with those derived from FA norms. They concluded that LSA captures a very broad semantic space while FA captures a narrow semantic space. They also remarked that empirical methods for capturing broad semantic spaces should be possible but are not currently available.

The current critique and assessment of FA is motivated by two objectives: 1) the desire to create a new method that captures a broader semantic space than traditional FA, 2) the desire to capture a more complete semantic representation of a word for a single individual. The critique is focused on both methodological challenges and theoretical challenges associated with FA. Following the critique, a new method is proposed in hopes of addressing some of the criticisms of FA and meeting the two motivating objectives.

The FA task, by nature, requires a distribution of responses gathered across several individuals. The strength of an associated word is measured by how many participants produced the word. Words that are produced by many participants are assumed to have a stronger association with the target word than words that are produced by a few participants. Two extreme scenarios that can diminish the value of the response distribution are when 1) each response is generated by only a single participant and 2) all or most participants produce the same common response. In the first case, we are left with a large network of weak associates and very little predictive value. In the second case, we are left with a single strong associate with high predictive value which may be fairly uninteresting.

Singletons and idiosyncratic responses

In an FA task, when 100 participants are asked to respond to a target word with a related word, it is common for some of the participants to respond with a word that no other participant generates. These words have been called idiosyncratic words or singletons. Within the context of this discussion, a response will be described as "idiosyncratic" if the response is demonstrably unique to an individual (e.g., a proper name) while a response will be described as a singleton if it is the product of one individual. A singleton response may be idiosyncratic or it may be a weak associate that could become a true associate with a large participant count.

Singleton responses pose both a practical and a theoretical challenge. Typically these responses are all treated as idiosyncratic noise and discarded. As a result, their presence diminishes the sample size and is generally viewed as a problem. Theoretically, these responses are problematic because we cannot objectively determine whether the response is truly idiosyncratic to the individual or if the word is simply a weak associate. For instance, Nelson et al. (1998) report in the USF norms that the word "HUSBAND" has prompted the responses listed in Table 1, but with the exception of "STUPID", the singleton responses appear to be semantically linked to "HUSBAND". Although it is reasonable to remove truly idiosyncratic responses from the associate list, declaring all singletons to be noise appears to artificially narrow the scope of associates.

Singleton responses can also be a burden in terms of the magnitude of the responses which must be discarded. In extreme cases, low frequency words such as "USURP" have produced as many as 60% singleton responses (Nelson et al., 1998). For the complete USF norm database (Nelson et al., 1998), 17.7% of the responses for a target word were singletons. As can be seen in Figure 1, only 15% of the target words produced fewer than 10% singleton responses.

Table 1

Free Association Responses for "HUSBAND" from Nelson, et al. (1998)

Response	Frequency
wife	146
man	3
spouse	3
love	2
father	1
leader	1
lover	1
boyfriend	1
males	1
married	1
mate	1
stupid	1
<No Response>	3

Dominant Responses

Another type of response that can overwhelm a free association task is the most common or *dominant* response. For example, according to the USF norm database, 96% of the responses to the cue "IN" were "OUT". In the whole USF database, dominant responses are much more common across words than singletons with an average of 32% of responses in the USF norm database being dominant responses. Although the number of responses associated with the dominant word is clearly important, this is an inefficiency in the single-response free association task. As can be seen in Figure 2, the dominant response was responsible for more than 10% of the responses for all but 5% of the words.

The dominance of a single response, whether appropriate or not, also reduces the descriptive range of the associate list. With a small number of participants offering alternatives to the dominant response, the possibility that a relevant associate will be generated by two of the participants is reduced. As a result, there is less opportunity for non-singleton responses to gather association strength. In short, a strong dominant associate shows strength at the cost of other possible associates.

Words with strong dominant responses tend to have a low proportion of singleton responses and words with weak dominant responses tend to have a high proportion of singleton responses (see Figure 3). In the USF norms, the proportion of dominant responses and singleton responses are negatively correlated ($r = -.52$; $p < .0001$; $df = 5014$).

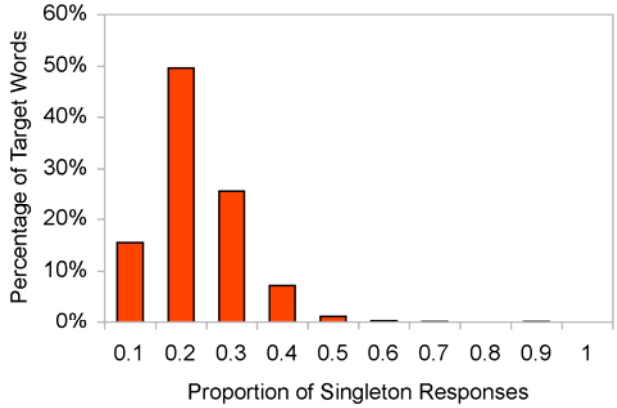

Fig 1. The proportion of singleton responses for the words from the USF norms (Nelson et al., 1998).

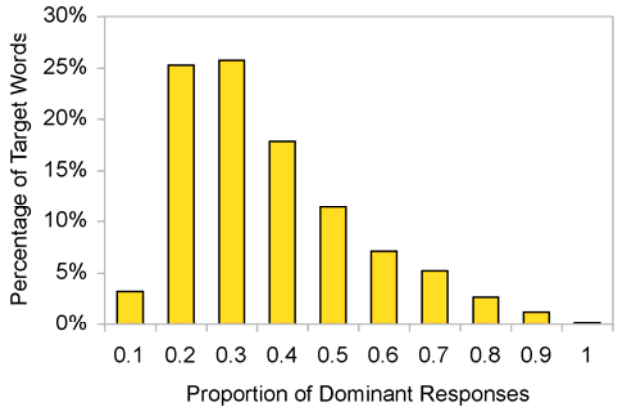

Fig 2. The proportion of dominant responses for the words from the USF norms (Nelson et al., 1998).

This means that the distribution of responses for most words will suffer from one of these two problems. In fact, half of the responses in the USF norms are either singleton or dominant responses with the lowest combined proportion of singletons and dominant responses being the target "SOUP" with 20% of the responses falling into either of these two categories. As figure 4 indicates, the singleton and the dominant-response inefficiencies are marginal challenges when viewed independently, but since they are negatively correlated, they combine into a broad substantial problem.

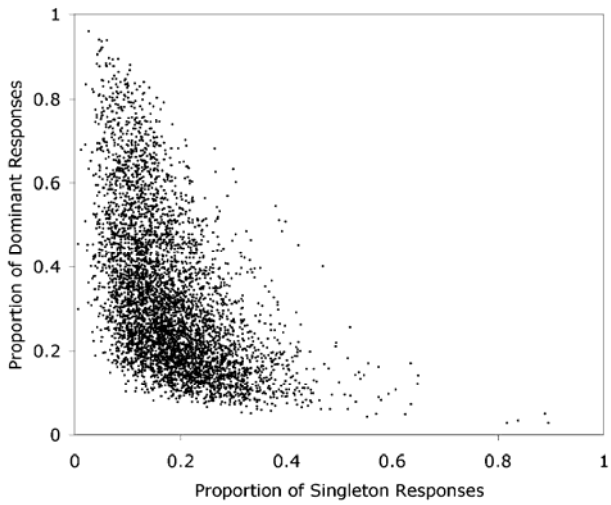

Fig 3. A comparison of the dominant response count and the singleton response count for the words from the USF norms (Nelson et al., 1998).

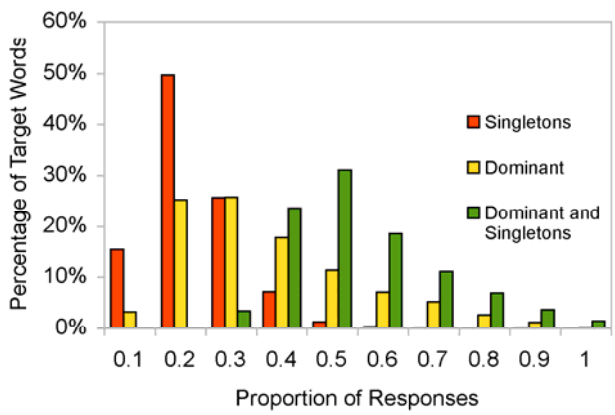

Fig 4. The proportion of both singleton dominant responses for each word from the USF norms (Nelson et al., 1998).

Response Strategies

The cues "HUSBAND" and "IN" also provide examples of the potential problem of response strategy bias. While antonyms are clearly an important feature of the semantic space, they may be overrepresented in a free association task. It could be reasonably argued that the concept of *husband* requires the existence of *wife*, but the degree to which *wife* dominates (89% of all responses) the other responses seems inappropriate. Participants may default to a strategy of antonym production in order to reduce the pool of associates. When a target word has an antonym this strategy would simplify the task for the participant by narrowing the selection of related words from which to choose. One result of this strategy, however, would be an artificial amplification of the antonym association strength at the cost of other candidates.

Antonymy and synonmy have been compared by Perea and Rosa (2002) with FA, LDT and a 9-point semantic similarity scale. They did not find significant differences between antonym pairs and synonym pairs with any task. They did find a significant effect of the type of semantic relationship when a third semantic relationship of shared-category (e.g., cat-RABBIT) was included, but they attributed this effect to word frequency and word length differences between the categories. To our knowledge, a more direct assessment of the antonym selection strategy in FA has not been conducted, but it is an empirical question we are investigating.

Collective Response

Another limitation of using FA to develop semantic representations is that it is inherently dependent on the responses of many participants. Because the product of FA is a distribution of responses across several participants, individual differences and an understanding of the semantic space for a specific word or a specific individual is unapproachable. The importance of individual differences has recently been highlighted by Stolz, Besner, and Carr (2005) in regard to the LDT. They found that fundamental aspects of the data such as test-retest reliability and inter-item reliability were present only at the group-level of analysis and varied substantially from individual to individual. Hutchison, Balota, Cortese and Watson (2007) have suggested that a statistical normalization for reaction times from an LDT may return reliability to the individual level, but such a statistical correction is not likely for FA because the response being measured is qualitative (a word) rather than quantitative (a reaction time).

FA provides a good measure of the set of associates averaged across individuals and can be used to compare groups with different hypothesized association networks. When looking at individual differences, the best use for the FA data is to determine if an individual is a member of one of two groups with hypothesized different FA behaviors. Stacy (1997), for instance, has shown that FA is an important part of a model used to distinguish between individuals who will use alcohol or marijuana in the future and individuals who will not use alcohol or marijuana in the future. However, many questions about individual differences are not approachable with the FA task. For example, a hypothesis about the semantic network for a specific word for a single individual would be very difficult, if not impossible, to approach using the FA task.

New Methods

The points raised in the critique of FA broadly fall into three categories: factors that artificially narrow the semantic span for a target word, inefficiency in measuring association strength, and a lack of sensitivity to individual differences. I have developed a new method to overcome these challenges that is aimed at creating a more complete semantic representation for a single word in a single participant. In the method, participants are asked to provide several associates for a single target word.

McEvoy and Nelson (1982) compared category norms gathered with one response and category norms gathered with multiple responses and found set sizes (the number of nonidiosyncratic responses for a target category) were highly correlated. More recently, Nelson, et al. (2000) compared free association responses with a single response (FA-1) and two-responses (FA-2). Again, response set size was correlated for the two tasks, but set size was generally found to be larger when the second response was included. The larger set size with FA-2 suggests, as Nelson, et al. (2000) acknowledge, that FA-1 may underestimate the response set size. They also suggest that the increase in set size was largely the product of new words added as a second response and they consider these associates to be less valid than first-response associates, presumably because they may be less directly linked to the original target word.

Nelson, et al. (2000) concluded that pooling first and second responses in an FA-2 task decreased reliability in set size measurements as compared to FA-1 set size. They also raised the concern that a chaining response strategy in which response n may be an associate of response n-1 rather than a true associate of the original target word. Although their analysis discounted this concern about chaining, the discrepancy between FA-2 pooled and FA-1 set sizes led them to conclude that FA-1 tasks should be used.

Chaining falls into a broader class of methodological concerns that have been raised about within-subjects designs (Greenwald, 1976). When deciding whether a study should be a within-subjects or a between-subjects design, the statistical, methodological and theoretical repercussions should be considered (for review, see Keren, 1993). Perhaps the largest factor in determining which design to use is the goal of the study. The goal of this study is to develop a method that generates a more complete set of word associates for a target word than is possible with the traditional single-response free association task. Naturally, the additional associates should be clearly related to the target word and a model derived from the new task should be able to better predict responses than a model derived from the single-response task. This expectation led me to test the predictive ability of the new method in the subsequent analysis. If a model based on within-subjects data predicts between-subjects data better than a model based on between-subjects data, then concerns about comparing associates across the designs should diminish.

To broaden the semantic span for a target word, I used a five-response free association task (FA-5). Using five responses increases the opportunity for a chaining strategy to occur. To avoid the potential influence of chaining, only words that were produced as a first (of five) responses were considered associates, but the strength of the association was based on the number of individual who produced the associate word in any of the five response positions. This approach allows a word that would have been discarded as an idiosyncratic response to be treated as a legitimate associate if it is supported by responses in positions two through five.

METHOD

Participants

Sixty-four participants were given the FA-1 task and forty-seven participants were given the FA-5 task. Five participants in the FA-1 task and one participant in the FA-5 task reported that their primary language was not English and, as a result, they were excluded from the analysis. All participants were female undergraduate students enrolled in psychology classes at Western Kentucky University. Each participant earned credit for a class research requirement and/or extra credit by participating in the study. Participants were all female because the current study was part of a screening process for a second project examining behavioral changes across the menstrual cycle. The data collection described in this study was approved by the Human Subjects Review Board at Western Kentucky University.

Materials

Both the FA-1 and FA-5 tasks were conducted as paper-and-pencil tasks. The FA-1 form had 120 words with 60 words on each page in two columns. Beside each word was an underlined blank space for the participant to write an associate word. The instructions “Please write the first word that comes to your mind when seeing the word provided.” were at

the top of the page in the FA-1 task. The FA-1 form used is in Appendix A. Twelve participants used a version of this form that was missing "DOCTOR" and "GOOD". The FA-5 form had 20 words with 10 words on each page and five numbered underlined spaces next to the target word in two columns. The instructions at the top of each page for the FA-5 task were "Please write the first 5 words that come to your mind when seeing the word provided." The FA-5 form used is in Appendix B. Nineteen of the words in the FA-5 task were also present in the FA-5 task. These nineteen common words will be the basis for the analysis conducted.

Design and Procedure

After answering a two-page demographics questionnaire, the individuals participated in either the FA-1 or the FA-5 task. A double-sided FA-1 page was used for all participants in the FA-1 condition and a double-sided FA-5 page was used for all participants in the FA-5 condition. Half of the participants in each group were given the page with one side first and the other half of the participants in each group was given the page with the other side first.

RESULTS

Set Sizes Across Methods

Response set sizes were calculated for each word by counting only the responses that were generated by two or more participants. Set size calculations were made for FA-1 responses, all FA-5 responses, the first response of the FA-5 responses (FA-1/5), and the first response of the FA-5 responses with frequencies calculated from the whole FA-5 response set (extended FA-1/5). The calculated set sizes for each of the 19 words present in both tasks are in Table 2. The FA-1 and FA-1/5 set size calculations were both made because the production of five responses instead of a single response might have repercussions on the first word produced.

The FA-1 (M = 7.53, SD = 2.41) and FA-1/5 (M = 6.74, SD = 1.85) set sizes were not significantly different with $t(18) = 1.62$, $p = .12$ (paired, two-tailed). The extended FA-1/5 (M = 14.11, SD = 3.68) set sizes were significantly larger than the set sizes for FA-1/5 with $t(18) = 11.84$, $p < .001$ (paired, one-tailed) but were still significantly smaller than the FA-5 set sizes (M = 31.32, SD = 4.12) with $t(18) = 24.77$, $p < .001$ (paired, one-tailed).

Association Strengths

The association strengths for FA-1/5 and extended FA-1/5 were highly correlated. The correlations and t-values are shown in Table 3. For all but one dominant response word, the association strength was larger in the extended FA-1/5 calculation than in the FA-1/5 calculation. For six of the nineteen words, however, a non-dominant associate received more support than the original dominant associate. As a result, six associates that had been the dominant associates in the FA-1/5 calculation were displaced by other associates when the extended FA-1/5 calculation was used.

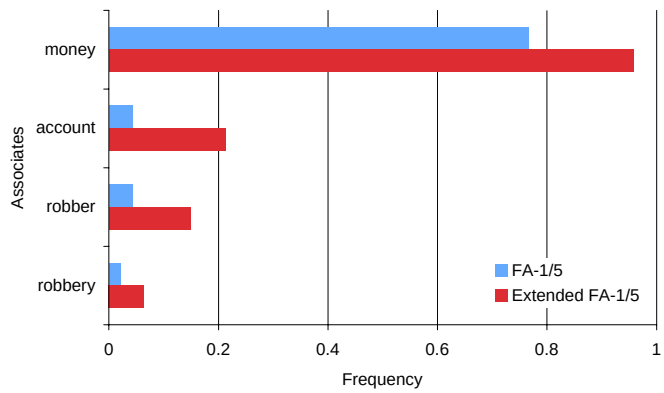

Fig 5. The FA-1/5 response frequencies for the target "BANK" that had the highest correlation between association strengths with and without extension.

Figure 5 shows the non-singleton associates for the target word (BANK, r = .98) with the highest correlation between the FA-1/5 and extended FA-1/5 association strengths. In this example, the extended FA-1/5 calculation rendered the singleton "ROBBERY" a legitimate associate and the associate "ACCOUNT" as a stronger associate than "ROBBER" which had been its equal in the FA-1/5 calculation.

Figure 6 shows the non-singleton associates for the target word (PARK, r = .60) with the lowest correlation. The lowest nine associates were singletons in the FA-1/5 calculation that were converted into legitimate associates with support from second through fifth responses. The most striking change is that "GRASS" which was a singleton in the FA-1/5 calculation is the dominant response with additional support. The support changed the ranking of several associates but, as the correlation suggests, strong associates generally received more support than weak associates.

Table 2

Set Sizes Calculated from FA-1 and FA-5 Responses

	FA-1	FA-5	FA-1/5	FA-1/5 Extended
ARM	5	38	7	18
BACK	7	34	8	14
BANK	3	25	3	4
CLAY	11	30	9	17
CONTROL	9	23	5	12
FORCE	8	35	9	16
FRONT	6	34	6	13
GAME	9	32	8	15
HOME	5	30	4	14
LABOR	6	35	8	14
LEVEL	7	35	7	20
MAD	7	27	4	12
NEED	6	30	6	13
NIGHT	7	24	5	9
PARK	12	34	9	18
ROCK	11	32	6	13
SIDE	11	34	8	13
WISE	6	30	8	14
WOMEN	7	33	8	19
Averages	7.53	31.32	6.74	14.11

Table 3

Correlations and T-tests for the FA-5 Target Words

	Response Count	Correlation Between FA1/5 and Extended FA1/5	t
ARM	25	0.71	4.79
BACK	25	0.77	5.83
BANK	9	0.98	13.47
CLAY	24	0.85	7.57
CONTROL	33	0.68	5.16
FORCE	29	0.79	6.71
FRONT	20	0.86	7.32
GAME	28	0.76	6.03
HOME	31	0.73	5.74
LABOR	21	0.95	13.45
LEVEL	34	0.67	5.16
MAD	19	0.86	6.99
NEED	19	0.82	5.9
NIGHT	17	0.70	3.76
PARK	26	0.60	3.65
ROCK	21	0.83	6.5
SIDE	29	0.72	5.42
WISE	19	0.93	10.36
WOMEN	26	0.81	6.85

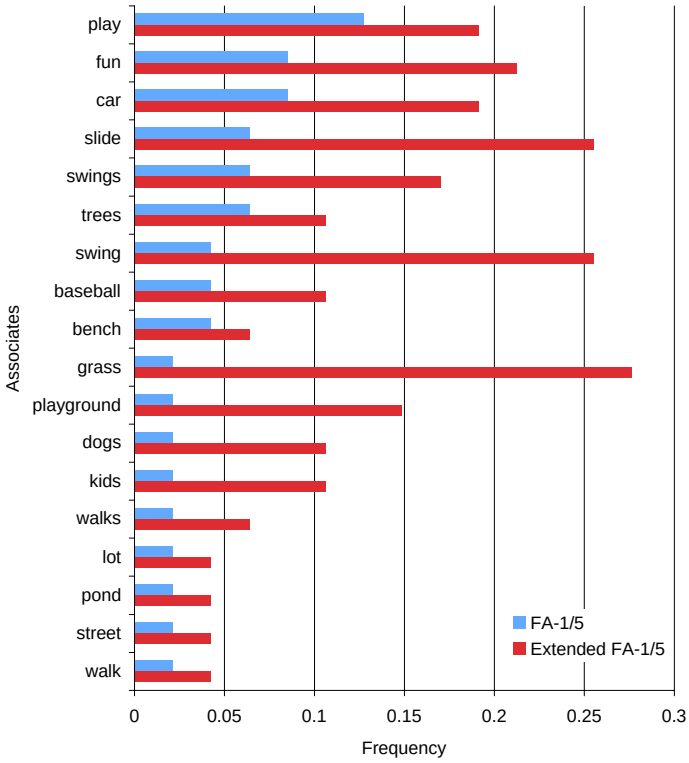

Fig 6. The FA-1/5 response frequencies for the target "PARK" that had the lowest correlation between association strengths with and without extension.

Ability to Predict Associates

If the extension of the task to include five responses to support the initial response creates a more accurate representation of the semantic connections between words, then a model based on the new extended task should predict associate generation better than a model based only on the first response. To test this hypothesized increase in predictive ability, simple models of association were created and tested using ten-fold cross-validation.

For each target word, one-tenth of the FA-5 dataset was set aside for testing and a frequency distribution was created based only on the first response in the remaining nine-tenths of the dataset. Each word that occurred two or more times in the training set was included in the associate list. The predictive ability of the associate list was tested by counting the number of first-responses in the test set that were predicted by the associate list from the training set. This process was repeated ten times with a different tenth of the dataset used as the testing set and an average number of predicted responses was created for each target word. Since there were 46

participants, the training set size alternated between 41 and 42 while the testing set size alternating between 5 and 4.

Associate lists based on the extended FA-1/5 data were similarly created and tested with ten-fold cross-validation. The average number of predicted responses in the test set for all target words is plotted in Figure 7. For seventeen of the nineteen target words, the extended FA-1/5 models (M = 2.37, SD = .50) predicted more test words than the FA-1/5 models (M = 1.83, SD = .39) with $t(18)=8.97$, $p < .001$ (paired, one-tailed).

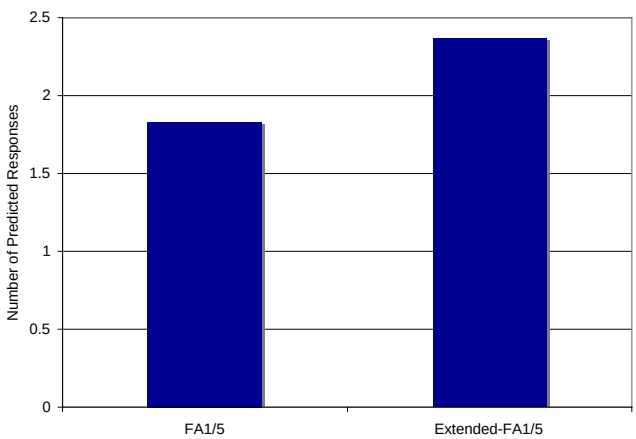

Fig 7. The predictive ability of FA-1/5 and extended FA-1/5 assessed using ten-fold cross-validation.

DISCUSSION

The single-response free association task is excellent for acquiring a list of the strong associates for many words, but it has shortcomings when the focus is on a complete set of associates or on individual differences. Requiring multiple responses to each target word raises the possible problem of a chaining response strategy in which a response is influenced by the preceding response rather than the original target word. One way to ensure that associates are not the product of chaining, but due to a direct association with the target word is to require that each associate occur at least once as a first response in the dataset. Once this criterion has been met, association strength can be calculated based on the number of individuals who gave the associate as a response in any of the response positions. This additional support allows singletons that are not idiosyncratic to be included in the associate list for a target word. The support from multiple responses also reduces competition between associates. While dominant associates remain strong in this extended FA-1/5 approach, the cost of a dominant response on the diversity of associates is reduced. After choosing a dominant associate, a participant still has opportunities to provide other associates.

Although it would be premature to draw conclusions about the impact of multiple responses on response strategies like the antonym response strategy, the results for FRONT suggest that this is an issue worth considering. As is shown in Figure 8, the dominant associate for FRONT was “BACK” in both the FA-1/5 and the extended FA-1/5 calculations, but the non-dominant responses “FACE” and “DOOR” both receive more additional support than “BACK”. This could be a simple shift of associates, but it is also consistent with first-responses being biased towards antonyms in a way that multiple-responses are not.

In terms of gathering information on the largest number of target words, acquiring support from additional responses is clearly inefficient because it takes much more time for a participant to create five associates for a word than one associate. If, on the other hand, the objective is to create a complete description of a target word, then this extended FA method is more efficient. Table 4 shows the average percentage of singleton and dominant responses for the FA-1/5 responses and the extended FA-1/5 responses. The percentage of responses that do not fall into either of these two categories is also provided. It is this last category that should be maximized in order to create a complete description of the target word because it represents the responses that are strengthening non-dominant associates.

In summary, the extended free association task provides a diverse set of associates for a single word in a way that rules out chaining and makes it possible for individual differences to be considered. The task is not a general replacement for traditional FA, but may be used to assess hypotheses with specific predictions about the links between a word and a fairly broad semantic context. Discrepancies between traditional FA and extended FA may also reveal word production strategies that may or may not reflect differences in the underlying semantic representation. Finally, because there are several responses gathered from each individual for each target word, the task may also be more sensitive to individual differences than traditional FA.

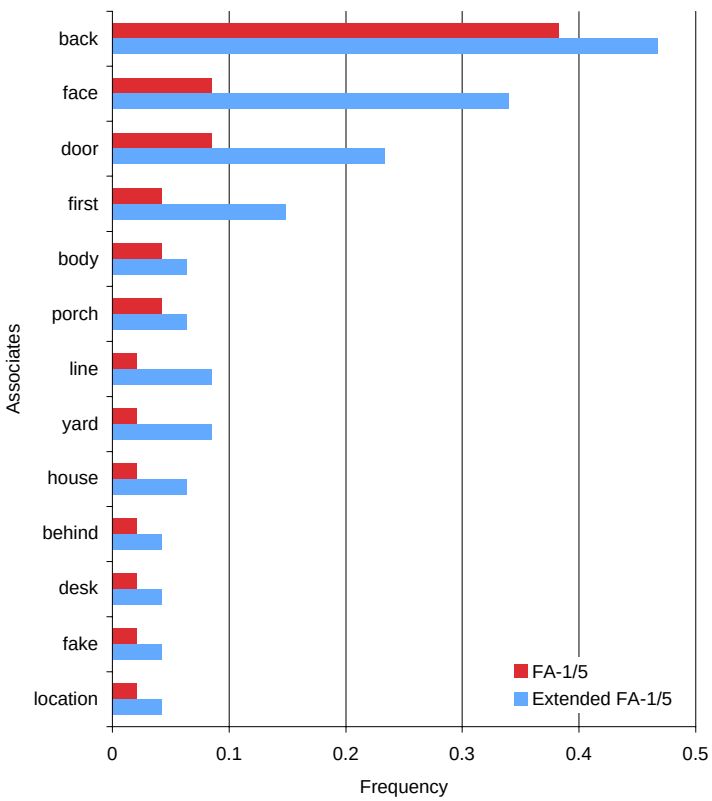

Fig 8. The FA-1/5 response frequencies for the target "FRONT" that had secondary responses acquire more support than the dominant antonym when extension was used.

Table 4

Dominant, Singleton and Other Responses for FA-5 Task with and without Extension

	FA-1/5	Extended FA-1/5
Dominant Responses	25.5%	21.5%
Singleton Responses	37.8%	9.9%
Non-dominant, Non-singleton Responses	36.7%	68.6%

Note. FA-1/5 percentages were calculated based on the total number of participants providing a first response. Extended FA-1/5 percentages were calculated based on the total number of responses (five per participant) excluding the responses that never appeared as the first response.

Implications of extended FA-1/5 for understanding semantic memory

The main motivation for creating extended FA-1/5 was to enable the creation of a detailed list of associates for a target word with an increased focus on the representation provided by a single participant. A high-resolution associative map for a word has the potential to impact the study of semantic memory in at least two important ways. First, there is currently a disconnect between free association and other measures of word associativity (e.g. word relatedness and Latent Semantic Analysis). One potential cause for this disconnect is that traditional free association measures the relatedness between words that are strongly related while LSA and word relatedness tasks capture very broad semantic spaces. By broadening the semantic space captured, extended FA-1/5 has the potential to reveal a theory of semantic memory that unifies FA, LSA and word relatedness.

Second, there is a growing interest in the gross network properties of semantic memory (i.e. Steyvers and Tenenbaum, 2005) that is often based on single-response free association. Limiting these network models of semantic memory to only the strong responses may lead to conclusions that simplify the theorized network and reduce connectivity. The level of connectivity is fundamentally important to these models. If connectivity is underestimated, then the fundamental computation used to describe the flow of activation would be based on false assumptions (Nelson, McEvoy and Pointer, 2003).

The increased focus on the semantic map for a single individual has the potential to add a third important impact on the study of semantic memory in the area of group and individual differences. While group differences have been measured across words (e.g. Stacy, 1997), this new task allows a closer inspection of the semantic representations.

For instance, it would be reasonable to expect gender differences in the associative networks for some words. LABOR may evoke associates such as BIRTH and HOSPITAL for women while evoking associates such as WORK and MANUAL for men. By acquiring several associates for an individual, we can determine if individuals cling to a single salient definition (LABOR: BIRTH, HOSPITAL) or are flexible (LABOR: BIRTH, WORK).

Finally, requiring a participant to generate several associates may be useful in assessing aspects of the individual. An inability to produce more than the obvious associates may indicate a restricted vocabulary or a reduced reading ability. Producing

negative associates within a specific semantic domain may reveal negative emotions associated with that domain. In summary, when the empirical focus is on individual differences or the detailed semantic representation of a word, extended FA-1/5 overcomes many of the drawbacks of single-response FA and provides new clarity in the investigation of semantic memory.

REFERENCES

Deerwester, S., Dumais, S. T., Furnas, G. W., Landauer, T. K., & Harshman, R. (1990). Indexing by latent semantic analysis. *Journal of the American Society For Information Science*, *41*, 391-407.

Greenwald, A. G. (1976). Within-subjects designs: To use or not to use? *Psychological Bulletin*, *83*, 314-320.

Hutchison, K. A., Balota, D. A., Cortese, M. J., Watson, J. M. (2007). Predicting semantic priming at the item level. *The Quarterly Journal of Experimental Psychology*, *1*, 1-31. Retrieved May 21, 2008, from http://www.informaworld.com/smpp/content~db=all?content=10.1080/17470210701438111

Keren, G. (1993) Between- or within-subjects design: A methodological dilemma. In G. Keren & C. Lewis (Eds.), *A Handbook for Data Analysis in Behavioral Sciences* (pp. 257-272). Hillsdale, NJ: L. Erlbaum Associates.

Maki, W. S. (2007). Judgments of associative memory. *Cognitive Psychology*, *54*, 319-353.

McEvoy, C. L., & Nelson, D. L. (1982). Category name and instance norms for 106 categories of various sizes. *American Journal of Psychology*, *95*, 581-634.

McNamara, T. P. (2005). *Semantic priming: Perspectives from memory and word*. New York: Taylor & Francis Group.

Meyer, D. E. & Schvaneveldt, R. W. (1971) Facilitation in recognizing pairs of words: evidence of a dependence between retrieval operations. *Journal of Experimental Psychology*, *90*, 227-234.

Nelson, D., McEvoy, C., & Dennis, S. (2000). What is and what does free association measure? *Memory & Cognition*, *28*, 887-899.

Nelson, D., McEvoy, C., & Pointer, L. (2003). Spreading activation or spooky action at a distance? *Journal of Experimental Psychology: Learning, Memory and Cognition*, *29*, 42-52.

Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (1998). The University of South Florida word association, rhyme, and word fragment norms. Retrieved May 18, 2007, from http://www.usf.edu/FreeAssociation/

Perea, M., & Rosa, E. (2002). The effects of associative and semantic priming in the lexical decision task. *Psychological Research*, *66*, 180-194.

Stacy, A. W. (1997). Memory activation and expectancy as prospective predictors of alcohol and marijuana use. *Journal of Abnormal Psychology*, *106*, 61-73.

Steyvers, M. Shiffrin, R. M. & Nelson, D. L. (2004). Word association spaces for predicting semantic similarity effects in episodic memory. In A. F. Healy (Ed.), *Experimental Cognitive Psychology and its Applications. Festschrift in honor of Lyle Bourne, Walter Kintsch, and Thomas Landauer* (pp. 237-240). Washington, DC: American Psychological Association.

Stolz, J. A., Besner, D., & Carr, T. H. (2005). Implications of measure of reliability for theories of priming: Activity in semantic memory is inherently noisy and uncoordinated. *Visual Cognition*, *12*, 284-336.

APPENDIX A: FA-1 FORM

Please write the first word that comes to your mind when seeing the word provided.

home		alto	
clear		park	
side		atom	
experts		progress	
clay		london	
bass		test	
fiddle		force	
most		pawn	
white		card	
sin		low	
ammo		need	
lady		yard	
remember		cat	
very		front	
you		effect	
mile		basis	
computer		bluegrass	
knight		brooks	
final		night	
bank		bishop	
french		meet	
even		zen	
keyboard		game	
inch		drum	
mad		stomach	
rock		idea	
sheep		anatomy	
himself		wise	
done		ago	
joy		upon	
good		doctor	

APPENDIX B: FA-5 FORM

Please write the first 5 words that come to your mind when seeing the word provided.

side	1.	2.
	3.	4.
	5.	
clay	1.	2.
	3.	4.
	5.	
bank	1.	2.
	3.	4.
	5.	
force	1.	2.
	3.	4.
	5.	
front	1.	2.
	3.	4.
	5.	
labor	1.	2.
	3.	4.
	5.	
level	1.	2.
	3.	4.
	5.	
need	1.	2.
	3.	4.
	5.	
night	1.	2.
	3.	4.
	5.	
park	1.	2.
	3.	4.
	5.	