SUPPLEMENTARY INFORMATION

A Simplified Example of SVD Analysis

Here we present a SVD analysis of a made-up dataset, which was adapted and modified from the supplementary information of our previous study (Sung et al., 2012). The input data to be analyzed here is a 6-by-4 binary matrix, which represents six different words (w1, w2, w3, w4, w5, and w6.) named by four different subjects (s1, s2, s3, and s4). From the matrix below, we see that subject 1 (s1) named first three words but not the others since cell values of column 1 are set to 1 for words w1, w2, and w3 and to 0 for words w4, w5, and w6. Similarly, the fourth column tells us that subject 4 (s4) named the first, fifth, and sixth words during a fluency test. Note that the order of columns or rows does not matter in SVD analysis.

$$\begin{array}{c} w1 \\ w2 \\ w3 \\ w4 \\ w5 \\ w6 \end{array}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}\#$$
$$s1 \quad s2 \quad s3 \quad s4$$

Figure S1. Simplified input matrix for demonstration. Rows indicate the six different words and columns represent the four participants.

From this matrix, we can reasonably infer that a vector representing the first word (w1) would be located in a neutral position as a result of SVD analysis since it co-occurs with all other words, although it co-occurs more frequently with some than others. Also, the vectors w2 and w5 would be separated widely since they are mutually exclusive. At first glance, there seem to be two major clusters of vectors, one with w2, w3, and w4 and the other with w5 and w6. The result of SVD is presented in Figure S2. The vectors are positioned in the 2-dimensional space.

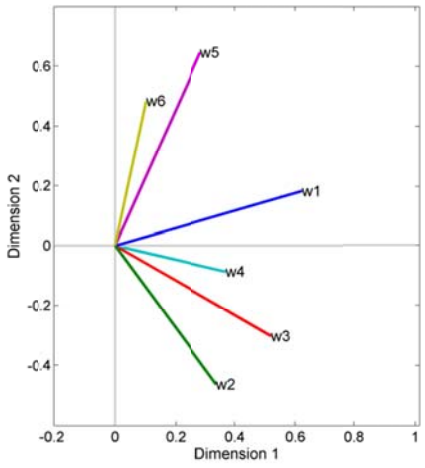

Figure S2. Word vectors represented in 2-dimensional vector space as a result of SVD analysis.

As expected, we see two major clusters in Figure S2. That is, w2, w3, and w4 form one cluster and w5 and w6 form a second one along the dimension 2, according to the angles between these vectors. It is interesting that the vector angle between w4 and w1 is smaller than that between w3 and w1, which is counterintuitive since w3 co-occurs with w1 more frequently than w4 does (see Figure S1). However, it turns out that when 3-dimensional space is considered (dimensions 1-3; not shown here), the angle between w1 and w4 is much greater [87.1°; cos(87.1) = 0.05] than the angle between w1 and w3 [58.4°; cos(58.4) = 0.52]. Thus, in terms of vector angles in 3-D space, w1 is deemed to be more similar to w3 than to w4. Considering the simplicity of the example, this result critically demonstrates the importance of examining high-dimensionality of clustering analysis in verbal fluency.