Love, Language, and Linear Algebra: Linguistic Modeling of Personality and Mate Preference

Caleb Z. Marshall

Dr. Erin M. Buchanan

Dr. Melissa Fallone

Missouri State UniversityAbstract

This study utilized Latent Semantic Analysis to evaluate the relationship between personality and participants’ written personal account of an ideal romantic partner. From participants’ writing samples, we calculated thematic cosines (a measure of relatedness) between each male and female participant. Participants completed the Big Five Personality Questionnaire Short Form (Morizet, 2014), a personality inventory which evaluated participants’ openness, extraversion, agreeableness, conscientiousness and emotional stability. We examined if similarity among two participants’ personality traits predicted similar romantic writing cosines. Extraversion, agreeableness and conscientiousness were related to cosines, which suggested medium-small relationships from similar personality traits to similar written responses about mate preference. This relationship is consistent with previous studies on mate preference, which suggests that Latent Semantic Analysis could be a valuable tool for quantifying mate preference beyond traditional survey methods. Finally, Latent Semantic Analysis constructs continuous measure of mate preference. This is crucial, as we utilized several Multilevel Models, a parametric statistical test.

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Sexual and romantic desirability are vital in forming a basic unit of human culture, the mated pair. Through natural selection, general preference for certain traits, such as intelligence and physique, lead to our evolution as a species. Romantic preference, an individual’s abstract set of desirable traits in a mate, defines many cultural phenomena. In many ways, our similarities in individual mate preference shape our social environment. For example, the literature suggested that men value attractiveness more than women in survey based research paradigms. This specific sex difference was observed by Feinstein (1990) in a meta-analysis of 28 separate samples of American females and males. However, Feinstein also found similar differences in personal ads and billboards targeting males and females, which suggests that survey based results often correlate realistically with real-world sex differences in mate preference.

In a far-reaching cross-sectional study, Buss (1989) examined sex differences in mate preference across 37 samples from 33 distinct cultural paradigms. To compare mate preference and sex differences across cultures, Buss administered a three-part survey. This survey asked for participants’ demographic information (age, sex, religious and familial background). The second portion of the survey asked participants for their ideal age to marry, their preferred age difference to a potential spouse, and how many children they desired. The final section asked participants to rate 18 characteristics (i.e. sociability, intelligence, chastity) on how important they were in determining a potential romantic partner. Incredibly, Buss found that sex differences in mate preference were almost entirely homogeneous across all cultures. Examples included higher preference among women for fiscally stable partners, and higher preference among men for younger female partners.

Within the same study, Buss (1989) also carefully checked census data from each country to determine how mate preference influenced mate choices. As an example, in every culture studied, an age-gap of approximately three years was found between older men and younger women in census data. This dovetailed neatly with the second survey section which assessed participants’ ideal age difference between a potential mate. Yet, age differences are easily-measured, external variables. Moreover, as stated by Buss, age differences were the most statistically reliable findings in his study, while other variables, such as previous sexual experience, showed weaker effects across different cultures.

Buss’s (1989) and Feingold’s (1990) research suggests that mate preference is a valid cognitive construct in multiple cultures and paradigms. Moreover, certain sex differences in preference, such as physical attractiveness and age, are apparent in census and environmental data. Yet, the relationship of other traits, such as personality or intelligence, to concrete mate choice is more complex. In survey-based research of Brazilian college students, Castro, Hattori, and Lopez (2012) found that preferences in non-physical traits (i.e., humor, intelligence) did not always correlate with concrete perceptions of current or recent mates. Their results show how mate preference may significantly differ across sex within a sample without necessarily predicting individuals’ perceptions of real-world romantic partners (Castro et al., 2012).

Castro et al.’s findings highlight the difference between our abstract romantic preferences and our concrete sexual selection process. These results imply that people often choose mates which do not fit their stated preferences. This discrepancy necessitates research into the intricacies of romantic preference and its role in evolutionary psychology and human cognition. Of course, while an individual’s romantic preferences may fail to predict their mate choices, certain social phenomena can be explained as a function of observed gender differences in romantic preference.

As an example, Feingold’s (1990) meta-analysis explored the types of empirical methodologies used to study romantic preference and mate choice. He also compared this meta-data with linguistic analyses of advertisements and billboards targeted towards men or women specifically. Interestingly, he noted that advertisements targeting men focus on attractive female partners more than advertisements for women, a conclusion that mirrored Buss’ (1989) findings and meta-data collected from survey-based research in romantic preference. That advertisements dovetail with observed research shows the direct applicability of empirical research in romantic preference. It also reveals the influence of romantic preference in shaping our understanding of desirability across two distinct genders.

Of course, that romantic preference influences society suggests it also motivates individuals and influences their actions. Botwin, Buss, and Shackelford (1997) found that individuals from both sexes prefer romantic partners whose personality traits mirror their own. Long-term partners were likely to exhibit similar personality traits, showing a distinct connection between personality preferences in romantic partners and successful long-term romantic relationships. Even more, among all participants, Botwin et al. (1997) found that certain personality traits were unappealing. These included disagreeableness, emotional instability, and non-equal intellect-openness between partners. In relationships which had lasted longer than a year, personality differences were even stronger predictors of dissatisfaction (Botwin et al., 1997).

Botwin et al.’s (1997) results suggest a relationship between mate preference and mate choice which is consistent across several physical and personality traits. In observed concrete mate choices, similar personality scores are strong indicators of relational satisfaction. Yet, personality is a factor which Castro et al. (2012) suggests plays a lesser role in abstract romantic preference, especially among males. Back, Penke, Schmukle, and Asendorpf (2011) also observed that, in short-term socio-sexual interactions (i.e., speed dating scenarios), an individual’s agreeableness not only predicted desirability but also significantly correlated with participants’ ability to predict their desirability among fellow participants.

This study examined the effect of personality differences on mate preference among males and females. However, unlike previously mentioned research, we measured participants’ mate preference through written responses to a prompt. We hypothesized that, like previous non-linguistic research, similarity in participants’ personality scores would predict mate preference as recorded through responses to a written prompt. To incorporate linguistic data, we utilized Latent Semantic Analysis (LSA), an algebraic technique which converts word frequency and co-occurrence into thematic cosines, which behave like correlations. (Landauer, Folt, & Laham, 1998) These thematic cosines allowed us to compare similarity from one participant’s written response to another.

**Method**

**Participants**

A sample of undergraduate students (*N* = 105) was recruited from a large Midwestern university. All participants were enrolled in an introductory psychology course and received two research-participation credits for completing the study. Relatively even samples of male (*N* = 53) and female (*N* = 52) participants were recruited. The average age of the participant was around 19 years of age (*M* = 18.75, *SD* = 1.60), and the majority were white (96.15%) with the remainder not answering (3.85%). Sample collection occurred over a two-month period from October through early-December.

**Materials and Procedure**

All participants received online survey materials through Qualtrics, an internet survey platform. After reporting demographic information (e.g., gender, age, academic major, ethnicity), participants completed the Big Five Personality Trait Short Questionnaire (Morizot, 2014), which assessed Openness, Extraversion, Agreeableness, Conscientiousness and Emotional Stability. Finally, in random order, participants responded to a pair of writing prompts. One concerned their interests and hobbies (“Describe your interests and/or hobbies”), while the other asked them to describe their ideal romantic partner (“Describe an ideal date with your perfect romantic partner”). The order of prompts was counterbalanced, and responses had to exceed a minimum of 2200 characters to move on with the study. This requirement was to ensure enough information density in the writing samples to guarantee usable latent semantic data. For this specific study, we did not utilize the interests-and-hobbies written data. In the future, we may analyze whether similarities in writing on other dimensions (i.e., interests, personal statements, etc.) moderates the relationships of personality and romantic writing. However, in this study, we only tested the relationship between similarity across each personality measure with romantic writing.

**Results**

Data analysis was conducted in two major steps: LSA to create the dependent thematic cosine variable, and several multilevel models (MLM) examining the influence of individual participants’ personality differences on romantic writing similarity as measured by thematic cosines.

**Latent Semantic Analysis**

Raw written data were marked with a participant number, gender, and prompt number. LSA was conducted in R using the *lsa* (Wild, 2015) package. Initially, LSA encodes the word frequency and co-occurrence of each participant’s written response in a text-frequency matrix. This matrix was normalized using log weighting to control for the sparsity/skew of text frequencies, that is, the differences in number of very frequently versus infrequently used words. LSA was then performed, which created a matrix of concepts by documents with values in this matrix representing the relationship of each concept to a document. Cosine values between each male-female participant combination were calculated, and therefore, the final dependent variable dataset included 5485 cosine values (i.e., male participant one to female participant one, two, etc.). The complete scripts and data set can be found at: https://osf.io/5qw67/.

**Data Screening**

Next, the independent variables were added to the cosine values. Difference scores were calculated by subtracting our male participant’s score from our female participant’s score across each personality variable. Following this, we took an absolute value to normalize the order effects of subtraction on our personality measure. Next, the data were analyzed for assumptions of parametric regression. Mahalanobis distance was calculated on the cosine scores and personality responses (Tabachnick & Fidell, 2012). Only one participant-pair fell outside the Mahalanobis cutoff score (22.46) and was excluded. Data were then screened for accuracy, additivity, normality, linearity and heteroscedasticity with all necessary assumptions being met before analysis.

**MLM Regression Analysis**

Following data screening, descriptive statistics were calculated for romantic cosines and personality measures across both males and females. The average romantic cosine (*M* = .19, *SD* = .17) was relatively small and showed a comparatively large standard deviation. Personality scores ranged from 10-50 on an interval scale. Although we utilized a difference score in our MLM; however, for convenience, Table 1 shows personality means, standard deviations, and Cohen’s *ds* (Lakens, 2013) across both males and females.

In our analysis, each personality variable was analyzed in a separate MLM. We chose this design to control for the correlated error introduced by examining each participant paired with every other opposite gender participant (i.e., therefore, controlling for male participant one being represented in the data multiple times across female participants). We compared an intercept-only model, a random-intercept model without predictors, and a random-intercept model with personality differences as a predictor (Field, Miles,, & Field, 2012).

Except for the MLM examining Openness, the random-intercept model with predictors was the best fit for our data in each MLM. However, due to the repeated measures of the data, we included all models from the random-intercepts main effects, as we wished to control for correlated error. Models’ significance were evaluated using an ANOVA; however, in order to determine the best-fit for our data, we utilized the Aikake Information Criterion (AIC). A lower AIC corresponds to less information lost, and hence models with lower AIC scores correspond to better fits for our data. Individual model’s degrees of freedom, intercepts, as well as significance among all models can be found in Table 2.

We found that differences in extraversion, agreeableness, and conscientiousness were predictors of similarities in thematic cosines across romantic writing. With negative slopes, this finding suggests that smaller differences in personality predicted larger thematic cosines. Therefore, as personality scores were more similar (small differences, closer to zero), the larger the overlap between the romantic writing provided for participants. Difference in Emotional Stability and Openness were not predictors of similarity in thematic cosines. For convenience, see Table 3 for predictors, intercepts, standard errors, and *p*-values for each predictor.

**Discussion**

Our results show that similarity in extraversion, agreeableness, and conscientiousness predicted similarity in writing about a romantic partner. With the largest *b*-value, Agreeableness as a predictor aligns with existing findings by Back et al. (2011) and Botwin et al. (1997), who suggested that agreeableness was the strongest personality predictor for high mate value and relational satisfaction in concrete mate choices. Since our study examined mate preference specifically, we cannot draw conclusions related to mate choice. However, our results show that similar levels of agreeableness predict similarities in written responses. This suggests that further research in mate preference and personality may uncover a similar relationship of agreeableness to mate preference as in Back’s and Botwin’s studies on mate choice.

However, we did find that linguistic modelling of mate preference can return similar results as traditional survey methods. But what justifies the use of linguistic modelling if survey methods return similar results? In examining the structure of our measure versus traditional surveys, we begin to see profound differences. Traditional surveys examining mate preference utilize prefabricated questions constructed around observed constructs related to mate preference (such as socio-economic status or personality). Responses are usually rated on a Likert-scale, which restricts a construct to analysis through an ordinal measure. Often to avoid complications, we assume Likert-style data behaves similarly to continuous measures. This assumption is to satisfy the statistical assumptions of the parametric statistical tests used to convert our data into publication-worthy results. Usually, this assumption rests on the hypothesized continuity of the underlying construct.

However, applied statisticians in several fields, such as Jamieson (2004) in Oncology or Grice, Barrett, Schlimgen, and Abramson (2012) in Behavioral Science reject the validity of parametric statistical tests with ordinal measures. Among critiques of these methods are the misapplication of standard deviation from group means as a measure of central tendency or the incorrect pairing of discrete measures with statistical tests which depend on continuous variances to construct a normal distribution.

While Grice et al. (2012) propose Observation Oriented Modeling as one of many elegant alternatives to null hypothesis testing, many talented researchers across the Behavioral Sciences depend on traditional parametric statistics to conduct their work. So, as a complement to these non-parametric methods of analysis, we suggest constructing measures which better suit the mathematical underpinnings of null hypothesis testing. In our study, by utilizing writing as a measure of mate preference, the dependent variable was a continuous measure instead of the traditional ordinal survey measures. Since mate preference is observed to be stable across culture (Buss, 1989) and age (Schwarz & Hassbrauck, 2012), it is logical to assume that the distribution of mate preference across the global population is a continuous distribution, regardless of its general shape or other defining characteristics.

Because we assume that the underlying distribution is continuous, it seems natural to use the common parametric statistical tests used in much of Behavioral Science. However, the assumptions behind parametric null hypothesis testing depend on the continuity of the underlying distribution *and* measure. That does not mean writing is a perfect measure for quantifying mate preference, nor are we guaranteed that the distribution of thematic cosines is identical to the distribution of mate preference. However, we do know that the statistical assumptions and screenings of our Multilevel Model are conducted appropriately with respect to a continuous, ratio dependent variable.

In summation, these results suggest that a linguistic measurement (e.g., thematic cosines) of mate preference corroborate the findings of traditional survey based research. However, thematic cosines also provide appropriately continuous data for parametric statistical tests by allowing participants to respond freely to a prompt rather than responding to prefabricated questions. Further research is needed to understand the validity of Latent Semantic Analysis in measuring mate preference. Yet, these promising results suggest that linguistic modelling may be applicable to traditionally non-linguistic problems in diverse areas of Behavioral Science. Finally, and perhaps most importantly, Latent Semantic Analysis provides statistically appropriate, continuous measures for parametric statistical tests, which further reinforces the validity and reliability of statistically based findings in Psychology and Behavioral Science.

References

Axler, S. (2015). Polar Decomposition and Singular Values Decomposition. In (3rd ed.) *Linear Algebra Done Right (*pp. 233-239). New York, NY: Springer Publications.

Back, M. D., Penke, L., Schmukle, S. C., & Asendorpf, J. B. (2011). Knowing Your Own Mate Value. *Psychological Science*, *22*(8), 984–989. doi:10.1177/0956797611414725

Botwin, M.D., Buss, D.M., & Shackelford, T.K. (1993). Personality and mate preference: Five factors in mate selection and marital satisfaction. *Journal of Personality*, *65*(1), 107-136. doi: 10.1111/j.1467-6494.1997.tb00531.x

Buss, D. M. (1989). Sex differences in human mate preferences: Evolutionary hypotheses tested in 37 cultures. *Behavioral and Brain Sciences*, *12*, 1-49. doi:10.1017/S0140525X00023992

Castro, F.P., Hattori, W.T., & Lopes, F.A. (2012) Relationship maintenance or preference satisfaction? Male and female strategies in romantic partner choice. *Journal of Social, Evolutionary, and Cultural Psychology*, *6*(2), 217-226. doi: 10.1037/0099213

Feingold, A. (1990). Gender differences in effects of physical attractiveness on romantic attraction: A comparison across five research paradigms. *Journal of Personality and Social Psychology*, *59*(5), 981-993. doi: [10.1037/0022-3514.59.5.981](http://psycnet.apa.org/doi/10.1037/0022-3514.59.5.981)

Grice, J.W., Barrett, P.T., Schlimgen, L.A., & Abramson, C.I. (2012). Toward a brighter future for psychology as an observation oriented sciences. *Behavioral Sciences*, *2*(1), 1-22. doi: 10.3390/bs2010001.

Haufe, C. (2008). Sexual selection and mate choice in evolutionary psychology. *Biological Philosophy*, *23*, 115-128. doi: 10.1007/s10539-007-9071-0

Jamieson, S. (2004). Likert scales: how to (ab)use them. *Medical Education*, *38*(12), 1217–1218. doi:10.1111/j.1365-2929.2004.02012.x

Kenrick, D. T., Sadalla, E. K., Groth, G., & Trost, M. R. (1990). Evolution, traits, and the stages of human courtship: Qualifying the parental investment model. *Journal of Personality*, *58*, 97-116. doi:10.1111/j.1467-6494.1990.tb00909.x

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for *t*-tests and ANOVAs. *Frontiers in Psychology*, *4*, 863. doi: 10.3389/fpsyg.2013.00863

Landauer, T. K., Folt, P. W., & Laham, D. (1998). An introduction to latent semantic analysis. *Discourse Processes*, *25*(2), 259–284. doi: 10.1080/01638539809545028

Miller G.F. (2000). *The mating mind: how sexual choice shaped the evolution of human nature*. New York City, New York: Doubleday.

Morizot, J. (2014). Construct validity of adolescents’ self-reported big five personality traits: Importance of conceptual breadth and initial validation of a short measure. *Assessment*, *21*(5), 580-606. doi: 10.1177/1073191114524015

Schwarz, S., & Hassebrauck, M. (2012). Sex and age difference in mate-selection preferences. *Human Nature*, *23*, 447-466. doi: 10.1007/s12110-012-9152-x

Tabchnick, B.G., & Fidell, L.S. (2001). *Using Multivariate Statistics*. Boston, MA: Allyn and Bacon.

Wild, F. (2015). *lsa: Latent Semantic Analysis*. R package, version 0.73.1

Table 1

*Means, Standard Deviations, and Effect Size for Personality and Thematic Cosines across Sex.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Personality Measures | Female *M* | Female *SD* | Male *M* | Male *SD* | *ds* |
| Openness | 36.83 | 6.27 | 36.89 | 6.05 | 0.01 |
| Extraversion | 39.60 | 6.96 | 37.15 | 7.63 | 0.34 |
| Agreeableness | 37.65 | 7.09 | 34.91 | 6.03 | 0.42 |
| Conscientiousness | 37.65 | 7.09 | 34.64 | 6.03 | 0.46 |
| Emotional Stability | 26.61 | 7.51 | 32.00 | 7.94 | 0.70 |

Table 2

*Model statistics for MLM analyses*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Models | *df* | AIC | BIC | Log. Lik. | χ2 | *p* |
| Intercept-Only | 2 | -1755.52 | -1744.29 | 879.76 |  |  |
| Random-Intercept | 3 | -2168.23 | -2151.40 | 1087.12 | 414.72 | < .0001 |
| Openness | 4 | -2168.37 | -2145.912 | 1088.18 | 2.13 | .14 |
| Extraversion | 4 | -2176.166 | -2153.715 | 1092.0832 | 9.93 | .002 |
| Agreeableness | 4 | -2181.519 | -2159.067 | 1094.7593 | 15.28 | .0001 |
| Conscientiousness | 4 | -2185.26 | -2162.81 | 1096.63 | 19.03 | < .0001 |
| Emotional Stability | 4 | -2166.46 | -2144.01 | 1087.23 | 0.22 | .64 |

*Note.* The intercept-only model and random-intercept model is identical for each independent variable and hence is only listed once.

Table 3

*Individual predictors included in the third and final random-intercepts model.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Predictor | *b* | SE | *t* | *p* |
| Openness | 0.001 | 0.0001 | 1.46 | .14 |
| Extraversion | -0.002 | 0.0001 | -3.16 | .002 |
| Agreeableness | -0.003 | 0.001 | -3.92 | < .0001 |
| Conscientiousness | -0.002 | 0.001 | -4.37 | < .0001 |
| Emotional Stability | <0.001 | 0.001 | 0.47 | .64 |

*Note*. *df* = XXX.