Geographically varying associations between personality and life satisfaction in the London metropolitan area

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Residential location is thought to influence people's well-being, but different individuals may value residential areas differently. We examined how life satisfaction and personality traits are geographically distributed within the UK London metropolitan area, and how the strength of associations between personality traits and life satisfaction vary by residential location (i.e., personality–neighborhood interactions). Residential area was recorded at the level of postal districts (216 districts, n = 56,019 participants). Results indicated that the strength of associations between personality traits and life satisfaction depended on neighborhood characteristics. Higher openness to experience was more positively associated with life satisfaction in postal districts characterized by higher average openness to experience, population density, and ethnic diversity. Higher agreeableness and conscientiousness were more strongly associated with life satisfaction in postal districts with lower overall levels of life satisfaction. The associations of extraversion and emotional stability were not modified by neighborhood characteristics. These findings suggest that people's life satisfaction depends, in part, on the interaction between individual personality and particular features of the places they live.

geographical psychology | neighborhood | personality | life satisfaction | person–environment

Where is the best place to live? Numerous "livability" rankings of cities and neighborhoods have been published in academic journals and newspapers (1–4). Such rankings tend to imply that all people would value the same residential areas equally. Places are often ranked by residents' average happiness or life satisfaction—without considering how these places might match with specific dispositions of individuals. However, it seems likely that people's life satisfaction depends on the interactions between neighborhood characteristics and individual dispositions (5, 6). For example, a location with high cultural diversity might enhance the lives of residents who are eager to explore new customs and cuisines, but increase the anxiety and discomfort of residents who prefer to live by their own social traditions.

A growing number of studies have shown that personality traits are geographically clustered, and that these regional personality clusters are correlated with many sociocultural factors (6, 7). For example, the west coast of the United States is characterized by higher openness and emotional stability compared with the rest of the country, whereas the east coast has lower emotional stability and conscientiousness (7). One important question arising from these findings is whether the geographical clustering of personality represents adaptive patterns, so that people with certain personality traits are found in specific neighborhoods because these locations provide them higher levels of happiness for their personalities (6, 8–10). High extraversion, for instance, might be clustered in specific neighborhoods because these neighborhoods provide more opportunities of social interaction for individuals with high extraversion (11, 12). Thus, personality provides a psychological measure to test whether and how the people's dispositions and neighborhood characteristics jointly influence life satisfaction.

In the present study, we used data from more than 56,000 individuals living in the metropolitan area of London (United Kingdom) to examine the role of personality–neighborhood interactions in predicting life satisfaction. First, we examined how mean levels of life satisfaction and personality traits are spatially distributed across London. Although earlier studies have reported geographical differences in aggregated levels of personality and life satisfaction (6), these studies have not used the relevant spatial statistics to assess the geographical patterns. We used spatial analysis to quantify how strongly life satisfaction and different personality traits are geographically clustered. To further contextualize these geographical patterns, we assessed how the mean levels of life satisfaction and personality traits of neighborhoods were related to specific neighborhood characteristics, such as population density and crime rate.

Second, we investigated whether personality traits correlate with life satisfaction differently depending on residential location. This analysis addressed the issue of personality–neighborhood interactions in determining people's life satisfaction, because the focus was on geographically varying associations between personality traits and life satisfaction. The "person–environment fit" hypothesis postulates that a better match between person and environment leads to higher satisfaction, because the person's behavior is better in line with the prevailing

Significance

Recent studies in geographical psychology have demonstrated regional variations in personality—people with similar personality traits are more likely to be found in some regions than others. What is the psychological significance of such spatial clustering? Our study was motivated by the person–environment hypothesis, which postulates that the match between people's personality and neighborhood characteristics is important for people's life satisfaction. The results showed that personality traits were differently related to life satisfaction in different postal districts of London metropolitan area, and these varying associations were related to specific neighborhood characteristics, such as population density and ethnic heterogeneity. These findings demonstrate how individuals with different personality dispositions derive life satisfaction from different aspects of their social and physical environments.

social norms, and the person's needs are better fulfilled (13–15). To test how personality was differently related to life satisfaction in different neighborhoods, we fitted regression models that allowed personality traits to be differently associated with life satisfaction in different neighborhoods. To examine the specific neighborhood characteristics associated with higher or lower fit with personality traits, the neighborhood-specific regression slopes were then correlated with neighborhood characteristics and mean levels of personality. A positive correlation between the regression slope and mean personality level would indicate an adaptive spatial clustering of personality, so that people with high levels of the trait are living in neighborhoods where the trait is most strongly associated with higher life satisfaction.

Most previous studies have examined psychological differences between relatively large geographical units, such as states and counties (7). To get more detailed measures of people's residential locations and their surroundings, we determined neighborhoods at the finer resolution of postal districts. Life satisfaction was rated by the participants using the Satisfaction with Life Scale (16), and personality was self-reported by using the Big Five Inventory (17) that measures extraversion, neuroticism, agreeableness, conscientiousness, and openness to experience. Given the lack of previous research on the topic at the small-area spatial scale, we did not have predefined hypotheses of spatial patterns of life satisfaction or personality traits.

Results

Mean-Level Scores. First, we examined how strongly the aggregated life satisfaction and personality traits of postal districts were spatially clustered. This analysis was achieved by assessing spatial autocorrelations to determine whether neighboring districts were more similar to each other than were districts that were further apart—higher autocorrelations indicating more similarity between neighboring districts. The spatial autocorrelations reported

Fig. 1. Clustering of high (red) and low (blue) values of personality traits and life satisfaction. Values are Getis-Ord G* estimates with values above 1.96 and below −1.96 indicating statistically significant clustering. The outline of the Thames River running through London is shown in white.

in *SI Appendix*, Fig. S1 demonstrated that life satisfaction and personality traits exhibited spatial autocorrelation. Openness to experience was the most spatially autocorrelated trait ($r = 0.77$), followed by extraversion ($r = 0.45$) and life satisfaction ($r = 0.44$). These spatial effects extended beyond the first-order neighbors (i.e., neighbors of neighbors, and so on) but decreased linearly with increasing distance. Conscientiousness was the least spatially autocorrelated trait ($r = 0.22$), and its autocorrelation did not carry beyond the first-order neighbors; that is, knowing the level of conscientiousness of a postal district was moderately informative of conscientiousness levels of the nearest neighbors but not informative of conscientiousness of postal codes beyond that. Emotional stability ($r = 0.30$) and agreeableness ($r = 0.32$) had slightly higher spatial autocorrelations than conscientiousness.

To further illustrate the spatial clustering of life satisfaction and personality traits, we applied a "hotspot analysis" based on the Getis-Ord G* estimator to identify the locations of specific clusters of high and low scores of life satisfaction and personality (Fig. 1; *SI Appendix*, Fig. S2 for the distribution of raw scores). Openness to experience had the most prominent clustering pattern, with high openness being concentrated in central London (e.g., Islington and King's Cross) and lower levels observed in the outer regions of the metropolitan area. Low conscientiousness was clustered around the same area as high openness to experience. Clusters of high extraversion and emotional stability were located in southwest of central London (e.g., Wandsworth borough). High levels of life satisfaction were clustered around the same area (e.g., Richmond borough). Pockets of low life satisfaction were observed in northwest, northeast, and south London. Low agreeableness was most strongly clustered around the Westminster borough and central London, where many of the busiest streets and popular tourist attractions are located.

We then examined whether the spatial patterns of life satisfaction and personality traits were associated with neighborhood characteristics by correlating the aggregated personality scores of the postal districts with neighborhood variables measuring sociodemographic factors, housing, and land use within the postal districts (Table 1; see *SI Appendix*, Table S1 for extended correlation table). Openness to experience was associated with lower neighborhood income and employment rate, lower voting activity, higher crime rates, and higher proportion of people receiving income and disability support, whereas the reverse correlations with these neighborhood characteristics were observed for life satisfaction. Higher levels of agreeableness were observed in neighborhoods with lower population density and lower housing prices, greater proportion of older people and families with children, and more land area used for domestic gardens and green spaces.

To estimate how strongly personality differences between postal districts were linked to neighborhood characteristics included in the present analysis, we fitted backward stepwise regression models that predicted the postal-district level personality traits with all of the available neighborhood variables, successively removing variables with $P > 0.15$ in the regression model. The most predictive combinations of neighborhood variables accounted for 78% of variance in openness to experience, 67% in life satisfaction, 46% in extraversion, 33% in agreeableness, 26% in conscientiousness, and 24% in emotional stability.

Associations Between Personality and Life Satisfaction. To examine whether personality traits were differently associated with life satisfaction in different postal districts, we fitted regression models predicting people's life satisfaction by their personality traits in different postal districts (adjusted for age and sex), which allowed people's personality traits to have different associations with their life satisfaction in different postal districts. This produced a distribution of regression coefficients for each trait. The 95% range across the 216 postal districts was 0.24–0.35

Table 1. Selected sociodemographic correlates of mean-level scores of personality and life satisfaction of postal districts

	E	S	A	C	O	LS
Population structure						
% Older people (65+)	−30	—	29	31	−58	25
% Couple households with children	−48	−20	40	—	−68	−26
% Lone-parent households	—	−17	—	−34	20	−60
Fertility rate	−31	—	26	—	−22	−51
Mortality rate	—	−24	—	−22	—	−33
Population density	42	—	−33	−26	61	—
% Christian religion	−15	—	—	34	−43	37
% White ethnic background	—	—	—	36	−31	60
Physical environment and housing						
Mean house price	42	27	−31	—	42	44
% Domestic buildings	36	—	−20	−14	45	—
% Domestic gardens	−24	−16	28	16	−47	—
% Nondomestic buildings	24	—	−34	—	51	—
% Greenspaces	−23	—	24	—	−39	14
Social indicators						
Turnout borough election	−15	—	30	18	−37	34
Total crime rate	—	—	—	−29	34	—
Income rank	—	15	—	39	−34	59
Employment rate rank	—	—	16	39	−44	48

Correlations are reported as $r \times 100$. All correlations with absolute value ≥ 14 are statistically significant ($n = 216$ postal districts) and only these correlations are shown. The full correlation table is shown in *SI Appendix*, Table S1. A, agreeableness; C, conscientiousness; E, extraversion; LS, life satisfaction; O, openness to experience; S, emotional stability (low neuroticism).

for emotional stability (mean = 0.30, SD = 0.04), 0.08–0.23 for extraversion (mean = 0.17, SD = 0.04), 0.07–0.21 for conscientiousness (mean = 0.14, SD = 0.04), −0.02–0.13 for agreeableness (mean = 0.06, SD = 0.05), and −0.13–0.04 for openness to experience (mean = −0.05, SD = 0.05). These distributions indicated that the strengths of associations between personality traits and life satisfaction varied across different postal districts. The coefficient distributions are further illustrated in *SI Appendix*, Fig. S3 and the maps of the spatially varying regression coefficients are shown in *SI Appendix*, Figs. S4 and S5.

We then examined whether specific neighborhood characteristics were associated with amplified or attenuated associations between people's personality traits and life satisfaction. We correlated the regression coefficients of the personality traits derived from the regression models described above with neighborhood characteristics and average personality scores of the postal districts. As shown in Table 2, the association between openness to experience and life satisfaction was more positive among individuals living in neighborhoods with higher population density, higher house prices, higher proportion of religious and ethnic minorities, lower personal income, and higher unemployment rate. The association was also more positive in postal districts with comparatively high mean openness to experience. Higher agreeableness and higher conscientiousness were more strongly associated with life satisfaction in postal districts with lower average levels of life satisfaction. For conscientiousness, this effect was observed particularly in relation to socioeconomic factors; high conscientiousness was associated with higher life satisfaction especially in postal districts with lower income and employment rates, higher proportions of individuals receiving income or disability support, and where average levels of conscientiousness and extraversion were low. The association between higher agreeableness and life satisfaction was most prominent in postal districts with more families with children and lower housing prices, and where mean levels of openness to experience and extraversion were low (Table 2; see *SI Appendix*, Table S2 for an extended correlation table with

Table 2. Selected sociodemographic and personality correlates of regression slopes of personality scores predicting life satisfaction in different postcode districts

	E	S	A	C	O
Population structure					
% Older people (65+)	—	—	—	–23	–27
% Couple households with children	—	—	24	—	–35
Fertility rate	—	—	24	—	—
Population density	—	—	—	—	33
% White ethnic background	—	—	–17	–14	–22
Physical environment and housing					
Mean house price	—	—	–22	–17	19
% Domestic gardens	—	—	14	—	–21
% Nondomestic buildings	—	—	—	—	27
% Greenspaces	—	—	—	—	–22
Social indicators					
Turnout borough election	—	—	—	–22	–17
Income rank	—	—	—	–22	–17
Psychological variables					
Extraversion	—	—	–16	–18	20
Emotional stability	—	—	—	—	—
Agreeableness	—	—	—	—	–13
Conscientiousness	—	—	—	–19	–16
Openness to experience	—	—	–18	—	47
Life satisfaction	—	—	–27	–30	—

Correlations are reported as $r \times 100$. All correlations with absolute value ≥ 14 are statistically significant (n = 216 postcode districts) and only these are shown. The full correlation table is shown in *SI Appendix*, Table S2. A, agreeableness; C, conscientiousness; E, extraversion; O, openness to experience; S, emotional stability (low neuroticism).

different neighborhood characteristics). In contrast, the associations of emotional stability and extraversion with life satisfaction were not modified by any of the included neighborhood characteristics.

Discussion

The current results provide several insights into the role of personality and place in affecting people's life satisfaction. First, higher levels of life satisfaction were observed in the most affluent regions of southwest London. Pockets of low life satisfaction were observed in northwest, northeast, and south London, where the proportion of ethnic minorities is the highest. Neighborhood characteristics accounted for two-thirds of the variance in life satisfaction between postal districts, indicating a substantial link between sociodemographic factors and average life satisfaction of neighborhoods.

Of the five personality traits, openness to experience showed the highest degree of spatial clustering. There was a marked spatial pattern of high openness to experience observed in the urban center from where the average level of openness gradually decreased when moving to the outer regions of the metropolitan area. Openness to experience was related to a mixture of neighborhood characteristics, including higher population density and higher housing prices, higher ethnic and religious diversity, and higher crime rate. Together these findings are in agreement with studies showing that openness is associated with broad interests and tolerance for alternative lifestyles and ideas (18). These dispositions are often thought to characterize residents of densely populated urban areas (19), which was demonstrated empirically by the present data. Another personality disposition characterizing the city center was a cluster of low agreeableness in the western central London area, which is one of the most densely populated areas in London with busy pedestrian traffic (20), and with high crime rates and housing prices. This could be interpreted to support the popular notion of

"urban alienation," which suggests that residents of densely populated urban areas tend to be less considerate toward other people (21).

The second part of our analysis examined how associations between personality traits and life satisfaction varied across postal districts. In agreement with many earlier studies, life satisfaction was most strongly determined by emotional stability and extraversion (22). Our findings indicated that the associations of emotional stability and extraversion with life satisfaction were not at all modified by specific neighborhood characteristics measured in our study. This lack of interaction effects supports the temperamental hypothesis of personality and life satisfaction, which postulates that emotional stability and extraversion are associated with life satisfaction directly and largely independently of people's environmental circumstances (22–24).

By contrast, the overall inverse association between openness to experience and life satisfaction was weak (22), but this association was most strongly dependent on neighborhood characteristics. Living in a densely populated, ethnically heterogeneous neighborhood with low proportion of older people and families with children provided the best match for individuals with high openness to experience. In addition, individuals with high openness were more likely to be found in neighborhoods where openness was more positively associated with life satisfaction. This correlation between mean levels and regression slopes suggests that people with high openness may be more likely to move to neighborhoods with high openness because these areas provide them more happiness. Other personality traits did not show such an adaptive pattern. Thus, except for openness to experience, the spatial distributions of personality traits did not represent adaptive patterns in which high levels of personality trait would have been found in areas that provided people the highest levels of happiness for their personalities.

Higher agreeableness and conscientiousness were stronger predictors of life satisfaction in neighborhoods with lower average levels of life satisfaction, suggesting that these personality traits are more important determinants of life satisfaction for individuals living in less favorable environmental circumstances. It has been suggested that agreeableness and conscientiousness are associated with life satisfaction mainly via instrumental mechanisms (22). That is, individuals with higher agreeableness and conscientiousness tend to manage their life decisions better (e.g., fewer conflicts with other people, more careful planning ahead) than those with low agreeableness and conscientiousness, and, therefore, the associations of agreeableness and conscientiousness with life satisfaction become expressed differently depending on external circumstances (22, 25–27). In more affluent neighborhoods, life satisfaction may be less determined by individual differences in agreeableness and conscientiousness, because these neighborhoods provide a higher overall level of instrumental support and resources for life satisfaction (28, 29). In less affluent neighborhoods, individuals are more likely to encounter stressors and difficult life situations (28, 29), which may increase the role of individual differences in agreeableness and conscientiousness.

On a more general level, the findings suggest two separate geographical constellations of personality in the London metropolitan area. High openness to experience and extraversion were characteristic of urban neighborhoods, whereas high agreeableness and conscientiousness were observed in more suburban neighborhoods, as indicated by neighborhood correlates. Openness to experience was more positively related to life satisfaction in neighborhoods with higher extraversion, lower agreeableness, and lower conscientiousness. By contrast, agreeableness and conscientiousness were more strongly associated with life satisfaction in postal districts with lower mean extraversion and, for agreeableness, lower mean levels of openness to experience. These correlations between mean levels and regression slopes of the two personality

constellations (i.e., high openness to experience and extraversion versus high agreeableness and conscientiousness) suggest a possible adaptive pattern in which higher agreeableness and conscientiousness are less likely to be found in urban neighborhoods with high extraversion and openness to experience, because these neighborhoods provide less life satisfaction for individuals with high agreeableness and conscientiousness.

The main strengths of the present study include a large sample size, a fine-grain geographical resolution in determining participants' residential location at the level of postal districts, the use of spatial statistics to assess the degree of clustering, and the assessment of not only mean levels of neighborhood personality but also the spatially varying associations between personality and life satisfaction. However, the analysis was limited by cross-sectional data. Neighborhood personality differences may emerge via people's selective mobility, but also via socialization processes (6), and the present data could not separate these effects. Another limitation is that the sample was self-selected and, therefore, not completely representative of the general population, which may have biased some of the results. Also, we did not examine the interactions between psychological and sociodemographic factors in determining residential choices. It is clear that personality alone cannot determine where people live, because factors such as socioeconomic status, age, ethnicity, and family status are important determinants of residential mobility. Longitudinal data are needed to determine the dynamics of selection and socialization effects, and the sociodemographic constraints on those effects (10, 30, 31). It is also important to investigate whether the patterns of findings observed in the present analysis generalize to other cities and countries.

In conclusion, the present study extend the burgeoning field of geographical psychology (32) by demonstrating how life satisfaction and personality traits can be differentially distributed and spatially clustered within a metropolitan area. The analysis of personality–neighborhood interactions showed that openness to experience, agreeableness, and conscientiousness were differently associated with individuals' life satisfaction depending on their residential location and the specific characteristics of those locations. Thus, finding the best place to live depends on the match between individual dispositions and neighborhood characteristics.

Methods

Participants. Participants were from the Big Personality Test online survey advertised and hosted by the British Broadcasting Corporation on its Lab U.K. website (https://ssl.bbc.co.uk/labuk/experiments/personality). The survey collected information on psychological characteristics, childhood experiences, and sociodemographic factors. Completion of the survey took ~30 min. Data were collected between 2009 and 2011 with a total sample of 588,014 participants covering Great Britain. The present sample included 56,019 individuals who lived in the Greater London metropolitan area. Mean age was 33.2 (SD = 12.2), and 36.7% were men. *SI Appendix*, Table S3 provides additional sociodemographic details about the sample.

Measures. Life satisfaction was measured with the Satisfaction With Life Scale (16) consisting of five items rated on a seven-point scale (1 = strongly disagree; 7 = strongly agree). Cronbach's internal consistency estimate was 0.91 in the present sample, and other psychometric properties of the scale have been shown to be good as well (33). Personality was assessed with the 44-item Big Five Inventory (17), each item rated on a five-point scale (1 = strongly disagree; 5 = strongly agree). The internal consistency estimates

were 0.85 for extraversion, 0.76 for agreeableness, 0.83 for conscientiousness, 0.83 for neuroticism, and 0.80 for openness to experience. *SI Appendix*, Table S4 shows the correlations between personality traits and life satisfaction at the level of individuals and aggregated level of postal districts.

Residential location was self-reported by the participants and was coded at the resolution of postcode districts (e.g., BR5, WC1, SE13). There were 216 postal districts included in the present analysis. The boundaries and numbers of participants by postal districts are shown in *SI Appendix*, Fig. S6. Data on neighborhood characteristics were derived from the London Ward Atlas (http://data.london.gov.uk/datastore/package/ward-profiles-and-atlas) in which sociodemographic information from the Census and other information on land use and housing have been recorded at the level of administrative wards. London area included in the present analysis covered 647 wards, so in most cases a single postcode district was covered by more than one ward. We transferred the ward-level data to postal districts by overlaying the centroids of the wards on the postal district areas. The neighborhood characteristics for a postal district were then determined as the averaged values on each variable over the wards whose centroids fell within the postal district borders.

Statistical Analysis. To reduce the role of sampling error in calculating average scores of personality and life satisfaction of postal districts, a random-intercept multilevel linear regression model was fitted for each of the traits, adjusted for age and sex. The empirical Bayes predictions from these models were used in subsequent analyses. Using random-intercept model predictions rather than raw mean scores had the effect of shrinking extreme values toward the overall mean in postal districts with fewer participants and greater individual-level variance, thus producing more robust estimates. The empirical Bayes estimates correlated very strongly with the raw-mean scores of the postal districts (r = 0.93 for extraversion, 0.86 for emotional stability, 0.80 for agreeableness, 0.79 for conscientiousness, and 0.99 for openness to experience).

Random-effect linear regression was also used to determine the spatially varying associations between personality traits and life satisfaction. However, a single multilevel model that did not take into account spatial patterning of postal districts attenuated the regression coefficients considerably compared with raw regression coefficients, reducing the SD across postal districts by an average of 80% (*SI Appendix*, Table S5). In order not to shrink the coefficients too much toward the overall mean (thereby ignoring the spatial patterning of the postal districts), a separate random-slope multilevel regression was fitted for each postal district by including data from the postal district of interest and its nearest neighbors (i.e., postal districts with a shared boundary based on queen's adjacency rule), adjusted for age, sex, and all of the personality traits. In each regression model, the participants were nested within postal districts, and the regression coefficients between personality traits and life satisfaction were determined as the empirical Bayes predictions for each of the postal district of interest in turn from these 216 models. This analysis allowed each postal district to "borrow strength" from its neighboring postal districts when estimating the regression coefficients for the personality traits.

The spatial clustering of personality and life satisfaction was assessed with Moran's I spatial autocorrelation coefficient and with Getis-Ord G* local clustering method (34). Moran's I tests the overall level of spatial autocorrelation across the study area, that is, whether postal districts close together are more similar to each other than postal districts further apart. Higher positive values indicate greater clustering of similar postal districts. The G* estimate is used to locate specific clusters of high and low values in areas that have high (or low) value and that also have neighbors with high (or low) values in the outcome of interest. This method allows one to identify the concentration of "hot-spots" in the study region. The G* estimates can be interpreted as z scores, with values above 1.96 and below −1.96 indicating statistically significant clustering. The spatial analysis was performed by using the *spdep* package of R 2.15.2 statistical software (35).

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