Big Data-Based Cultural Psychology Analysis

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Abstract

This paper aims to review recent research employing big data methods to analyze cultural values, social change, and eco-geographical effects. In the domain of social change, corpora such as Google Books, social media platforms, and literary collections have been utilized to reveal cultural shifts accompanying urbanization and short-term economic slowdowns. Regarding eco-geographical dimensions, researchers have drawn upon Twitter and Sina Weibo text corpora to investigate cultural diversity in countries and regions along the 'Belt and Road' , cultural value misalignment and subjective well-being between rural and urban China, as well as air pollution and cultural adaptation across various Chinese cities. Additionally, this paper discusses the integration of traditional research methodologies with big data analytics, along with the challenges and future prospects for large-scale cultural data analysis.

Full Text

Preamble

Cultural Psychological Analysis Based on Big Data

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Abstract

This paper reviews recent research employing big data methods to analyze cultural values and their relationship to social change and ecological geography.

Regarding social change, corpora from Google digitized books, social media, and literary works have been used to demonstrate cultural shifts accompanying urbanization and short-term economic slowdowns. In the ecological geography domain, researchers have analyzed Twitter and Sina Weibo text corpora to examine cultural diversity along the "Belt and Road"countries and regions, cultural value mismatch and subjective well-being between rural and urban China, and air pollution and cultural adaptation across different Chinese cities. Additionally, this paper discusses the integration of traditional research methods with big data analytics, as well as the challenges and future prospects of cultural big data analysis.

Keywords: big data, culture, values, social change, ecological geography

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With the development of mobile internet technology, big data derived from online networks and communication records is profoundly influencing our lives, work, and thinking. Although the history of big data technology is relatively short, the extensive literature from the past decade demonstrates that it has become a significant issue in philosophy, natural sciences, and social sciences, providing social science research with a fourth paradigm following experiments, theory, and simulation, and even giving rise to the independent discipline of computational social science [1-2].

Early big data psychological research primarily focused on relatively intuitive psychological concepts such as basic emotions and consumer decision-making, with fewer studies addressing abstract psychological concepts like culture and personality [3]. However, with advances in computational linguistics and machine learning technologies, cultural psychological analysis based on big data has become feasible. This paper reviews researchers' use of big data methods to analyze cultural values and their effects on social change and ecological geography from temporal and spatial dimensions. Furthermore, we summarize major corpora, feature dictionaries, and machine learning models, and discuss the challenges and prospects of cultural big data analysis.

1. Characteristics and Advantages of Big Data

In general terms, big data refers to data collections that cannot be perceived, acquired, managed, processed, or served within a tolerable time frame using traditional IT technologies and software/hardware tools [4]. Big data is characterized by its vastness, convenience, precision, and cost-effectiveness, enabling it to rapidly emerge across various research fields and gradually become a new tool for social science [5]. Compared with traditional data research methods, big data offers unparalleled advantages. First, in terms of data volume, big data encompasses much larger and more comprehensive datasets than traditional data analysis, enabling simultaneous analysis of massive amounts of data. Second,

regarding structure, big data exists in three forms: structured, semi-structured, and unstructured, whereas traditional data is typically structured, easy to annotate, and simple to store. In contrast, the vast majority of data currently generated by users on platforms like Facebook, Twitter, and YouTube is unstructured [6]. Third, concerning data sources, traditional data analysis collects data with low coverage and high concentration, whereas big data collection features broad coverage and high dispersion. Fourth, in data processing speed, traditional data analysis suffers from low timeliness and slow speed, while big data processing is instantaneous and fast, matching the velocity of data generation.

Currently, there are two primary methods for analyzing cultural psychology using big data. The first is dictionary-based frequency analysis, which examines keywords related to numbers, expressions, and language to study individual or group emotions and values. This approach is relatively simple and coarse-grained [3]. The second is model-based predictive analysis, which employs machine learning models to identify users' personality, values, and ideology. This method is more precise and provides a more comprehensive grasp of psychological characteristics [5]. Using these two analytical pathways, cultural psychology can be examined across temporal and spatial dimensions. Temporally, trend analysis can be conducted in the context of social change, such as historical cultural shifts under urbanization and globalization, value changes brought by economic fluctuations, and personality changes across different generations. Spatially, ecological geography analysis can be performed, examining regional cultural differences within specific political and economic frameworks, urban-rural disparities caused by different household registration systems, and cultural adaptation under various ecological environments.

This paper aims to review research using big data to analyze cultural values and their effects on social change and ecological geography. Additionally, we discuss the ethical and methodological limitations of big data and the necessity of cross-validation between traditional and big data methods in future research.

2. Temporal Analysis

From a temporal perspective, researchers have utilized Google digitized books, social media, and literary corpora to analyze cultural shifts in the context of urbanization and the "new economic normal." Methodologically, these studies primarily employ frequency analysis based on keyword dictionaries or characteristic behaviors, as well as predictive models based on machine learning.

2.1 Historical Development and Cultural Change

Culture takes many forms, but nearly all cultural concepts are constructed around relationships between individuals and groups. Cultures emphasizing individual values and goals are typically termed individualistic, while those emphasizing group values and goals are termed collectivistic—the individualism/collectivism dimension is also the most widely discussed concept in cultural

psychology [7]. Numerous studies indicate that the growth of material wealth and the social-ecological shift from rural to urban areas represent one of the most important trends in contemporary society, accompanied by tremendous changes in cultural values—a global trend of rising individualism and weakening or challenged collectivism [8].

Human culture is often reflected in language [9], and Google digitized books provides a massive, century-spanning corpus whose linguistic features can be used to identify cultural values and their historical trends [10-11]. Trend analysis based on individualistic keywords (e.g., self, unique) and collectivistic keywords (e.g., collective, obedience) reveals that with social modernization and urbanization, the usage of individualistic vocabulary in both English and Chinese has become increasingly frequent, while collectivistic vocabulary usage has decreased or remained relatively stable [11-13]. Analysis using first-person singular pronouns as an indicator of individualism shows that American English, Chinese, French, German, Spanish, Hebrew, Italian, and Russian have all exhibited rising individualism since World War II [13-14].

To further investigate cultural and behavioral changes from a social change perspective, researchers analyzed emotional expression in China and the United States between 1960 and 2008 [15]. Love and affection have long been considered fundamental human needs, with humans naturally possessing the capacity for emotional communication through verbal behaviors (e.g., saying "I love you," "I like you") and nonverbal behaviors (e.g., hugging, kissing) to convey affection and establish intimate relationships [16]. Simultaneously, human behavior is a product of culture, and the individualistic values brought by urbanization and globalization have inevitably influenced how people express intimacy and love, with individualistic cultures emphasizing more direct verbal or nonverbal emotional expression [8]. Using Google digitized books corpora in American English and simplified Chinese, this research examined changes in emotional behavior keywords between 1960 and 2008 and their relationship with rising individualism.

The results indicate that although emotional keywords appeared less frequently in Chinese books than in English books, both showed a significant upward trend in recent decades. Furthermore, individualism was positively correlated with the frequency of emotional vocabulary in both Chinese and American books. These findings provide further evidence that cultural change influences emotional communication patterns, with emotional communication becoming more prevalent as it adapts to individualistic urban environments [15].

2.2 Cultural Change in Economic Fluctuations

Culture is a product of human adaptation to the environment, and environmental changes manifest not only in long-term historical shifts but also in short-term economic fluctuations, which can trigger short-term cultural adjustments. Recent research shows that in American society, where individualism is the

mainstream value and continues to strengthen, adolescents during the Great Recession exhibited increased collectivism (e.g., concern for others and environmentalism) and showed signs of decreased or plateauing individualism (e.g., materialism) [17]. Additionally, when the economy prospers or unemployment decreases, Americans are more likely to give newborns uncommon names, endorse children' s autonomy, and prefer self-centered music. Conversely, when the economy declines or unemployment increases, Americans are more inclined to encourage children to help others and be liked by others, and prefer music expressing other-oriented values [18].

Although China has experienced a growth miracle since its reform and opening up, economic growth slowed after 2010, with GDP growth rate dropping from 10.6% to 7.7% in 2012—a decline of nearly three percentage points [19]. To further explore whether culture can undergo short-term adaptive changes in response to ecological changes, and to what extent, researchers analyzed collectivistic behaviors from 2010 to 2016 [20].

Through the application of big data in cultural trend analysis, this study examined behavioral footprints of active Sina Weibo users. From a cultural perspective, mentioning or talking with others (e.g., the "@UserName" behavior on Weibo) reflects an interdependent self and can serve as an indicator of collectivistic behavior [17]. The results revealed significant changes in users' collectivism (mentioning or conversing with others) over the seven-year period, with collectivism peaking during the 2011-2012 economic downturn and returning to normal levels when the economy stabilized from 2013-2016. This demonstrates that cultural behaviors on Chinese social media also rise and fall with economic fluctuations [20]. These studies reveal short-term cultural evolution, showing that culture is not static in adapting to ecological environments but is flexible and dynamic.

2.3 Cultural Change in Literary Works

Individual personality or character results from the interaction of genes and environment, and is thus deeply embedded in the cultural traditions in which it is inherited [21] and vividly presented in the daily language and literary works of that culture [22-23]. Although personality at the individual level represents a person' s stable attitudes toward reality and habitual behavior patterns, at the societal level, different eras often encourage different personalities, leading to variations in ideal character types. For example, with modernization and urbanization, openness and extraversion have become more important, as individuals in the new era need to explore the external world more and maintain more relaxed and free interpersonal relationships [24-25].

In recent years, with the maturation of computational natural language processing and machine learning technologies, analyzing novel characters' personalities and their underlying cultural characteristics through artificial intelligence methods has become possible. This study employs the "Wenxin" (Text Mind) Chinese

psychological analysis system and the Big Five personality prediction model developed by the Computational Cyber-Psychology Laboratory at the Institute of Psychology, Chinese Academy of Sciences [26] to conduct literary intelligence analysis of characters' personalities. First, selected novel texts are processed to extract all dialogues of each character. Then, word segmentation is performed, and all segmented words are statistically analyzed according to the "Wenxin" system to obtain word category distribution results. Finally, Big Five personality prediction scores for each character are obtained based on the prediction model.

Using this method, researchers analyzed characters in *Ordinary World*, a novel reflecting the growth and struggles of ordinary Chinese people during the early reform and opening-up period. The results showed that the younger generation of intellectual youths, Sun Shaoping and Tian Xiaoxia, scored higher on openness than the eldest sons in their families, Sun Shao' an and Tian Runye, reflecting the former' s character traits of embracing new ideas and loving adventure after experiencing reform [27]. Additionally, we conducted literary intelligence analysis of 35 heroines in Jin Yong' s novels, finding that modern heroines (e.g., the intelligent and unrestrained Zhao Min) scored higher on extraversion than traditional heroines (e.g., Shuang' er, who supports her husband and educates her children), reflecting the new image of Chinese women after World War II as independent, confident, and daring to love and hate [28]. These studies demonstrate the application of literary intelligence analysis in revealing cultural changes through fictional characters.

3. Spatial Analysis

From a spatial perspective, researchers have used social media data from Twitter and Sina Weibo to examine cultural diversity along the "Belt and Road," cultural value mismatch and subjective well-being between rural and urban China, and air pollution and cultural adaptation in eastern versus western Chinese cities.

3.1 Cultural Differences Along the "Belt and Road"

Culture is an important factor affecting regional cooperation and economic exchanges. For instance, individualists are more willing to establish economic and trade cooperation relationships with others, whereas collectivists show relatively lower willingness for economic cooperation and prefer acquaintances when choosing transaction partners [29]. Therefore, analyzing the characteristics of public sentiment along "Belt and Road" countries and regions and identifying effective cooperation models is a major issue related to national strategic implementation. However, due to vast territories, numerous ethnic groups, and extremely complex geopolitical, economic, and cultural factors (e.g., former Soviet influence, European and American colonialism, religious traditions), traditional sampling surveys cannot achieve full-sample analysis, nor can they accurately capture subjective reports from respondents. Social media big data can provide a massive, timely, and precise database of user behavioral traces and enable predictive

modeling for specific domains and issues.

Consequently, Wu Shengtao and colleagues combined cultural psychology with big data analytics, using social media Twitter data to analyze self-representation characteristics (independence or individualism) of "Belt and Road" countries and regions to explore behavioral patterns in regional cooperation and exchange —specifically, whether self-representation is independent or interdependent, and whether interpersonal relationship preferences favor universal trust among strangers or particularistic trust among acquaintances [30].

Researchers used the proportion of singular first-person pronoun usage (self-independence) on Twitter as an individualism indicator, normalized it, and obtained the distribution of individualistic culture across 69 "Belt and Road" countries and regions. To assess social trust in these regions, they extracted social trust data (universal trust, particularistic trust) for 28 "Belt and Road" countries from the World Values Survey (WVS) database and established a training model for individualism and social trust. Finally, using individualism as the independent variable and socio-economic variables as control variables (e.g., per capita GDP, Gini coefficient, and urban population ratio), they established a linear regression prediction model for social trust to predict social trust scores for "Belt and Road" countries and regions [30].

The results indicate substantial variation in individualism cultural indicators among "Belt and Road" countries and regions, primarily influenced by European and American colonial history and local religious traditions, with colonial history being the strongest factor influencing individualism. Furthermore, countries or regions with higher individualism rely more on universal trust among strangers and less on particularistic trust among acquaintances. Based on these results, the 69 "Belt and Road" countries and regions can be divided into three categories: first, the European-American model, comprising non-Islamic post-colonial countries or regions with high individualism; second, the Islamic model, comprising Islamic post-colonial countries or regions with high collectivism; and third, the Soviet model, including former Soviet countries or those never colonized by Europe or America, whose behavioral characteristics fall between individualism and collectivism [30].

Additionally, researchers mapped a psychological atlas of Chinese individualism/collectivism using word frequency analysis based on 1 million active Weibo users [31]. Specifically, they employed the validated Chinese text analysis software "Wenxin" system, using vocabulary related to individualism/collectivism mentioned in previous cross-cultural research. After discussion, they identified 53 individualistic words and 64 collectivistic words. They then calculated word frequencies of individualism/collectivism for different provinces, municipalities, and autonomous regions based on users' registered locations and compared regional differences at the provincial level. The results revealed that southern Chinese exhibit higher individualism than northern Chinese, and overseas users show higher individualism and lower collectivism than domestic users, demonstrating that intra-national regional differences in individualism/collectivism

also exist.

3.2 Urbanization and Cultural Value Mismatch

From an evolutionary perspective, collectivism has adaptive value in "resisting psychopathology." Numerous studies demonstrate that collectivism plays an important role in social bonding and human well-being, with higher collectivism associated with higher subjective well-being (e.g., more positive emotions, fewer negative emotions), particularly under conditions of resource scarcity and environmental threat [32]. However, with modern social change and rapid urbanization, individualism continues to grow while collectivism is challenged, inevitably leading to person-environment cultural value mismatch—individuals accustomed to or adhering to collectivistic cultural values suddenly find their external ecological environment changed, making them prone to experiencing psychological stress or unhappiness.

Using urbanization level as a moderating variable, researchers examined the relationship between collectivism and subjective well-being, hypothesizing that the correlation between collectivism and well-being would be stronger in low-urbanization areas and weaker in high-urbanization areas. Given that previous small-sample surveys struggled to address macro-level issues like urbanization, this study combined Weibo big data analysis based on word frequency with large-sample national survey data for analysis at both group and individual levels [33].

Study 1 used the Weibo Basic Emotion Lexicon (Weibo-5BML) [34] to conduct sentiment analysis of Weibo content from 1.6 million active users across 31 provinces/municipalities/autonomous regions in mainland China in 2014. The results showed that at the provincial level, collectivism scores significantly negatively predicted negative emotions (e.g., sadness, anger, fear, disgust) among Weibo users. Urbanization level moderated the relationship between collectivism and negative emotions: in low-urbanization areas (e.g., Guizhou, Gansu), collectivism was significantly negatively correlated with negative emotions among Weibo users, whereas this relationship was not significant in high-urbanization areas (e.g., Beijing, Shanghai). For positive emotions (e.g., happiness), the effect of collectivism was not significant, nor was the moderating effect of urbanization level.

Study 2 used data from the 2010 China Family Panel Survey, which included nearly 30,000 individual interviews nationwide [35], and employed multilevel regression modeling. The results revealed that individual-level collectivism significantly positively predicted positive emotions and negatively predicted negative emotions. Urbanization level moderated the relationship between collectivism and subjective well-being: in low-urbanization areas, higher collectivism was associated with more positive emotions and fewer negative emotions, whereas in high-urbanization areas, the effects of collectivism on both positive and negative emotions were not significant.

With dramatic social changes, rural China and its nurtured collectivistic cultural values are undergoing differentiation. Through social media-based group analysis and nationwide sample-based individual analysis, this research reveals the public opinion reality of person-environment mismatch and the socio-psychological mechanisms of subjective well-being during China' s rapid urbanization. On one hand, Chinese people, generally collectivistic, may not have immediately adapted to commerce- and stranger-dominated ecological environments in rapidly developing cities, resulting in value mismatch and lower perceived well-being. On the other hand, some individuals still living and working in rural environments (or living marginally in cities as migrants) are actively or passively exposed to individualistic value temptations, and this value mismatch also leads to lower well-being. Notably, this study used traditional large-sample survey data to replicate and validate the findings from Weibo big data.

3.3 Air Pollution and Cultural Adaptation

Numerous studies show that culture is influenced by ecological environments. For example, under relatively harsh ecological conditions, people exhibit more interdependent cultures and personality traits more inclined toward self-preservation, with lower extraversion, openness, and conscientiousness related to self-growth [36]. Among various causal theories, Climato-Economic Theory considers both natural and social environmental influences on individualism-collectivism, examining the causes of individualism-collectivism from the interactive perspective of economic development and climate environment, and has been validated cross-culturally [37]. Air pollution is a new environmental threat emerging in industrial society, fundamentally affecting human living conditions and a wide range of psychological and behavioral outcomes. Therefore, the research hypothesized that air pollution would positively predict collectivistic tendencies and negatively predict individualistic tendencies in regional residents.

Researchers selected air quality data for Beijing, Shanghai, and Chengdu for 2015 and 2016, using PM2.5 as the primary pollutant. These three cities were chosen because they represent northern, southern, and western regions respectively, with differences in economic development levels and overall air quality, and because they experienced many polluted days during 2015-2016. Raw data were sampled hourly using the Air Quality Index (AQI), where higher values indicate more severe pollution. For Weibo data, referencing previous studies [13,38] and considering characteristics of Weibo content, researchers identified 27 individualistic keywords and 36 collectivistic keywords. They then used regular expressions to search and match keywords in each Weibo post, summing frequencies to obtain individualism and collectivism scores. Additionally, they excluded Weibo posts that forwarded external website links or potentially involved advertisements based on keywords like "http://t.cn" and "http://m.weibo.cn," and removed duplicate Weibo posts based on text content.

Finally, correlation analysis was conducted between daily-level air pollution severity and individualism/collectivism in Weibo posts, and multilevel regression modeling was established for daily-level individualism/collectivism and air pollution [39]. The results showed that overall, air pollution was significantly negatively correlated with individualism and significantly positively correlated with collectivism—when air pollution was severe, people recognized that all individuals within their group faced common physiological and psychological threats from air pollution. The results also showed regional differences: for Chengdu residents, air pollution significantly predicted both individualism and collectivism, but this effect was not significant for Beijing and Shanghai residents, indicating that economic development level moderates the effect of air pollution on individualism and collectivism expression. This model partially supports Climato-Economic Theory, which posits that harsh climate environments in low-income regions lead to higher collectivistic tendencies.

4. Limitations and Prospects

Although big data analytics has emerged in social science research and offers incomparable advantages over traditional methods, using big data for cultural analysis still has certain limitations.

First, regarding data collection, online big data has many characteristics different from traditional scientific data, including multi-source heterogeneity, interactivity, timeliness, social nature, burstiness, and high noise. Not only is there abundant unstructured data, but data is also highly real-time, with large amounts generated randomly and dynamically [3]. Consequently, much information collected through big data is repetitive or meaningless, causing unnecessary resource waste.

Second, regarding data accuracy, despite rapid advances in computer and data collection technologies, results from big data analysis remain insufficiently precise. Online analysis is primarily based on semantic speculation, and keywords extracted through frequency analysis in big data are polysemous, leading to inaccurate information.

Third, regarding data usage, although the ultimate goal of cultural analysis is to promote mutual understanding between different nations and cultures, understand differences, and facilitate common development, some hegemonic countries may use big data cultural analysis results to interfere in other nations' political affairs and cultural strategies, ultimately turning cultural psychological analysis based on big data into a weapon for attacking other countries.

Finally, regarding data privacy and security, although cultural psychological analysis based on big data targets collective or regional cultural psychology, since group cultural data is aggregated from individual data, data collection and analysis still involve personal privacy. With the growth of online network services and internet users, individuals have more opportunities to use the internet, making privacy issues increasingly prominent. How to balance and manage

the relationship between personal privacy and research needs requires further consideration and discussion.

Therefore, future research should strive to overcome these limitations of big data in cultural psychological analysis. First, to improve data accuracy, online big data analysis can be combined with offline traditional data analysis—that is, integrated with direct information—while algorithmic models for data collection and analysis also require further development and refinement. Second, to prevent misuse of analytical results, global researchers should jointly seek appropriate solutions and common data laws to address the improper use of national or regional cultural psychological analysis based on big data. Third, research ethics should be prioritized in big data analysis, with personal privacy protection as the primary principle, promoting the establishment of corresponding laws and regulations for data privacy protection.

In summary, this paper reviews recent research applying big data analytical methods to cultural psychology and its effects on social change and ecological geography across multiple domains. Specifically, researchers have employed methods such as frequency analysis, behavioral analysis, and predictive modeling to conduct temporal trend analysis and spatial geographic analysis of cultural psychology, providing entirely new research perspectives and analytical methods for cultural psychological research.

However, it is worth noting that big data represents not only a change in data collection methods and statistical analysis for traditional cultural psychology research. While providing new methods for traditional research, it also has extremely high political, economic, and cultural application value, while simultaneously posing enormous ethical and political risks.

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Note: Figure translations are in progress. See original paper for figures.