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Interpreting the humanistic space of urban-rural interface using consumption behaviors

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ABSTRACT

The Urban-rural interface is a transitional geographic space, bordering between urban and rural areas and experiencing intensive flows of material, energy and information, in terms of goods, money, people, data and ideas. This interface can be viewed as a physical space exhibiting climatic, topographical, soil, hydrological and bioecological properties, and more importantly, as a humanistic space exhibiting social, cultural and economic properties. Consumption behaviors are humanistic properties that can be viewed as an integration of social, cultural and economic conditions and interactions in a specific human geographic space. Interpreting the humanistic aspects of border areas using consumption behaviors is a type of macro space interpretation stemming from a microcosmic perspective. In this study, we conducted a questionnaire survey from 1166 households in Gongyi City, Henan Province, China, and used interactive geographic detectors to explore the humanistic aspects of the urban-rural interface using residents' consumption behaviors. Our results revealed that the spatial patterns delineated by consumption behaviors, a humanistic property influenced more by other humanistic properties, were similar to the spatial patterns delineated by land use, a humanistic property influenced more by other physical properties. However, there were some differences or inconsistencies between the delineated humanistic and physical spaces, indicating that social and economic developments are not occurring at the same pace in places where similar physical conditions prevail. Our results also revealed that differences in consumer consumption behaviors among residents of the urban-rural interface are influenced by complex interactions of economic, social, and spatial factors. We concluded that emphasizing the optimization of humanistic spaces, in addition to the improvement of physical spaces, is essential in enhancing the sustainable development of urban-rural interface. Our results showed that interactions between these factors are promoted by the additive effects of the urban-rural interface and these interactions in turn strengthen the interpretation power of these factors. Such synergistic effects are most evidently reflected by the interactions between spatial factors and economic and social factors.

1. Introduction

The urban-rural interface (URI) is a transitional geographic space, bordering between urban and rural areas and experiencing intensive flows of material, energy and information, in terms of goods, money, people, data and ideas. This interface can be viewed as a physical space exhibiting climatic, topographical, soil, hydrological and bioecological properties, and more importantly, as a humanistic space exhibiting social, cultural and economic properties. The URI can be viewed as a cultural landscape where imprints of transformation resulted from human activities and social-economic processes are embedded in the physical geographical environment.

In the agricultural society, between urban and rural areas, there existed obvious boundaries like city walls. In the industrial society, many cities expanded beyond their boundaries and encroached into their surrounding rural areas. In many parts of the world, the boundaries between cities and rural areas became blurred and an ecotone emerged, gradually or abruptly. The transitional zone between urban and rural areas has attracted the attention of more and more researchers, but their studies were mostly city biased. They viewed the transitional zone, and explored its ecological functions, more as the urban growth or urban expansion boundary (Woods, 2009; Newell and Cousins, 2015). In practice, the asymmetric urban and rural relationship has been converted to a symmetrical one, and the development of

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the URI is viewed as the processes of boundary crossing, moving and blurring (Lichter and Brown, 2011), reflecting a deep-rooted interpenetration of urban and rural areas.

There has been a long history of academic research on the URI. German geographer Louis (1936) first paid attention to this unique geographical space. He defined the extent of an URI from the perspective of geography. Pryor (1968) expanded the social connotation of the URI much further. Early studies paid more attention to the URI's natural attributes (Gaile, 1992; Baker, 1995), but now more and more attention is paid to its social attributes. For example, Sharp and Smith (2003) incorporated social factors into the analytical framework of the URI, and determined whether these social relations have a discernible impact on non-farmer support or on the tolerance of agriculture. Sharp and Clark (2010) further identified some roots of the rural-urban fringe concept and made comparisons across a number of ecological, occupational, and sociocultural attributes. Sharma-Wallace (2016) regarded the URI as a distinct geographical space, and synthesized its social and environmental characteristics. Hiner studied the URI by focusing on its social and ecological heterogeneities, identities and ideologies (Hiner, 2014, 2015). She believed that the URI is situated between two places which are perceived to be different but indelibly linked. Although the functional differences between “rural” and “urban” people (or those seen as “been-heres” versus “come-heres”) seem to be diminishing, differing perspectives and preferences persist along the rural-urban edge. Other researchers have also studied the social attributes of the URI from different focuses, such as value conflict (Pfeffer et al., 2005), residents' sense (Soini et al., 2012), farm persistence and adaptation (Inwood and Sharp, 2012).

Scholars have explored the URI in different countries and regions (Gaile, 1992; Baker, 1995; Meagher, 2001). Most of the earlier studies were based on the developmental status of the URI in developed countries. But studies emerged in the late 20th century had focused on the URI in developing countries, especially for Asian countries, suggested that situations of the URI in developing countries were different from those in developed countries. After a long-term research of selected Asian countries, Canadian scholar Mcgee (1997) put forward the famous “Desakota” mode which was mainly about the “gray” area formed by the interactions between urban and rural areas. Subsequent empirical research for the “Desakota” development of Asian countries and regions, carried out other researchers, including studies by Firman (1997), Sit and Yang (1997), Wang (1997) and Qiao et al. (2016). Recent researches on the URI since the 21st century continued to focus on developing countries, and, generally, it is believed that as time goes on the URI problems in developing countries have become increasingly complex (Epstein and Jezeph, 2001; Audas, 2004).

As an ecotone between urban and rural areas, the interactions between economic, social, cultural, and physical elements in an URI can be particularly active, and at the same time, different contradictions and conflicts between urban and rural areas may also be extremely intensive. From the planning perspective, how to enhance and promote the URI's positive effects and mitigate or avoid its negative impacts and how to promote a healthy and coordinated development of the URI and associated urban and rural areas to further a region's economic development are major issues that need to be focused on, from both theoretical and practical perspectives.

Despite the fact that the rural commuter belts within city regions are major loci of population change, economic growth and dynamic social change, most researches tend to ignore these belts but focus on the built-up city cores (Phelps, 2006). Studies with an urban focus define the URI as “extended borders of a city” that act as “an important boundary between urban areas and suburban ecological reservation spaces” (Bengston et al., 2004). Such a definition focuses on the control of the URI as an extension of cities and ecological preservation, which highlights the spatial function of the URI as borders in a physical space. A resurgent concern for the URI is part of a wider debate surrounding urban growth and possible development encroachment onto the countryside immediately abutting built-up areas (Gallent, 2006). Qiao and Ma (2016a) argued that the URI is not merely boundary but also space for the exchange of social, cultural, and economic elements between urban and rural areas. Halfacree (2006) proposed a “triple space” model to represent the URI as a space essentially consists of three levels of meaning, i.e., perceptual space, living space and expressive space. Browder (2002) regarded the URI not only as a spatial concept that exists between urban and rural areas, but also as a network of interactions between social, cultural, and economic elements. Also, the URI has heterogeneity, complexity, transitional, and sensitivity characteristics (Qiao and Ma, 2016b) that require comprehensive and multidisciplinary research (Lockaby et al., 2005), especially from a social perspective.

Consumption as a human activity integrates social, economic, and cultural elements. Consumption behaviors and physical space are interrelated and interacting: consumption behaviors are affected and reshaped by physical space, and physical space are also affected and reshaped by consumption behaviors (Rushton, 2005). Consumption behaviors in different locations with different physical spaces, such as cities, villages, or the URI, are influenced by different humanistic elements in terms of social, cultural, and economic interactions and ethics. Consumption behaviors, as a part of the mechanism of social processes, also endows physical spaces, which are always in flux, with humanistic properties, and reshapes physical spaces to exhibit humanistic characteristics. New urbanization in China are focused on a true integration of urban and rural areas (Li and Hu, 2015; Tan, 2015), particularly on the integration of urban and rural societies and cultures, as well as the integration of physical and humanistic geographic spaces (Jahan, 2012). Urbanization in China has gradually shifted from quantity-oriented to quality-oriented. Researches that utilize a bottom-up approach and a human behavior perspective and focus on social transforming aspect could significantly facilitate sustainable urbanization and regional development in China (Mayer et al., 2016).

In this study, we used a survey and interactive geographic detectors to understand consumption behaviors, to investigate the differences between physical and humanistic spaces, within the URI between Gongyi City and nearby rural areas, and to explore factors that potentially caused differences in consumption behaviors in different types of spaces. Our study provides a unique perspective for understanding the spatial systems of the URI, and can be used as a theoretical reference for the sustainable development of the URI and associated urban and rural areas.

2. Methodology

2.1. Sample area

Gongyi City is located in west central Henan Province, China. It is located in an area that transitions from the second to the third topography ladder in China. The terrain gradually lowers from the south to north. The total land area is 1041 km^2. A total of 15 towns, 5 subdistrict offices, and 314 administrative villages are under Henan Province's jurisdiction. The city acts as both a physical interface and a humanistic interface (an administrative and transportation interface), and therefore is a typical area for interface research (as shown in Fig. 1). Qiao and Ma (2016b) found that the interface between Gongyi City and nearby villages has been emerged gradually, taking Gongyi City and strong economic towns as cores since 2015. This is a typical representation of a new type of interface found in small and medium cities, and therefore, Gongyi City is selected as such a case study area in this research.

2.2. Data collection

We collected data through a questionnaire survey. We conducted a pre-preliminary survey in August 2016 before using the finalized

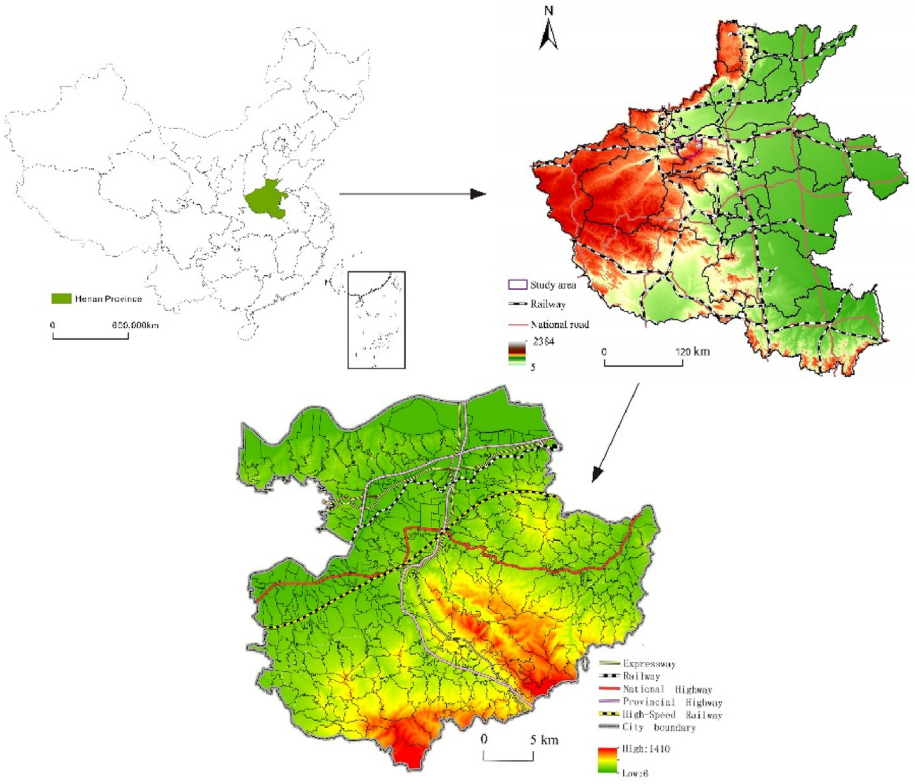

Fig. 1. Geographic location of the research area.

survey. We revised and refined the questionnaire based on the pre-preliminary survey results. We conducted the finalized survey in September 2016. We utilized both fixed-location questionnaire distribution methods and random household visits. We distributed a total of 1382 questionnaires, and a total of 1257 participants completed the questionnaires. The questionnaire return ratio was 90.1%. After an analysis of the validity of the questionnaires, we used a total of 1166 valid questionnaires for our study. The questionnaire validity rate was 92.8%. The content of the questionnaire mainly focuses two aspects. The first aspect covers the basic attributes of the respondents, such as gender, age, family size and other social attributes, education and other cultural attributes, family income, income sources, housing and other economic attributes. The second aspect covers the attributes of household consumption, such as loan consumption status, loan consumption usage, consumption ratio, consumption structure, action, and so on.

The selection of survey areas involved both group selection and random selection. First, we selected specific areas. Based on our previous research results (Qiao and Ma, 2016b), the URI was delineated through information entropy of land use. Spatial distribution of the interface areas shows as an axial strip. The outermost margin of the axial strip acted as the border of our survey area (as shown in Fig. 2). The survey area included 4 types of spatial areas: urban areas, interface between urban and rural areas, interface between town and rural areas, and rural areas. The preliminary delineation of these four types of spaces is based on the previous findings related to the present situation of land utilization in Gongyi. Among them, the spatial extent of city includes 4 sub-district offices of the Gongyi municipal government. The interface between urban and rural areas is the transition zone between city and peripheral villages. The interface between town and rural areas is the border area of a township (with the town government as its core) and the town's neighboring villages. Other areas within the strip are rural areas. Second, we conducted group selection. We selected specific urban and village survey groups based on the 4 types of spatial areas, which included a total of 4 sub-district offices and 38 villages. Third, we conducted random selection. We randomly selected households in the survey area. Ultimately, we selected a total of 1382 survey households.

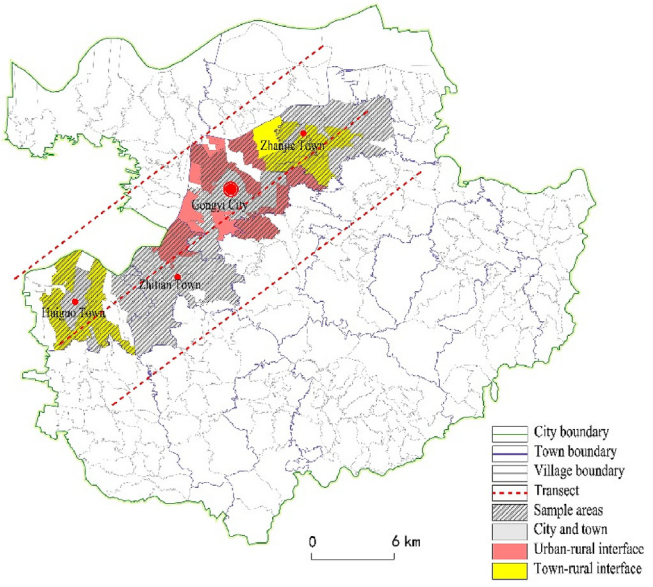

Fig. 2. Survey and sample areas.

2.3. Spatial structure of samples

Among the 1166 valid questionnaires, there were 170 (15.23%) samples from urban areas, 147 (13.17%) samples from interface between urban and rural areas, 303 (27.15%) samples from interface between town and rural areas, and 496 (44.44%) samples from interface between rural areas. Table 1 lists the basic characteristics of the survey samples.

Table 1
Basic characteristics of survey subjects.

Item	Category		Sample Num.	Ratio (%)	Item		Category	Sample Num.	Ratio (%)
Social Characteristics	Gender	Male	699	63.9	Economic Characteristics	Family Annual Income	Below 30,000	490	43.9
		Female	394	39.1			30,000–50,000	413	37.0
	Age	18–25	9	0.8			50,000–100,000	176	15.8
		25–35	259	24.4			Above 100,000	37	3.3
		35–45	687	64.7					
		45–60	89	8.4		Main Income Source	Agricultural income	177	15.9
		Above 60	18	1.7			Wage	739	66.2
	Residence	Agricultural residence	752	75.6			Investment income	186	16.7
		Non-agricultural residence	243	24.4			Interest and rental income	3	0.3
	Marital Status	Married	1030	95.6			Pension	11	0.9
		Unmarried	47	4.4					
	Household Size	1	7	0.6		Housing Type	Commercial housing	347	31.1
		2	12	1.1			Welfare housing	39	3.5
		3	230	20.6			Self-built House	640	57.3
		4	407	36.5			Rented	90	8.1
		5 or Above 5	460	41.2		Number of			
Cultural Characteristics	Education	Primary school or less	78	7.1		Owned Cars	0	627	56.2
		Middle School	411	37.4			1	443	39.7
		High school	411	37.4			2	36	3.2
		College or above	198	18.1			Above 2	10	0.9

Not all questions in the 1166 valid questionnaires were answered by the 1166 survey subjects. Therefore, the total number of answers for some of the questions may not be 1116. We found that the kind of information missing from the questionnaires does not involve the core issues of the study and does not affect the analysis results. Hence, all 1166 questionnaires are treated equally as valid questionnaires.

2.4. Research methods

2.4.1. Entropy method

Information theory regards information as a measurement of the systematization of a system, and entropy as a measurement of what is not systematized within a system. The entropy value and the information content of a system indicator (or an index of a system) are inversely related. An index with a higher weight plays a more important role in comprehensive assessments of a system (Wang et al., 2015). Based on these principles, both weights and comprehensive scores of various indexes can be calculated (Duvernoy et al., 2018).

In this study, we used information and entropy to construct the comprehensive assessment system for consumption behaviors, and to calculate both weights and comprehensive scores of the indexes of consumption behaviors for the samples, according to the following procedure (Qiao, 2004):

- First, to calculate the proportion of variable j under index i: $p_{ij} = {}^{x_{ij}}/_{\sum x_{ij}}$;
- Then, to calculate the entropy value of index i: $e_i = -k \sum p_{ij} \ln p_{ij}$, where $k = {}^{1}/_{\ln m}$, m is the sample size;
- Third, to calculate the difference coefficient of index i: $g_i = 1 - e_i$; and
- Fourth, to calculate the weight of index i: $a_i = {}^{g_i}/_{\sum g_i}$.

2.4.2. Geographic detectors

Geographic detectors assume that geographic objects exist in certain spatial locations and that impacts of environmental factors on changes in geographic objects differ spatially. If the spatial variation of a given environmental factor is consistent with the spatial change of a geographic object, then the environmental factor influences the occurrence and development of the geographic object (Wang et al., 2010). In this study, we used a factor detector and an interactive detector (Wang and Hu, 2012) to detect impacts of environmental factors on spatial differentiations of consumer consumption behaviors, and to examine explanatory and causal powers of interactions among different factors.

We used a factor detector to detect whether a given geographic element is responsible for the differentiated distribution in values of a given index. Specifically, we compared the total variance of an index in different groups of areas to the total variance of the index in the entire research area. The formula for the power of determinant (*PD*) of various influence factors is:

$$P_{D,H} = 1 - \frac{1}{n\sigma_H^2} \sum n_{D,i}\sigma_{H,i}^2 \quad (1)$$

where D is an influence factor, H is the consumer consumption behavior index, $P_{D,H}$ is the *PD* of D on H, n is the number of samples and σ^2 is the sample variance, and i is the type of samples. The value of $P_{D,H}$ falls between 0 and 1. The greater the value, the more obvious the effect of the influence of a factor on the consumer consumption index.

We used an interactive detector to detect the interactions among different influencing factors, to assess specifically whether the interaction between any two influencing actors would increase or decrease the *PD* on dependent variables, and to compare the $P_{D,H}$ values of the two factors to the $P_{D,H}$ value of their interaction when they were distributed in a superimposed or tangential way. The likely outcome may include: enhance, enhance-bivariate, enhance-nonlinear, weaken, weaken-univariate, weaken-nonlinear, and independent.

3. Results

3.1. Consumer consumption behavior indexes

Humans are social beings. The behavioral space or spatial behaviors of human beings are an important dimension for understanding the relationship between “society” and “space”. From social, cultural, economic and other perspectives to explore consumer consumption behaviors has become the mainstream of research (Spaargaren and Oosterveer, 2010). Research on the characteristics of humanistic spaces in the URI from the perspective of residents' consumption behaviors required a comprehensive assessment of consumption behaviors by means of consumption behavior index. Some previous studies (Kwan, 2000; Lysgard, 2016) demonstrated that the effects of consumption philosophy on consumption behaviors act as a “path” of reliance based

Table 2
Assessment indexes and weights for consumption behaviors.

First-Level Index and Weight	Second-Level Index and Weight
Consumption philosophy (0.1795)	Whether loan for consumption (0.0873)
	Loan consumer consumption usage (0.0922)
Consumption level (0.2512)	Household annual income (0.1768)
	Consumption ratio (0.0744)
Consumption space (0.1308)	Durable goods purchase location (0.0493)
	Fast-moving consumer goods purchase location (0.0815)
Consumption structure (0.4385)	Food consumption ratio (0.1210)
	Education consumption ratio (0.0932)
	Entertainment consumption ratio (0.1374)
	Medical consumption ratio (0.0869)

Quantification of Second-Level Index: Whether loan for consumption (if the answer is YES, the value is 1; otherwise, it is 0); Loan consumer consumption usage (if the usage is for durable goods purchase, the value is 1; otherwise, it is 0); Household annual income (Family's annual real income); Consumption ratio (the ratio of household annual consumption to household annual income); Durable goods purchase location and Fast-moving consumer goods purchase location (Purchase in this village, 1; Purchase in this town, 2; Purchase in this city, 3; Purchase in this province, 4); Food consumption ratio (the ratio of food consumption to total consumption); Education consumption ratio (the ratio of education consumption to total consumption); Entertainment consumption ratio (the ratio of entertainment consumption to total consumption); Medical consumption ratio (the ratio of medical consumption to total consumption).

on behavioral “habits.” Therefore, the consumption philosophy acts as a soft constraint with the consumption level acting as the core element (Mishra, 2015). The consumption space acts as a hard constraint, and the consumption structure reflects the differences in consumption levels (Mansvelt, 2008). As such, we constructed a comprehensive assessment index system for consumption behaviors using these four perspectives: (1) consumption philosophies, (2) consumption levels, (3) consumption spaces, and (4) consumption structures. We then used the comprehensive assessment index to calculate the indexes of residents' consumption behaviors. In accordance with information theory, all indexes were standardized, entropy values of the indexes, as well as their weights, were calculated (as shown in Table 2).

3.2. Humanistic space scope of the URI

We calculated the consumption indexes of the sample residents using the above index system. We also calculated the average value of each urban sub-district and administrative village. We created a vector map to depict the villages. Fig. 3 shows the distribution of consumer consumption behavior index values for Gongyi City in terms of humanistic spaces. We grouped the areas into 3 categories: high, medium, and low index value areas. The high index value areas were primarily distributed among Gongyi City and towns, also known as “urban areas” in terms of dimensions in humanistic space. The low index value areas were distributed among communities far away from towns, such as Huiguo and Zhitian, and communities to the northeast of Zhanjie. These areas are considered “rural areas” in terms of dimensions in humanistic space. The medium index value areas were distributed among the Xiaoyi sub-district in urban areas, the surrounding communities of Zhitian, and villages between Gongyi City and Zhanjie, which are considered as the “URI” in terms of humanistic attributes in geographic space.

According to behavioral geography, consumption behaviors differ based on individuals' values and lifestyles, which correspond to their residential locations. This forms different social classes with different consumption behaviors (Chen et al., 2016). Divergence were also reflected in Gongyi City in terms of residents' consumption behaviors and corresponding residential locations. For instance, the three sub-districts of the urban areas had high economic levels. Most residents in these sub-districts were native urban residents, and their consumption

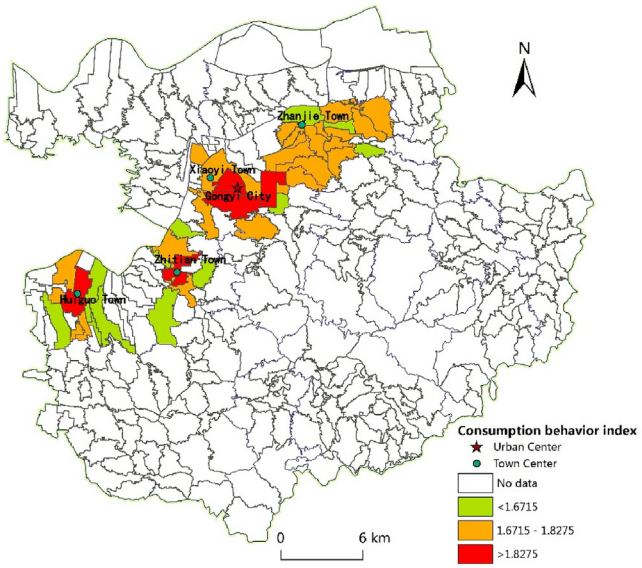

Fig. 3. Spatial distribution of consumption behavior index values.

philosophies, habits, and behaviors were largely affected by the urban society and culture in which they resided. Comparatively, the Xiaoyi sub-district was originally a town, and most of its residents were life-long residents. Although its economic level was similar to that of the other sub-districts, residents' consumption behaviors were more affected by the community's original background as a rural society and culture, and exhibited humanistic attributes that corresponded to the URI. Among the three town sample areas, the consumption behavior indexes of Huiguo and Zhitian were higher than Zhanjie. The farther away from the town center an area was, the lower the consumption behavior index. This observation was particularly obvious in the URI. Zhanjie, however, did not conform to this rule. On the one hand, Zhanjie is the seat of Gongyi County's (currently Gongyi City) government offices, meaning that the area has well-developed political, economic, and cultural characteristics that are unique unto itself. On the other hand, Zhanjie is adjacent to Gongyi City, exhibited characteristics more typical of the URI, due to close proximity to and influence of Gongyi City.

3.3. Comparison of humanistic spaces and physical spaces

The URI is not merely an explicit physical space such as an extension of cities or villages, but an implicit humanistic space for the flow of urban and rural elements. The complicated relationships between urban and rural areas are more obvious in the interface between them. In this study, we viewed the URI delineated by the consumption behavior index (a social attribute) as humanistic spaces. We viewed borders delineated by land use (an economic attribute) as physical spaces. The humanistic and physical spaces were similar (e.g. both had obvious transitional zones) and different, as shown in Fig. 4. In terms of spatial scope, physical spaces were larger than humanistic spaces. Our results indicated that the expansion of urban societies and economies lagged behind land use expansion. Our results also showed that urban expansions require a transition from the quantitative expansion of physical space to the qualitative transformation of humanistic space. In terms of spatial overlap of physical and humanistic spaces, the overlapped areas were clustered around urban centers and town centers. Moreover, our results indicated that the social and economic properties of border areas were affected more by urbanization and spatial proximity to urban centers. Our results also showed that increases in the distance from Gongyi City corresponded to decreases in influences of urban lifestyle. In terms of spatial separation of humanistic and physical spaces, solely

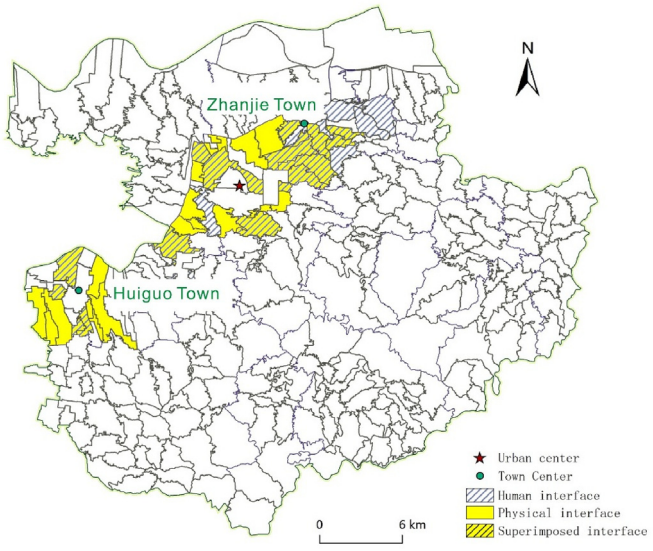

Fig. 4. Comparison of humanistic and physical spaces.

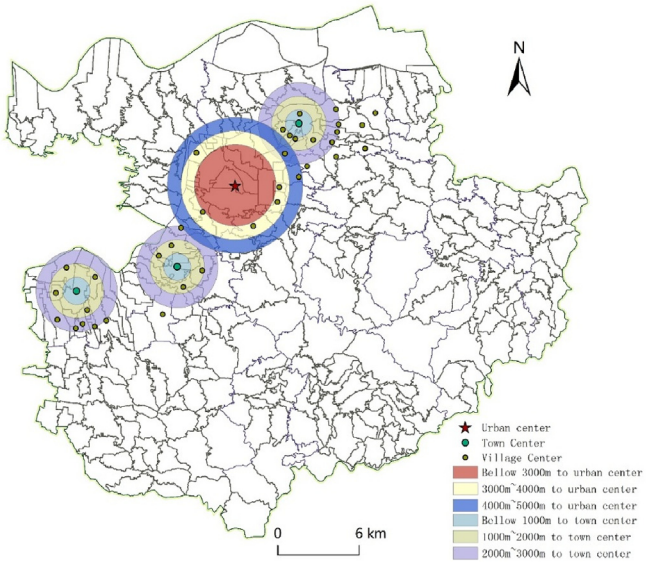

Fig. 5. Distances of samples from city and town centers.

physical spaces were primarily distributed near Huiguo, which is far away from Gongyi City's urban area. Huiguo is an industrial town where urbanization of people's life style has not been realized. Solely humanistic spaces were usually small and primarily distributed around Zhanjie. Zhanjie is adjacent to the central city, has been significantly influenced by urbanized societies and cultures, and its residents' lifestyles have been significantly influenced and affected by urban cultures.

The differences between humanistic and physical spaces signified that the role of the URI communities needs to be promoted in order to increase urbanization. Border areas are not merely physical spaces, they are not simply “land banks” for urbanization (Lin et al., 2016). Instead, border areas are a social and economic space for human activities, and they should not be treated as a passive extension of urban areas. Interface areas, specifically, need to be incorporated in urban development strategies and integrated into physical spaces in urban development to encourage “human” development. The traditional two-dimensional way of looking at cities and villages should be replaced by a more holistic and integrated lens for studying the complex and interrelated relationship between urban and rural areas. More attention should be given to the implicit two-dimensional separation between urban and rural areas, as well as the role of geographic separation (Wu and Cui, 2016). Interface areas should be used to facilitate the flow of urbanization into rural areas. Ultimately, a more integrated method would create a more realistic and sustainable system for urban development. The differences between humanistic and physical spaces also suggested that the urbanization of humans should be expedited in order to achieve a true integration of urban and rural areas. The fact that humanistic spaces are smaller than physical spaces shows that land urbanization is occurring at much faster rates than human urbanization. Furthermore, not encouraging and expediting urbanization can result in depressed and lagging urbanization, which in turn could potentially discourage the realization of urban aggregation, and result in “rural diseases” such as lags in localization of industry, peripheralization of agriculture, antiquated, rural lifestyles, and unsystematic urban development. In the long term, depressed urbanization could hinder sustainable urbanization.

3.4. Factors causing consumption behavior differences

Consumption behaviors are not merely a type of economic behavior. They are also affected by social and spatial factors such as family, education, and location. Therefore, we selected 7 indexes from economic, social, and spatial perspectives to act as geographic detection variables. The 7 indexes were: (1) total agricultural and industrial production per capita (x_1), (2) net income per capita (x_2), (3) population density (x_3), (4) household size (x_4), (5) education level (x_5), (6) distance from city or town centers (x_6), and (7) distance from main transportation routes (x_7). We calculated total agricultural and industrial production per capita, net income per capita, and population density using the 2015 Gongyi Statistical Yearbook. We attained household size and education level measurements from survey data. We obtained the Euclidean distances from city and town centers, and from main transportation routes, using buffered zones in a vector map of villages in Gongyi City (as shown in Figs. 5 and 6).

Notes: The buffered zones were delineated with the grading standards used in the Urban and Rural Overall Plan of Gongyi City, Henan Province, China (2014–2030), released by the China Research Institution of Urban Planning and Design.

Table 3 lists results of the factor detector, the PD values for single factor on consumption behaviors. The PD of social and cultural factors, such as education level (X5) and household size (X4), were the strongest and most influential factors. The PD of economic factors, such as the total agricultural and industrial production per capita (X1) and

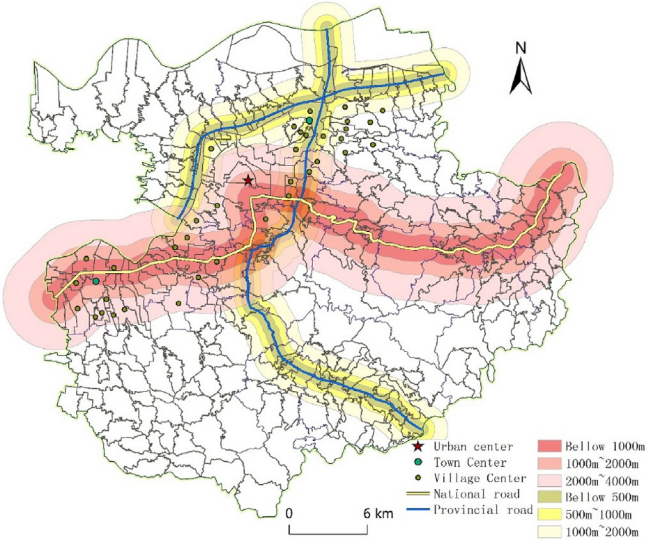

Fig. 6. Distances of samples from main transportation routes.

Table 3
Power of determinant of single factors.

	x1	x2	x3	x4	x5	x6	x7
	Agriculture and Industrial Production per Capita	Household Annual Income	Population Density	Household Size	Education	Distance from City/Town Centers	Distance from Main Transportation Routes
PD Value	0.863983	0.851086	0.72493	0.879462	0.892968	0.328915	0.317056

Table 4
Power of determinant of the interaction between factors.

	x1	x2	x3	x4	x5	x6	x7
x1	0.863983						
x2	1	0.851086					
x3	0.9928	1	0.72493				
x4	1	1	1	0.879462			
x5	1	0.997569	1	0.999828	0.892968		
x6	0.9928	0.912413	0.9928	0.966803	0.939494	0.328915	
x7	0.9928	0.944946	0.9928	0.919709	0.973577	0.667329	0.317056

household annual income (X2), were the second strongest factors. The PD of spatial factors, such as the distance from city or town centers (X6) and distance from main transportation routes (X7), were the weakest and least influential factors. There were no significant differences between social and cultural factors and economic factors in terms of their PD. The differences in the PD of spatial factors in comparison to other factors were significant. The above results indicated that consumption behaviors were largely affected by social, cultural, and economic factors, and were much less affected by spatial factors.

Table 4 lists results of the interactive detector, the PD values of the interactions of multiple factors. Clearly, PD values were increased by the interaction of any 2 factors. PD values of the interactions between spatial factors and other factors, such as economic, social, and cultural factors, increased most obviously. This further demonstrated that consumer consumption behaviors were a complicated and complex behavior that was affected by the interactions of multiple economic, social, cultural, and spatial factors. It also indicated that consumer consumption behaviors cannot be explained solely by spatial factors, but spatial factors can significantly enable other factors' influences on consumer consumption behaviors.

Results of the interactive detector (Table 4) show that the interpretation power of any two factors after interaction has been strengthened, which is mainly due to the additive effect of the interface. Because the URI is distant from the centers of both the urban and the rural systems, the influences from the centers of the two systems are relatively weak. Therefore, it is easy for new elements to enter, grow and develop. Which in turn will further boost the agglomeration of economic, social and cultural elements at the interface, and produce a growth effect that transcends the sum of the individual functions of the regional components, namely the additive “one plus one over two” effect.

Results of the interactive detector (Table 4) also show that impacts of the interactions between spatial factors and economic and social factors on consumption behaviors is the most obvious, which is mainly due to the synergistic effect. The synergistic effect reflects the qualitative change of factors when they meet the “niche suitable” for their growth. As the junction area of heterogeneous system, interface becomes the joint point or joint area from quantitative to qualitative change. At the URI, residents' consumption concept, consumption level, consumption structure and choice of consumption space are different from those of pure urban or pure rural areas, and are influenced by both core urban and rural areas. As a result, their consumption behavior is dynamic, comprehensive and complex, but different from that of urban citizens and rural farmers. That is to say, there are obvious differences in consumer consumption behaviors with the distance from cities and rural areas.

4. Conclusion and discussion

In this study, we used a questionnaire survey of 1166 households from Gongyi City, Henan Province, China and interactive geographic detectors to explore the humanistic spaces of the urban-rural interface (URI) using residents' consumption behaviors. Our primary findings are as follows:

(1) Within the URI, the humanistic space and the physical space do not overlap everywhere, according to consumer behavior. The overlapped areas are primarily distributed around city and town centers, and have achieved urban status in both compositional and cultural aspects. Non-overlapped areas are primarily distributed in villages far away from cities, where the landscape may look like urban but the residents' lifestyle is dominantly rural. Generally speaking, physical spaces are larger than humanistic spaces within the URI. Sustainable development of the URI through urbanization needs focus more on qualitative and humanistic promotion than on quantitative and physical expansion.
(2) Across the URI, humanistic space and physical space do not synchronize everywhere during the process of urban-rural integration, due to (a) more difficult and slower humanistic integration and (b) relatively easier and faster physical integration. Spatial variation in the degree of humanistic and physical synchronization across the urban-rural interface is due to the differentiated influences from responsible urban centers and rural areas. Sustainable development of the URI through full integration of cities and villages needs expedite and promote more in humanistic integration than in physical integration.
(3) Throughout the URI, differences in consumption behaviors are caused by differentiated and complex interactions between economic, social, and spatial factors. According to power of determinant (PD) values resulted from interactive geographic detections, social and cultural factors exhibited the strongest interactions, followed by economic factors, with spatial factors the weakest. PD values also indicated that interactions of multiple factors were much stronger than that of a single factor, due to the additive effects of the URI, as most obviously exemplified by interactions of spatial factors with other factors. It is clear that consumption behaviors were affected to a larger degree by interactions of multiple social, cultural, and economic factors and to a less degree by merely spatial locations. But the influences of social, cultural and economic factors on consumption behaviors was enhanced significantly

through interactions of these humanistic factors with spatial factors. Therefore, it is more effective to influence consumption behaviors by leveraging the synergistic effects of spatial factors and embedding interactions of humanistic (social, cultural and economic) factors in spatial contexts. Consumers' behaviors may be influenced more effectively, for example, by regulating travel needs, travel modes, travel conditions and travel costs throughout the URI.

This research revealed the problem of insufficient attention to social, cultural and economic factors in the urban-rural interface. Unlike most previous studies that still regard space as a carrier of social, cultural and economic processes, this study demonstrated that spatial processes are essentially interrelated with social, cultural and economic processes, and proved that space in fact is not just a carrier of, but is intrinsic to and an integral part of, social, cultural and economic processes and activities themselves. Further researches are needed to explore the subjectivity of rural areas and living spaces and to strengthen the fusion of physical space and elements and humanistic space and lifestyles within the urban-rural interface, because we believe that sustainable development of the URI in China will hinge ultimately on the harmonic coordination of the production, living and ecological aspects of the transitional geographic space.

CRediT authorship contribution statement

Yuling Ma: Data curation, Investigation, Methodology, Resources, Writing - original draft, Writing - review & editing. **Jiajun Qiao:** Funding acquisition, Project administration. **Dong Han:** Data curation, Investigation, Methodology.

Declaration of competing interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jrurstud.2019.12.014.

Author contributions

Yuling Ma and Jiajun Qiao designed survey; Yuling Ma and Dong Han conducted the survey with households and performed data analysis. Yuling Ma, Jiajun Qiao and Dong Han wrote the paper. All authors read and approved the final manuscript.

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