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Evaluation of the hexagonal and spherical model of vocational interests in the young people in Serbia and Bulgaria

Vladimir Hedrih[1], Marina Stošić[2], Ivana Simić[1], and Snežana Ilieva[3]

[1]*Department of Psychology, Faculty of Philosophy, University of Niš, Serbia*
[2]*Department of Psychology, Faculty of Philosophy, University of Belgrade*
[3]*Department of Social Work and Educational Psychology, University of Sofia, Bulgaria*

The aim of this study was to validate Holland's hexagonal and Tracey's spherical model of vocational interests in young adults in Serbia and Bulgaria. To this end, 1250 participants, 560 from Serbia and 690 from Bulgaria, filled in Serbian and Bulgarian versions of the Personal Globe Inventory (PGI, Tracey, 2002). Hubert and Arabie's randomization test of hypothetical orders, multidimensional scaling with fixed coordinates, Myors test and exploratory factor analysis were used. The results showed that the hexagonal and spherical models well explained the structure of vocational interests in both samples. The level of fit of the hexagonal model to the data obtained by using the PGI was generally higher than those established in the studies that used other Holland-based instruments. Furthermore, the levels of fit of both hexagonal and spherical model were in the same range like those obtained in previous studies in other countries. The results also pointed out a remarkable similarity in the structure of vocational interests in the Bulgarian and Serbian samples.

Keywords: Vocational interests, Cross-cultural, Spherical model, Personal Globe Inventory, Serbia, Bulgaria

Probably one of the best known models of vocational interests whose validity was confirmed in numerous cross-cultural studies was offered by John Holland (1959; 1976; 1994). His model of vocational interests, known as Holland's hexagon, consists of six types of vocational interests that are positioned at nodes of an equilateral hexagon. These six types of vocational interests are: *Realistic* (R), *Investigative* (I), *Artistic* (A), *Social* (S), *Enterprising* (E) and *Conventional* (C) and they are commonly referred to as RIASEC interest types.

Corresponding author: stosic.marina@gmail.com

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According to Holland, relationship between RIASEC types can be described by a circular order model. Types that are closer on the hexagon are more similar, while types farther away are less similar. There are three levels of similarity of interests. The most similar are the neighboring types of interest. Less similar are the skipping types – types that are separated by another type that lies in between them. The least similar are the opposing types of interests. Correlations between neighboring types will be greater than among the skipping ones, and correlations between skipping types will be even greater than between the opposite ones.

Holland's hexagon is two dimensional in the sense that it is a hexagon which is a two-dimensional geometric figure. The meaning of these two dimensions was first specified by Prediger (Prediger 1982, 1998; Prediger & Swaney, 2004) who called them *People-Things* and *Data-Ideas* dimensions. The first dimension passes through nodes where S and R types are, while the second is orthogonal to it and runs between I and A, and C and E.

The research done by Tracey and Rounds (1996a; 1996b) yielded results indicating the existence of a third dimension in addition to the two dimensions postulated by Prediger. The authors called this dimension *Prestige*. Based on this, they proposed a new structure model of vocational interests that became known as the spherical model of vocational interests. The spherical model (Tracey, 2002; Tracey & Rounds, 1996a), assumes the existence of 18 types of vocational interests that are distributed in three dimensional space. Eight of those 18 types are equidistantly distributed along the equator of the sphere forming an equilateral octagon. These types lie in the "Holland's plane" that Tracey also calls the "basic interest plane". Their names are *Social Facilitating, Managing, Business Detail, Data Processing, Mechanical, Nature/Outdoors, Artistic* and *Helping*. Five other types are positioned in the upper hemisphere of the model and represent higher prestige types, and five are positioned in the lower hemisphere comprising lower prestige types. The upper hemisphere types are Social Sciences, Influence, Business Systems, Financial Analysis and Science. The lower hemisphere types are Quality Control, Manual Work, Personal Service, Construction/Repair and Basic Services. Interest types Influence and Manual Work are positioned at the top and the bottom of the sphere respectively, representing activities with the greatest and smallest levels of Prestige.

The spherical model of vocational interests was initially created as an attempt to complement and improve the hexagonal model proposed by Holland. For this reason there is compatibility between the two models such that from the measures obtained using the spherical model RIASEC measures can be derived, but not vice versa.

Holland's model has been a subject of many studies. However, the results of these studies are not uniform and in the majority of countries lower levels of fit of the model to the data were found – Portugal, Pakistan, Indonesia, Brazil, Paraguay, France, Columbia, Mexico and Australia (Rounds & Tracey, 1996), Bolivia (Glidden-Tracey & Parraga, 1996), India (Leong, Austin, Sekaran, & Komarraju, 1998), South Africa (Du Toit & De Bruin, 2002), both mainland China and Hong Kong, although there were a few Chinese samples with high levels of fit (Long, Adams, & Tracey, 2005; Long & Tracey, 2006; Zhang, Kube,

Wang, & Tracey, 2013) and Spain—Basque Country (Elosua, 2007). Relatively high levels of fit of the model to the data were found on some US samples, Jamaica, Trinidad and Tobago, Japan, Iceland, Germany, Israel, South Korea, Serbia and Croatia (Einarsdóttir, Rounds, Ægisdóttir, & Gerstein, 2002; Feldman & Meir, 1976; Fouad & Mohler, 2004; Hedrih, 2006; Hedrih & Šverko, 2007; Nagy, Trautwein, & Lüdtke, 2010; Rounds & Tracey, 1996; Šverko & Babarović, 2006; Tak, 2004; Tracey, Watanabe, & Schneider, 1997; Wilkins, Ramkissoon, & Tracey, 2013; Yang, Lance, & Hui, 2005).

Compared to Holland's hexagon model, Tracey's spherical model has not been so vastly validated. After the initial confirmation in the US and Japan (Tracey, 1997a; Tracey, 2002; Tracey et al., 1997), the spherical model was so far evaluated in Ireland (Darcy, 2005), China (Long et al., 2005), Croatia (Šverko, 2008), Serbia (Hedrih, 2008) and Jamaica, Trinidad and Tobago (Wilkins et al., 2013). These studies have all reported results similar to those obtained on Tracey (2002) original US sample, confirming the spherical model.

The goal of the current study was to examine the structure of vocational interests on samples of young adults from Bulgaria and Serbia and compare the structure of these results with structures proposed by the hexagonal and spherical models of vocational interests. Search of the available international literature did not yield studies comparing the structure of vocational interests on Bulgarian samples to predictions of these models. On the other hand concordance of the structure of vocational interests in Serbia to the predictions of these models has been examined in several studies which uniformly confirmed the fit of the data to predictions of both models (Hedrih, 2008, Šverko & Hedrih, 2010). Given this situation and the fact that Bulgaria and Serbia are neighboring countries both located in the Western Balkans region of Europe, and with numerous cultural and linguistic similarities, Serbian results were used as reference.

Methods

Sample

Data were collected from 1250 participants. The Bulgarian sample included 690 participants, 189 of which were male (27.3%). Majority of participants from this sample were aged 20 to 26 years, with the mean age of 22.8 years, and all were university students.

The Serbian sample included 560 participants, 258 of which were male (46%). Majority of the participants in this sample were 20 to 24 years of age, with the mean age of 23.1 years. Of these, 374 were university students (66.7%).

Instrument

Participants in the Serbian sample completed the Serbian version of the Personal Globe Inventory (Hedrih, 2008; Tracey, 2002). The Bulgarian version of the questionnaire was created through the process of backtranslation. The questionnaire was translated from Serbian into Bulgarian and backtranslations were done into Serbian and English.

In the Serbian version, two items from the original were replaced as they contained occupations that did not exist in Serbia or were very unfamiliar ("personal shopper" became "personal caretaker" and "ride attendant" became "taxi driver"). These same items were replaced in the same way and for the same reasons in the Bulgarian version.

Procedure

The Bulgarian participants were all tested during their daily university lectures. During the administration that took 45 minutes, one researcher and a university lecturer were present. The researcher explained the purpose of the study and provided clarification when necessary. Data from the Serbian participants were collected by a number of interviewers. Interviewers visited residents of a number of settlements in Serbia at their homes, explained the purpose of the study and asked them to participate. For practical reasons, whenever it was possible, interviewers directed participants to complete the web-version of the instrument.

Analysis

Randomization test of hypothetical orders. To test the fit of the data to the circular and spherical structures proposed by the Holland's model and the spherical model, Hubert and Arabie's randomization test of hypothetical orders (Hubert & Arabie, 1987; Rounds, Tracey, & Hubert, 1992) was used. This test takes the correlation matrix and data about relative order of correlation sizes proposed by the model as input, and then creates all the possible permutations of rows and columns of the input correlation matrix, thus creating a new set of correlation matrices. It then counts the number of correlation matrices created through row and column permutations which conform equally well or better to the specified hypothetical order of correlation sizes than the original correlation matrix. This number is then divided by the total amount of correlation matrices created by row and column permutations and this proportion is the randomization p value of the test. This value can be interpreted as the significance level of the fit, with the null hypothesis being that the model fits permutation matrices equally well as the original correlation matrix. The correspondence index (*CI*) is also calculated in this testing procedure and this coefficient represents the difference between correct and incorrect correlation size order predictions (i.e. which correlation is greater than which) divided by the total number of predictions. The correspondence index is a descriptive measure of the level of fit of a model to data and it varies from –1 to 1, with a higher value indicating a better fit. We calculated both indices using the RANDALL software (Tracey, 1997b). In the years following the first studies of Holland inspired models of vocational interests, the randomization test of hypothetical orders has become a de facto standard procedure for testing fit of these models to data, having been used in hundreds of studies so far. Although other methods for testing model-data fit exist, using this test makes comparison of results with large numbers of previous studies possible.

Myors's test. The method proposed by Myors (1996; 1998) tests fit of the circular model to data by calculating correlation between ranked correlations obtained from data, and a hypothetical model expressed as correlation size ranks. This method was proposed as a simpler alternative to the randomization test of hypothetical orders for testing fit of the data to the order predicted by the circular model of vocational interests, but can also be used on all models that can be specified as orders of correlation sizes.

Constrained multidimensional scaling. The multidimensional scaling (MDS) procedure is a procedure that attempts to place objects in a space with predefined number of dimensions in such a way that their distances between each other are preserved as much as possible. It reports the discrepancy between interobject distances in the input data and distances in the solution with the defined number of spatial dimensions. The constrained procedure starts with both the number of space dimensions and positions of objects in this space as input and reports the discrepancy between the predefined object configuration and their real configuration derived from data. In this way this procedure may be used on a data matrix, in this case a correlation matrix, to test the extent to which real object relations conform to a theoretical model.

Exploratory factor analysis. Given the specificity of the latent structure of vocational interest data i.e. the fact that the largest eigenvalue factor, typically named the general factor, does not constitute a vocational interest dimension per se (for example Tracey, 2002), studies in this area typically apply an exploratory factor analysis procedure without rotation, so as not to disperse the variance of the first factor to the other two substantial factors. Given the works of Prediger (1982), Tracey (for example 2002) and other researchers suggesting a three dimensional structure of Holland interest types and a four dimensional structure of the spherical interest types, in the exploratory factor analysis procedures used in this study these numbers of factors were predefined for extraction. Tucker's coefficients of congruence were used to examine similarities between the factor structure in the Bulgarian and Serbian samples.

Results

Results of the procedures used to test the fit of the current data to Holland's hexagonal model are presented in Table 1. All indices indicate a good fit in both samples. Statistics that indicate the extent of deviation of the data from the model in the multidimensional scaling were not high, and the structures of interests in both samples were the same. The correspondence index was high and comparable in both samples. Myors' test produced similar results in both the Bulgarian and Serbian samples – correlation coefficients were .88 and .87, thus percentages of variance accounted for were 50% and 46% respectively.

Table 1
Results of multidimensional scaling with constrained coordinates, the randomization test of hypothetical orders and Myors' test used to test the fit of Holland hexagonal model

Test	Parameter	Bulgarian sample	Serbian sample
MDS with constrained coordinates	Normalized raw stress	.03	.03
	Kruskal's stress—1 coefficient	.17	.19
	Tucker's coefficient of congruence	.98	.98
Randomization test	Randomization *p* value	.017	.017
	Correspondence index (*CI*)	.94	.90
Myors' test	Spearman correlation coefficient	.88	.87
	Minimum amount of variance accounted for	50%	46%
Similarity of interest types' intercorrelation matrices	Spearman correlation coefficient	.978	

Deviations of individual interest types from their positions defined by the hexagonal model are presented in Table 2. Results show that *Investigative* type deviates from its predicted position in both samples and that this deviation is the highest. In the Bulgarian sample, two more types of interests, *Enterprising* and *Conventional*, deviate substantially from positions defined by the model. This could indicate a somewhat better fit of Holland's model to the data obtained in the Serbian sample, than those in the Bulgarian.

Table 2
Deviations of individual RIASEC types from the positions defined by the hexagonal model

Types of interests	Bulgarian sample	Serbian sample
Realistic	0.04	0.03
Investigative	0.07	0.08
Artistic	0.02	0.03
Social	0.02	0.03
Enterprising	**0.06**	0.03
Conventional	**0.05**	0.01
Mean	0.04	0.03

Note. Table shows the normalized raw stress-coefficients. Deviations from the positions specified by the model that are above-the-average are printed boldface.

Table 3
Unrotated factor structure of RIASEC interest types on the two samples

	Bulgarian sample			Serbian sample		
	F1	F2	F3	F1	F2	F3
R	.69	**-.49**	-.38	.65	**-.59**	-.34
I	.76	.24	**-.42**	.76	.20	**-.46**
A	.57	**.65**	-.28	.55	**.64**	-.28
S	.66	**.50**	**.44**	.64	**.60**	.33
E	.59	-.16	**.75**	.63	-.10	**.73**
C	.68	**-.66**	.01	.64	**-.69**	.08
% of variance accounted for	44.05	24.3	19.1	41.8	27.6	17.5
Total		87.6			86.9	

Note. Correlations and saturations exceeding .40 are printed boldface.

In both samples, the results of principal component analysis (Table 3) of the 6 RIASEC interest types indicated the presence of one general factor and two factors corresponding to two dimensions – *People-Things* and *Data-Ideas* – which account for 87% of variance. Tucker's congruence coefficients (Table 4) point to extremely high similarity of basic dimensions of RIASEC interest types in the two samples. All the tests used for the analysis of the spherical model point to its good fit to the data (Table 5). Results of the randomization test showed significant fit of the spherical model to the data in both samples (p=.001), and the correspondence index was moderately high (CI=.59). Application of Myors' test led to a similar conclusion – correlations were significant and the percentage of variance accounted for was 37%. Finally, indices of the degree of deviation of data from the model in the multidimensional scaling were not high, and the structures of interests in both samples were equal. In both samples there were 9 interest types whose deviations from the positions defined by the spherical model were above the average (Table 6). Seven of these were common for the Bulgarian and Serbian samples (*Mechanical, Helping, Financial Analysis, Personal Service, Construction/Repair, Basic Services* and *Artistic)*. Two were specific for the Bulgarian (*Managing* and *Manual Work*) and two for the Serbian sample (*Science* and *Nature/Outdoors*).

Table 4
Congruence of factor structures of Holland RIASEC types obtained on Bulgarian and Serbian samples: Tucker's congruence coefficients

		Serbian sample		
		F1	F2	F3
Bulgarian sample	F1	**1.00**	-0.01	-0.02
	F2	0.00	**0.99**	-0.17
	F3	0.02	0.17	**0.98**

Table 5
Results of multidimensional scaling with constrained coordinates, the randomization test of hypothetical orders and Myors' test used to test the fit of the spherical model

Test	Parameter	Bulgarian sample	Serbian sample
MDS with constrained coordinates	Normalized raw stress	.08	.05
	Kruskal's stress—1 coefficient	.27	.22
	Tucker's coefficient of congruence	.96	.98
Randomization test	Randomization *p* value	.001	.001
	Correspondence index (*CI*)	.59	.59
Myors' test	Spearman correlation coefficient	.69	.69
	Minimum amount of variance accounted for	37%	37%
Similarity of interest types' intercorrelation matrices	Spearman correlation coefficient	.963	

Table 6
Deviations of Tracey's 18 types of vocational interest from the positions defined by the spherical model

Types of interests		Bulgarian sample	Serbian sample
1	Social Facilitating	.05	.05
2	Managing	**.08**	.04
3	Business Detail	.03	.03
4	Data Processing	.04	.03
5	Mechanical	.09	.06
6	Nature/Outdoors	.07	**.07**
7	Artistic	.08	.07
8	Helping	.11	.07
9	Social Sciences	.07	.04
10	Influence	.05	.04
11	Business Systems	.05	.03
12	Financial Analysis	.11	.06
13	Science	.06	**.06**
14	Quality Control	.05	.03
15	Manual Work	**.13**	.04
16	Personal Service	.09	.06
17	Construction/Repair	.11	.06
18	Basic Services	.09	.06
	Mean	.08	.05

Note. The table shows the normalized raw stress-coefficients. Deviations from the positions specified by the model that are above-the-average are printed boldface.

Table 7 summarizes the results of principle component analysis without rotation conducted on Tracey's 18 types of interests. According to the theoretical model, a four-dimensional solution was expected. This expectation was confirmed and aside from the general component, three more factors were extracted that correspond to three dimensions *People-Things, Data-Ideas* and *Prestige.* The factor structures obtained in the two samples were very similar (Table 8). In both Bulgarian and Serbian samples, the four factors explained 80% of variance.

Table 7
Unrotated factor structure of Tracey's 18 types of vocational interests

	Bulgarian sample				Serbian sample			
	F1	F2	F3	F4	F1	F2	F3	F4
Social facilitating	.67	.31	**-.41**	-.31	.62	.33	**.36**	**-.45**
Managing	.65	-.21	**-.59**	-.17	.66	-.25	**.53**	-.26
Business Detail	.57	-.39	**-.61**	.12	.58	**-.42**	**.61**	.03
Data Processing	.62	**-.47**	.27	.32	.63	**-.48**	-.24	.30
Mechanical	.65	-.39	**.52**	.14	.68	-.34	**-.49**	.21
Nature/Outdoors	.59	.37	**.45**	.30	.62	**.43**	-.30	.34
Artistic	.37	**.61**	.19	.23	.33	**.66**	-.06	.22
Helping	.47	**.73**	-.16	-.11	.39	**.77**	.16	-.08
Social Sciences	.53	**.67**	-.07	.03	.45	**.71**	.13	.09
Science	.70	.34	-.09	.39	.62	**.42**	-.11	**.43**
Financial Analysis	.70	-.38	-.38	.27	.59	**-.40**	**.59**	.12
Business Systems	.61	-.37	**-.56**	.22	.68	**-.44**	**.42**	.20
Influence	.62	.39	.23	**.44**	.66	**.34**	.24	**.40**
Personal Service	.79	-.39	.15	-.18	.58	**.46**	-.14	**-.46**
Construction/Repair	.64	-.36	**.47**	-.34	.68	.16	-.20	**-.54**
Basic Services	.61	**.41**	.06	**-.47**	.82	-.36	-.18	-.10
Quality Control	.57	**-.44**	**.56**	-.20	.63	-.35	**-.59**	-.09
Manual Work	.68	.15	.05	**-.58**	.65	-.30	**-.54**	-.23
% of variance accounted for	38.3	18.8	14.3	9.0	37.8	20.2	14.1	8.7
Total			80.5				80.8	

Note. Correlations and saturation exceeding .40 are printed boldface.

Table 8
Congruence of factor structures of Tracey's 18 types of vocational interests obtained on Bulgarian and Serbian samples: Tucker's congruence coefficients

		Serbian sample			
		F1	F2	F3	F4
Bulgarian sample	F1	**1.00**	0.03	0.05	-0.01
	F2	-0.03	**0.98**	0.14	0.14
	F3	0.04	0.16	**-0.97**	-0.13
	F4	0.02	-0.12	-0.15	**0.97**

Discussion

Results of this study generally support the validity of both the hexagonal and spherical models of interests in the Bulgarian and Serbian samples of young adults. Although all the indices used to assess the fit of the two models showed numerically higher fit levels for the hexagonal then for the spherical models in both samples it should be noted that both complexity and comprehensiveness of these two models differ greatly making these fit indices effectively incomparable as indicators of comparative fit of models to the data. Having this in mind, these numerically better fit indices of the hexagonal model compared to the spherical replicate the results obtained in the previous studies with general population in Serbia (the hexagonal model CI=.93, the spherical model CI=.58; Hedrih, 2008), high school students in Ireland (the hexagonal model CI=.80, the spherical model CI=.58; Darcy, 2005) and college students in Japan (the hexagonal model CI=.69, the spherical model CI=.45; Tracey et al., 1997), the US (the hexagonal model CI=.89, the spherical model CI=.60; Tracey, 2002) Croatia (the hexagonal model CI=.89, the spherical model CI=.59; Šverko, 2008), China (the hexagonal model CI=.89, the spherical model CI=.53; Long et al., 2005) and Jamaica, Trinidad and Tobago (the hexagonal model CI=.97, the spherical model CI=.28; Wilkins et al., 2013) With regard to individual deviations of interest types from their positions in the hexagonal model, the highest in both samples was the deviation of the *Investigative* type. This is in accord with earlier findings of Šverko and Hedrih (2010) obtained on Serbian and Croatian samples using the PGI, which showed that the *Investigative* type shifted towards the center of the hexagonal model. It is possible that this is a real difference in the position of this type of interest in relation to other interests in the two countries. One possible explanation for the deviations of *Enterprising* and *Conventional* types on the Bulgarian sample could be that, during the second half of the 20th century, Bulgaria was a communist country and a member of the Warsaw pact with a corresponding Soviet style economic system and a more collectivism oriented culture. Contents and positions of at least some vocations differed in comparison to western style economies, and it is probable that vocations comprising these two types were in fact vocations where these east-west differences were the most pronounced. Although Bulgaria is an EU member state now with a western style economy and its culture is much more oriented towards individualism, it is possible that differences in the way people in Bulgaria perceive these vocations still persist to a certain extent. If this is the case, then it could be expected that in the future these deviations will diminish and ultimately disappear. The alternative option is that these deviations stem from some lasting properties of the Bulgarian culture and society, in which case, they should be replicable in future studies and should then be considered as indicating a real difference in the position of these types in these countries.

Relative to deviations of types of interests from their positions within the spherical model, most of the types of interests deviating from their predicted positions are the same in both samples (*Mechanical, Artistic, Helping, Financial*

Analysis, Personal Service, Construction/Repair and *Basic Services*). Relative to prestige three of these types are of medium prestige level, one type is from the upper hemisphere, a three types are situated in the lower hemisphere. When *Financial Analysis* type is in question, a possible explanation for the deviation is that vocations comprising this type are still new in these countries and not yet differentiated enough from those comprising the *Business Systems* type. Relative to the other types, it is possible that these deviations also represent true difference in positions of these types in the societies in question. In the lower hemisphere the largest deviation on the Bulgarian sample from position defined by the model is that of the *Manual Labor* type. Only slightly lower deviation is that of the *Construction/Repair* type. A possible explanation for these deviations might be the different prestige level that was associated with these types of vocations during the communist era in comparison to prestige level associated with these vocations in the West.

When comparing general fit levels of Bulgarian and Serbian data to predictions of the spherical model result show similar levels of fit, except when MDS procedure is used, which indicates a somewhat lower fit level in the Bulgarian sample.

For the six-type RIASEC scales, factor analysis revealed an underlying structure comprised of three components (*General Factor, People-Things* and *Data-Ideas*), just like Holland's model predicts. This three-dimensional solution was the same in the two samples, which was indicated by extremely high Tucker's congruence coefficients, and it explained 87% of variance. Factor analyses of the 18 interest types confirmed a four-dimensional solution (*General Factor, People-Things, Data-Ideas* and *Prestige*) postulated by Tracey's model. Again, the factor structures in the two samples were identical (Tucker's congruence coefficients were above .97) and accounted for 80% of the total amount of variance.

The main limitation of this study in its aim to provide insight into the generalizability of the spherical and hexagonal interest models to the population of Bulgaria comes from the structure of the sample which constituted of young people of above average education, i.e. all of the Bulgarian participants were university students. It might be the case that if the data were collected on a sample with less formal education and exposure to the global culture results would be somewhat different. Further research studies in this area could focus on examining the hexagonal and especially the spherical model predictions on other populations, ideally as dissimilar as possible in the effort to determine the level of applicability and generalizability of these models on humans as a whole.

Conclusion

Although analysis of deviations of individual interest types from their positions defined by the given model raised some concerns that should be addressed in the further research, we can conclude that the results of model evaluation generally support the structural validity of both hexagonal and

spherical model of relations between vocational interests, and that these results resemble those obtained in other countries.

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