Article

Preferred Interpersonal Distances: A Global Comparison

Journal of Cross-Cultural Psychology
2017, Vol. 48(4) 577–592

DOI: 10.1177/0022022117698039
journals.sagepub.com/home/jcc
SAGE

Agnieszka Sorokowska[1], Piotr Sorokowski[1], Peter Hilpert[2], Katarzyna Cantarero[3], Tomasz Frackowiak[1], Khodabakhsh Ahmadi[4], Ahmad M. Alghraibeh[5], Richmond Aryeetey[6], Anna Bertoni[7], Karim Bettache[8], Sheyla Blumen[9], Marta Błażejewska[1], Tiago Bortolini[10,11], Marina Butovskaya[12,13,14], Felipe Nalon Castro[15], Hakan Cetinkaya[16], Diana Cunha[17], Daniel David[18], Oana A. David[18], Fahd A. Dileym[5], Alejandra del Carmen Domínguez Espinosa[19], Silvia Donato[7], Daria Dronova[12], Seda Dural[20], Jitka Fialová[21], Maryanne Fisher[22], Evrim Gulbetekin[23], Aslıhan Hamamcıoğlu Akkaya[24], Ivana Hromatko[25], Raffaella Iafrate[7], Mariana Iesyp[26], Bawo James[27], Jelena Jaranovic[28], Feng Jiang[29], Charles Obadiah Kimamo[30], Grete Kjelvik[31], Fırat Koç[24], Amos Laar[6], Fívia de Araújo Lopes[15], Guillermo Macbeth[32], Nicole M. Marcano[33], Rocio Martinez[34], Norbert Mesko[35], Natalya Molodovskaya[1], Khadijeh Moradi[36], Zahrasadat Motahari[37], Alexandra Mühlhauser[38], Jean Carlos Natividade[39], Joseph Ntayi[40], Elisabeth Oberzaucher[38], Oluyinka Ojedokun[41], Mohd Sofian Bin Omar-Fauzee[42], Ike E. Onyishi[43], Anna Paluszak[1], Alda Portugal[17], Eugenia Razumiejczyk[32], Anu Realo[44,45], Ana Paula Relvas[17], Maria Rivas[46], Muhammad Rizwan[47], Svjetlana Salkičević[25], Ivan Sarmány-Schuller[48], Susanne Schmehl[38], Oksana Senyk[26], Charlotte Sinding[49], Eftychia Stamkou[50], Stanislava Stoyanova[51], Denisa Šukolová[52], Nina Sutresna[53], Meri Tadinac[25], Andero Teras[54], Edna Lúcia Tinoco Ponciano[55], Ritu Tripathi[56], Nachiketa Tripathi[57], Mamta Tripathi[57], Olja Uhryn[58], Maria Emília Yamamoto[15], Gyesook Yoo[59], and John D. Pierce , Jr.[33]

Abstract

Human spatial behavior has been the focus of hundreds of previous research studies. However, the conclusions and generalizability of previous studies on interpersonal distance preferences were limited by some important methodological and sampling issues. The objective of the present study was to compare preferred interpersonal distances across the world and to overcome the problems observed in previous studies. We present an extensive analysis of interpersonal distances over a large data set (N = 8,943 participants from 42 countries). We attempted to relate the preferred social, personal, and intimate distances observed in each country to a set of individual characteristics of the participants, and some attributes of their cultures. Our study indicates that individual characteristics (age and gender) influence interpersonal space preferences and that some variation in results can be explained by temperature in a given region. We also present objective values of preferred interpersonal distances in different regions, which might be used as a reference data point in future studies.

Keywords
interpersonal distance, spatial behavior, culture, cultural psychology

[1]University of Wroclaw, Poland
[2]University of Washington, Seattle, WA, USA
[3]SWPS University of Social Sciences and Humanities, Sopot, Poland
[4]Baqiyatallah University of Medical Sciences, Tehran, Iran
[5]King Saud University, Riyadh, Saudi Arabia
[6]University of Ghana, Legon, Ghana
[7]Catholic University of Milan, Italy
[8]The Chinese University of Hong Kong, Shatin, Hong Kong
[9]Pontificia Universidad Católica Del Perú, Lima, Peru
[10]Federal University of Rio de Janeiro, Brazil
[11]D'Or Institute for Research and Education, Rio de Janeiro, Brazil
[12]Institute of Ethnology and Anthropology RAS, Moscow, Russia
[13]Russian State University for the Humanities, Russia
[14]Moscow State University, Russia
[15]Federal University of Rio Grande do Norte, Natal, Brazil
[16]Ankara University, Turkey
[17]University of Coimbra, Portugal
[18]Babes-Bolyai University, Cluj-Napoca, Romania
[19]Universidad Iberoamericana Ciudad de Mexico, Mexico
[20]Izmir University of Economics, Izmir, Turkey
[21]Charles University, Prague, Czech Republic
[22]Saint Mary's University, Halifax, Nova Scotia, Canada
[23]Akdeniz University, Antalya, Turkey
[24]Cumhuriyet University, Sivas, Turkey
[25]University of Zagreb, Croatia
[26]Ivan Franko National University of Lviv, Ukraine
[27]Federal Neuro-Psychiatric Hospital, Benin City, Nigeria
[28]University of Belgrade, Serbia
[29]Central University of Finance and Economics, Beijing, China
[30]University of Nairobi, Kenya
[31]Norwegian University of Science and Technology, Trondheim, Norway
[32]National University of Entre Rios, Concepción del Uruguay, Argentina
[33]Philadelphia University, PA, USA
[34]University of Granada, Spain
[35]University of Pécs, Hungary
[36]Razi University, Kermanshah, Iran
[37]University of Science and Culture, Tehran, Iran
[38]University of Vienna, Austria
[39]Pontifical Catholic University of Rio de Janeiro, Brazil
[40]Makerere University Business School, Kampala, Uganda
[41]Adekunle Ajasin University, Akungba-Akoko, Nigeria
[42]Universiti Utara Malaysia, Sintok, Malaysia
[43]University of Nigeria, Nsukka, Nigeria
[44]University of Warwick, Coventry, UK
[45]University of Tartu, Estonia
[46]Universidad del Magdalena, Santa Marta, Colombia
[47]University of Karachi, Pakistan
[48]Constantine the Philosopher University in Nitra, Slovakia
[49]TU Dresden, Germany
[50]University of Amsterdam, The Netherlands
[51]South-West University "Neofit Rilski," Blagoevgrad, Bulgaria
[52]Matej Bel University in Banská Bystrica, Slovakia
[53]Universitas Pendidikan Indonesia, Bandung, Indonesia
[54]Mõttemaru OÜ, Tartu, Estonia
[55]Rio de Janeiro State University, Brazil
[56]Indian Institute of Management Bangalore, India
[57]Indian Institute of Technology Guwahati, India
[58]Lviv State University of Internal Affairs, Ukraine
[59]Kyung Hee University, Seoul, South Korea

Corresponding Author:
Agnieszka Sorokowska, Institute of Psychology, University of Wroclaw, ul. Dawida 1, 50-527 Wroclaw, Poland.
Email: sorokowska@gmail.com

Introduction

Interpersonal space, or interpersonal distance, is an essential feature of individuals' social behavior in relation to their physical environment and social interactions (Hall, 1966; Hayduk, 1983). It is a distance we maintain in interpersonal interactions, or in other words, "breathing space," an abstract area that surrounds each individual (Hall, 1966; Madanipour, 2003; Sommer, 1969), comparable with either a shell, a soap bubble, or aura (Sommer, 1969). According to Hall (1966), this space helps regulate intimacy in social situations by controlling sensory exposure. The possibility of increased visual, tactile, auditory, and olfactory stimulation is enhanced at closer distances, and people may feel intruded and react negatively when others adopt and maintain too close of an interpersonal distance (Felipe & Sommer, 1966; Hall, 1966; Mazur, 1977; Sawada, 2003; Smith, 1981; Sommer, 1969).

Classifying Social Distance

The classical proxemic theory (Hall, 1966) classifies interpersonal distance into four categories, each of which reflects a different relationship between individuals (Baldassare & Feller, 1975). These four types of distance are (a) *public distance* (above 210 cm; in this distance, voice shifts to higher volumes, and eye contact is minimized); (b) *social distance*, maintained during more formal interactions (122-210 cm, this distance precludes all but visual and auditory stimuli); (c) *personal distance*, maintained during interactions with friends (about 46-122 cm, vision is no longer blurred, vocalizations increase); and (d) *intimate distance*, maintained in close relationships (from 0 to 46 cm, this distance is characterized by poor and blurred vision, and increased perception of heat and olfactory stimuli; Hall, 1966).

Based on Hall's (1966) theory, the interpersonal distance people choose while interacting with others depends not only on the personal attitude toward another person but also on certain characteristics of dyads, like their gender or age, and the social environment where the interaction takes place. Indeed, studies confirm that the preferred interpersonal distance might be influenced by gender (Aiello, 1987; Horenstein & Downey, 2003; Ozdemir, 2008; Patterson & Edinger, 1987; Smith, 1981; Vranic, 2003). Furthermore, age seems to be an important factor for predicting dyad distances (Aiello, 1987; Burgess, 1983; Gérin-Lajoie, Richards, & McFadyen, 2006; Ozdemir, 2008; Rapp & Gutzmann, 2000; Webb & Weber, 2003); younger people generally prefer closer interpersonal distances than older individuals.

According to Hall's (1966) theory, *cultural norms* are the most important factors to describe the preferred social distance. Hall stated that what is intimate in one culture may be personal or social in another, and suggested that there are specific customs regarding the spatial behavior. He grouped the cultures into two different classes: *contact* and *noncontact* cultures. *Contact* cultures use closer interpersonal distances and engage in more touching, whereas people in *noncontact* cultures exhibit opposite preferences and behaviors (Hall, 1966). The general rule of grouping suggested by Hall was the geographic location, with Southern European, Latin American, and Arabian countries being the so-called *contact* cultures, and North America, Northern Europe, and Asian populations being the *noncontact* cultures (Hall, 1966). Although Hall's theory was frequently supported just by anecdotal evidence (see Baldassare & Feller, 1975), this notion constituted a basis for classical research on the cultural effects on human spatial behaviors. Below, we present a short overview of the previous findings and conclude with proposing some variables that could possibly account for previously observed variability.

Cultural Differences

Early cross-cultural research on spatial behaviors indicates that *contact* and *noncontact* groups differ significantly in preferred social distance. Studies show that Mediterranean societies prefer

closer interactive distances than Northern European and Northern American societies (Evans & Howard, 1973; Ford & Graves, 1977; Hayduk, 1983; Little, 1968; Triandis & Triandis, 1967; Watson & Graves, 1966). Notably, many of these early cross-cultural studies were performed in the United States with foreign and native students as participants (Baldassare & Feller, 1975). Although some results were later confirmed (Beaulieu, 2004; Evans, Lepore, & Allen, 2000; Remland, Jones, & Brinkman, 1995; Sommer, 2002), other empirical findings do not fully support the notion that interpersonal distances are closer in Southern European, Latin American, and Arab countries than in North America, Northern Europe, and Asian populations (Forston & Larson, 1968; Mazur, 1977; Remland et al., 1995). The original classification of Asian societies as predominantly *noncontact* is also problematic given the mixed results of previous studies (Beaulieu, 2004; Sussman & Rosenfeld, 1982; Watson, 1970). Furthermore, the spacing preferences in African countries have never been examined.

While showing variability of interpersonal distancing across cultures, previous results lack explanations as to why this variability occurs. It is an open question whether the division of cultures onto *contact*/*noncontact* based on geographical location is a detailed enough grouping rule for all populations across the globe, especially given that contact norms can vary widely across countries within the same continent even though they share cultural similarities (Shuter, 1976). It is likely that what has been explained in terms of vaguely defined cultural norms is underpinned by some psychological and ecological variables. Thus, we consider here several new variables that could be enumerated as distinguishing the countries that were previously found to be *contact* and *noncontact—environmental factors* (temperature of the inhabited region, parasite stress in a given country, and population growth rate) and *sociopsychological factors* (collectivism/individualism level, and wealth of the society, defined as Human Development Index [HDI]). We briefly justify our choices below.

Environmental factors. In the group of environmental factors, *temperature* may likely be related to the differences in cultural patterns of social proximity, as it was found to influence social distances during shorter interactions (IJzerman & Semin, 2010; Williams & Bargh, 2008; Zhong & Leonardelli, 2008). Hotter climate affects emotional intensity (Sorokowski, Sorokowska, Onyishi, & Szarota, 2013), which is likely related to intense and closer interpersonal contacts. Importantly, the hypothesized relationship of distance preferences and temperature might be associated with Hall's (1966) theory, as countries classified previously as *contact* cultures were also at the same time rather warm (see Sommer, 2002).

However, increased temperatures result in increased *parasite stress*. This relationship offers an alternative, competing hypothesis on temperature–distance association that would include the indirect effect temperature has on interpersonal distance. Many diseases can spread by a simple touch (Schweon, Edmonds, Kirk, Rowland, & Acosta, 2013), and a recent study showed that people were able to detect some infection cues in the body odor of others—this early innate immune response altered the pleasantness of body odor samples (Olsson et al., 2014). Reduction of interpersonal contacts or increasing the interpersonal distance has for centuries been a part of behavioral adaptation against epidemics (Fenichel, 2013), and in regions that have historically suffered from high levels of infectious diseases, people are indeed less extraverted and open (Schaller & Murray, 2008). Interpersonal distancing pattern might be thus another important factor in pathogen avoidance, as maintaining farther distance can decrease potential contamination risk. As regions of higher temperature typically suffer from higher parasite stress than regions of lower temperature, the increased parasite stress might indirectly lead to higher interpersonal distances in cultures of warmer climate.

Furthermore, maintaining too close interpersonal distance may result in increased arousal (Epstein & Karlin, 1975) and various forms of aggression and violence (see Regoeczi, 2008, for a review). It is therefore not surprising that social crowding produces avoidant response—this might be a way of avoiding conflicts (Worchel & Teddlie, 1976). Therefore, people

from countries of rapidly *increasing number of inhabitants* might be more likely to prefer farther interpersonal distances, thus reducing the risk for potential conflicts. Withdrawal response in such situations might be of particular importance in regions of higher temperature, as heat might increase aggression (Anderson, 1987) and social unrest (Yeeles, 2015).

Sociopsychological factors. In the group of social-psychological factors, regions characterized by closer interpersonal distances were rather poorer than regions characterized by farther preferred distances. The putative relationship of this variable to interpersonal distance is further suggested by the recent finding that the HDI was related to the level of social trust in a country (Özcan & Bjørnskov, 2011). We tested this observation by including HDI as one of the grouping variables in our study. Also, interpersonal distance might increase when interacting dyads differ in social status (Aiello & Jones, 1971; Dean, Willis, & Hewitt, 1975; Little, 1968). Possibly, in countries characterized with higher social inequality (i.e., lower HDI), the preferred distances might be greater.

Furthermore, the *Individualism–Collectivism* dimension (IC), first defined by Hofstede (1981), is one of the most important constructs used for the classification of cultures. People from collectivistic cultures rely to a considerable degree on close intragroup relationships, whereas people from individualistic cultures are highly independent and have strong feelings of autonomy within the group (Hofstede, 2001). In the present study, a 178-nation index of collectivism called ingroup favoritism from Van de Vliert (2011) study was utilized. Contrary to Hofstede's (2001) index, Van de Vliert index includes data on almost all countries around the world, which enabled us to analyze all the regions participating in our research.

Conclusion

In all, there is compelling evidence of cross-cultural variations in proxemic behaviors. Such differences might be underpinned by cultural norms, but at the same time, these norms could be associated with certain psychological and ecological variables. To replace previous speculations with solid empirical evidence, in the present study, we examined interpersonal distance preferences of 8,943 people inhabiting 53 study sites (42 countries) across the globe and across different social contexts. Given the exploratory nature of our empirical investigation, we are aware that at this stage of research, we cannot yet explain the exact mechanisms of influence of these variables on interpersonal distance preferences (although in the "Discussion" section, we speculate about the nature of relationship between the distance preferences and their significant predictors).

Hypotheses

Based on the prior assumption that people from different cultures differ in interpersonal distance preferences in different social contexts (social, personal, and intimate; Hall, 1966), we hypothesize significant variability in preferred interpersonal distances across countries when approaching a stranger (i.e., social distance), an acquaintance (i.e., personal distance), or a close person (i.e., intimate distance; Hypothesis 1). Second, consistent with numerous previous studies, we hypothesize that certain characteristics of interacting individuals, like gender or age, influence the preferences they have for interpersonal distance, with women and younger people maintaining closer interpersonal distances (Hypothesis 2). Third, we assume that cultural differences in interpersonal distancing are to some degree universally related to environmental and sociopsychological factors (Hypothesis 3). Based on earlier research and our assumptions, we hypothesize that some environmental and psychological factors could predict variability of interpersonal distance across countries. Lower population growth rate, higher ingroup favoritism, and higher HDI should be associated with closer interpersonal distance preferences. Furthermore, closer interpersonal distances should be observed in cultures of higher temperature, but it needs to be

remembered that higher temperature increments parasite stress. Thus, two competing hypotheses might be presented regarding the temperature and distance preferences. If the effect of temperature on personal distance preferences is direct, closer interpersonal distances should be observed in cultures of higher annual average temperature. If the effect of temperature is indirect, we expect the opposite association.

Materials and Methods

Participants

Our study was comprised of 8,943 participants (4,013 men, 4,887 women, and 43 unidentified) inhabiting 53 study sites in 42 countries. All participants provided informed consent prior to their inclusion in the study. In every country, authors recruited the participants personally. We intended to conduct our study among community members, and not students, with as diverse a sample of inhabitants as possible for each study site. Therefore, participants were recruited through advertisements, through personal contacts, in shopping malls, and so on; the recruitment methods were very similar across all study sites. All participants were specifically recruited for this study, and the study was conducted during the same time across all locations. The participants were ensured anonymity of their responses. Demographic characteristics of the samples, as well as a list of all study sites, are presented in Table 1.

Procedure

Participants completed a questionnaire consisting of demographic questions (age, sex) and three graphic questions concerning their preferred interpersonal distance. Based on the classical Hall's (1966) theory, we measured three separate categories of preferred interpersonal distances—distance to (a) a stranger, (b) an acquaintance, and (c) a close person. These measures reflected the previously defined categories of interpersonal distance: (a) social distance, (b) personal distance, and (c) intimate distance (Hall, 1966), respectively.

To conduct cross-cultural comparisons, the questions asked needed to be easily understood by participants all over the world (the task could not be demanding or ambiguous). Thus, we decided to use a simple, graphic task, because it was mostly language independent (see Figure 1). Answers were given on a distance (0-220 cm) scale anchored by two human-like figures, labeled A for the left one and B for the right one (Figure 1). Participants were asked to imagine that he or she is Person A. The participant was asked to rate how close a Person B could approach, so that he or she would feel comfortable in a conversation with Person B. The participants marked the distance at which Person B should stop on the scale below the figures. Details on the applied method can be found in Supplementary File 1. In every country, the participants completed paper-and-pencil questionnaires individually.

In addition to participants' report on gender and age, we analyzed country-specific environmental and sociopsychological factors: zoonotic and nonzoonotic parasite stress in a given region (Fincher & Thornhill, 2012), population growth rate (United Nations report, 2015), ingroup favoritism (Van de Vliert, 2011), average, yearly temperature in a given study site (provided by coauthors from given study sites), and the HDI (Human Development Report, 2013; http://hdr.undp.org).

Statistical Analyses

Our hypotheses focused on the general assumption that people across different cultures universally vary in the distances they prefer when interacting with others. The presented analyses aimed to explain the cultural similarities and variability. In the current sample, participants were nested

Table 1. Demographic Characteristics for Each of the 42 Countries Included in the Study.

	Sample size			Age	
Country	Total	Men	Women	*M* (*SD*)	Range
Argentina	201	71	130	32.31 (11.16)	18-72
Austria	200	115	85	26.59 (9.73)	17-65
Brazil	480	300	180	36.51 (10.35)	19-70
Bulgaria	102	63	39	38.35 (8.95)	21-59
Canada	68	25	43	38.43 (10.15)	24-62
China	119	47	72	33.09 (6.41)	22-58
Colombia	100	41	59	41.10 (11.81)	21-74
Croatia	614	301	313	44.75 (11.65)	19-83
Czech Republic	167	80	87	36.48 (15.93)	18-79
Estonia	149	50	96	42.93 (12.30)	20-74
Germany	154	62	92	31.59 (13.39)	18-74
Ghana	103	52	51	40.42 (9.53)	23-65
Greece	94	42	49	38.77 (9.07)	20-71
Hong Kong	100	54	40	47.09 (9.98)	20-72
Hungary	237	76	161	37.80 (9.56)	19-62
India	299	135	164	34.10 (7.99)	20-73
Indonesia	92	25	67	41.74 (9.90)	23-66
Iran	607	261	345	38.80 (10.87)	18-88
Italy	322	127	195	48.39 (11.06)	20-86
Kazakhstan	120	60	60	37.03 (8.18)	21-61
Kenya	94	47	47	32.30 (7.26)	20-50
Malaysia	99	49	50	40.03 (8.92)	26-62
Mexico	158	77	80	38.81 (11.24)	19-77
Nigeria	603	299	297	39.00 (9.06)	18-70
Norway	100	72	28	41.29 (13.51)	22-77
Pakistan	125	55	66	36.17 (10.33)	20-69
Peru	102	49	53	31.66 (10.49)	20-58
Poland	428	161	254	40.07 (11.66)	20-87
Portugal	293	99	181	46.04 (11.17)	18-81
Romania	56	8	48	34.98 (6.68)	25-51
Russia	224	120	104	38.61 (13.86)	19-87
Saudi Arabia	198	87	111	36.16 (8.31)	22-70
Serbia	105	19	86	24.96 (7.01)	20-56
Slovakia	233	76	157	42.76 (11.74)	22-72
South Korea	100	50	50	41.76 (7.74)	27-59
Spain	199	93	106	47.10 (9.36)	24-67
Switzerland	179	110	69	48.77 (12.87)	21-75
Turkey	391	238	153	42.70 (13.59)	20-83
The United Kingdom	100	42	58	45.04 (11.57)	20-78
Uganda	93	56	35	34.89 (10.55)	17-72
Ukraine	311	66	245	29.20 (8.73)	18-61
The United States	424	153	271	41.74 (15.62)	18-83
Total	8,943	4,013	4,887	39.26 (12.25)	17-88

within countries and, therefore, we used multilevel modeling (Raudenbush & Bryk, 2002). To test the first hypothesis about variability in interpersonal distance across cultures, we used a

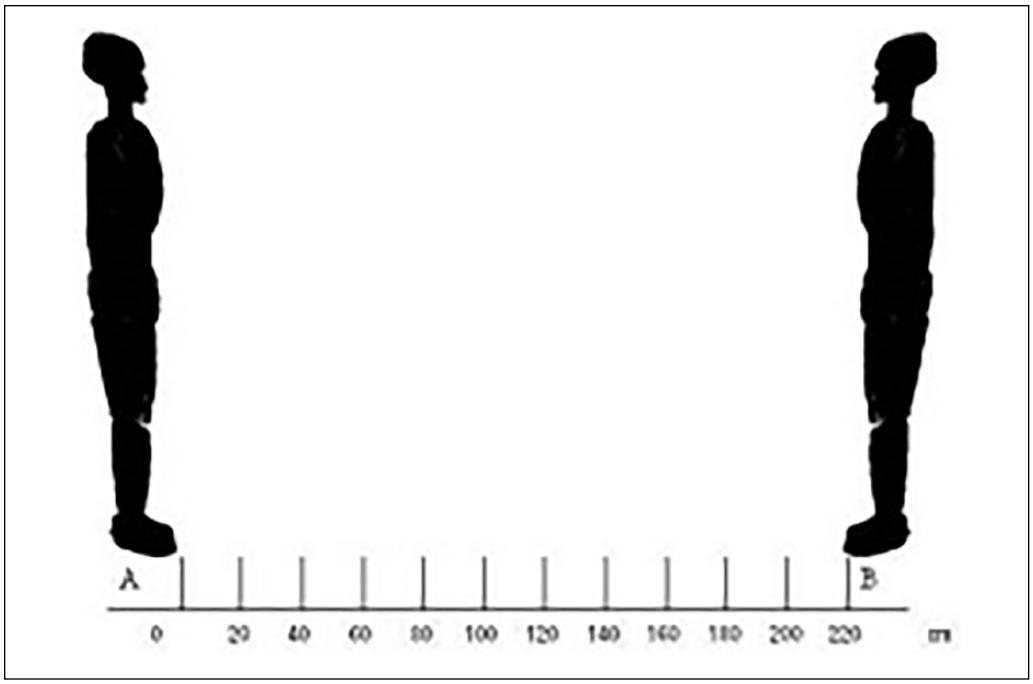

Figure 1. Graphic of distance shown to participants.

stepwise approach. First, we computed three null models for social, personal, and intimate interpersonal distance, respectively (see Supplementary File 1 for details of the models). To test significant differences of interpersonal distance across countries, we used a graphical method developed by Goldstein and Healy (1995), which allows comparing large groups of means simultaneously (see Supplementary File 1 for details of the method). Significant difference is suggested when the confidence intervals of two countries do not overlap.

To test our second hypothesis of predicting the variability in interpersonal distance across countries, we computed three models (for social distance, personal distance, and intimate distance) including all predictors discussed in the "Introduction" section in the three multilevel models (see Supplementary File 1 for details of the models).

We used SPSS 19 for descriptive statistics. For multilevel modeling, we used the lme4 package (Bates, Maechler, Bolker, & Walker, 2014) in R Version 3.0.2 (R Core Team, 2014). To find the best fitting model, we followed Zuur, Ieno, Walker, Saveliev, and Smith's (2009) suggestion to compare the inclusion of different random and fixed effects by deviance tests.

Results

Supplementary Table S1 shows means and standard deviations of each type of interpersonal distance for each sample. Overall, average interpersonal distance differed across various types of distance (social distance, personal distance, intimate distance; $M_{\text{social}} = 135.1$ cm; $M_{\text{personal}} = 91.7$ cm; $M_{\text{intimate}} = 31.9$ cm), supporting prior findings.

Variability of Interpersonal Distance Across Countries

We hypothesized that people differ in their preferred interpersonal distance across countries. Figure 2 shows the results of the graphical mean comparison across all 42 countries for

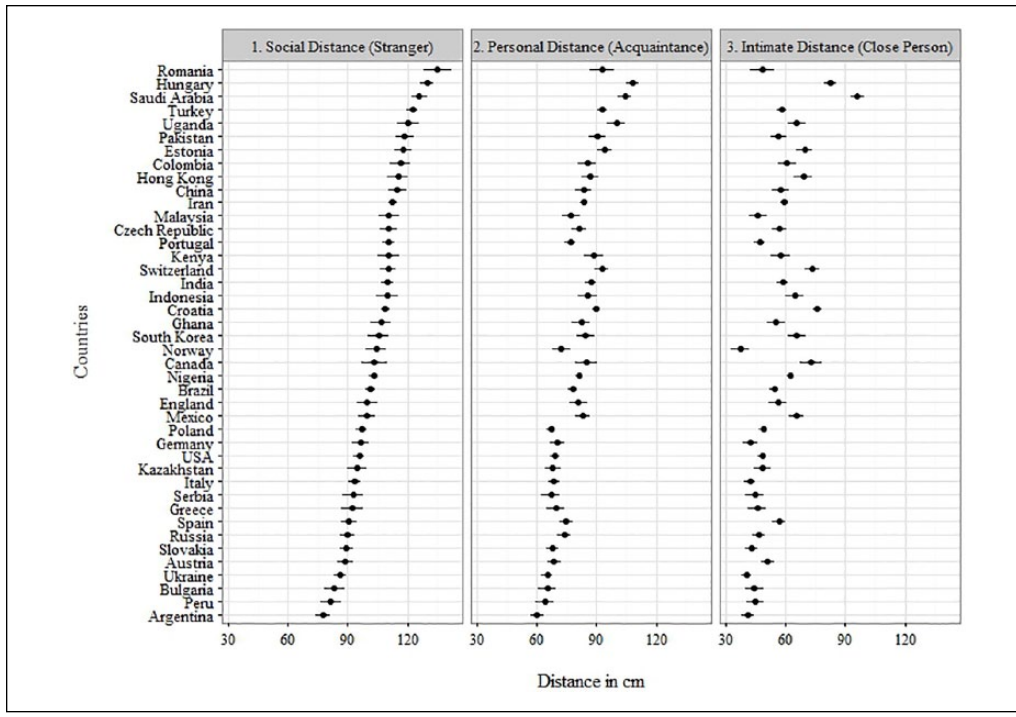

Figure 2. Mean values (cm) of social, personal, and intimate distance across all nations.
Note. Nonoverlap of the confidence intervals between any two countries indicates significant mean differences. Means for interpersonal distance with strangers are rank ordered.

interpersonal distance with strangers, acquaintances, and partner (i.e., social distance, personal distance, intimate distance). Inspecting the mean comparisons in Figure 2 shows significant variability in interpersonal distance across countries for different social interactions, supporting Hypothesis 1. In addition, as means for social distance are rank ordered, the order for personal and intimate distances provides insights in distance preferences pattern in relation to distance with strangers. The order for preferred personal distance indicates that the variability of this distance is in similar rank, whereas the social distance in a country is less predictive for the preferred intimate distance. This result is additionally confirmed by the inter-correlations between certain distance types. Pearson's r correlations showed high correlations of social and personal distance ($r = .69$) and personal and intimate distance ($r = .70$); the correlation between social and intimate distance was significant as well ($r = .38$), but not equally high as in the other cases.

Factors Predicting Variability in Interpersonal Distance Across Countries

We assumed certain environmental and psychological predictors of interpersonal distance across countries. Results of the three multilevel models are shown in Table 2.

We found that the variability of social distance across cultures was predicted by temperature ($\beta_1 = -.82$; $p = .01$) and gender ($\beta_8 = 3.67$; $p = .04$). The higher the annual temperature of a country, the closer was the preferred distance to strangers. Furthermore, women on average preferred to maintain greater distance with strangers. The result for personal distance show that age ($\beta_7 = .08$; $p = .01$) and gender ($\beta_8 = 2.65$; $p = .03$) predicted the variability, suggesting that older people preferred greater distance and, again, women preferred greater distance with acquaintances. Finally, the results show that the intimate distance is predicted by age ($\beta_7 = .08$; $p = .02$) and temperature ($\beta_1 = 1.27$; $p < .001$). This indicates that older people preferred greater

Table 2. Parameter Estimates for Multilevel Model.

Fixed effects (intercept, slope)	Preferred interpersonal distance											
	Social distance (stranger)				Personal distance (acquaintance)				Intimate distance (close person)			
	Estimate	*SE*	*t*	*p*	Estimate	*SE*	*t*	*p*	Estimate	*SE*	*t*	*p*
Intercept	**135.14**	26.96	5.0	.000	**91.72**	21.43	4.28	.000	31.85	24.66	1.29	.205
Slopes												
Age	0.03	0.04	0.81	.418	**0.08**	0.03	2.55	**.011**	**0.08**	0.03	2.39	**.017**
Gender	**3.67**	1.69	2.17	**.037**	**2.65**	1.19	2.23	**.034**	0.11	0.82	0.13	.895
Ingroup favoritism	0.26	4.20	0.06	.952	−1.22	3.33	−0.37	.716	−0.84	3.84	−0.22	.827
HDI	−34.13	32.37	−1.05	.299	−27.96	25.71	−1.09	.284	0.36	29.75	0.01	.999
Nonzoonotic	1.07	2.48	0.43	.669	−0.98	1.99	−0.45	.653	−3.26	2.25	−1.45	.156
Zoonotic	−3.86	3.28	−1.18	.248	−1.69	2.61	−0.64	.527	0.44	2.99	0.15	.884
Temperature	**−0.82**	0.33	−2.46	**.015**	0.08	0.28	0.29	.773	**1.27**	0.29	4.37	**.000**
Population growth	5.18	4.15	1.25	.220	3.73	3.30	1.13	.265	2.25	3.80	0.59	.558

Note. Significant estimates are in bold (*p* values are two-tailed). *N* = 8,943. HDI = Human Development Index.

physical distance to people they considered close, whereas the effect of temperature was reversed in comparison with interpersonal distance with strangers—the higher the annual temperature of a country, the greater was the preferred personal distance to a close person. Figure 3 illustrates the three types of preferred distances with regard to participants' gender and age.

Discussion

Owing to the quality and quantity of the data collected so far on the topic of cultural differences in proxemic behaviors, it was necessary and desirable to update the questionnaires and variables measured to erase the bias observed in previous studies. We present here an analysis of interpersonal distance preferences over a large data set (8,943 participants from 42 countries). As hypothesized, we observed significant variability in social, personal, and intimate distances across countries. Variability in preferred social distance was predicted by participants' gender and county's average temperature, indicating that women and people in colder countries prefer greater distance toward strangers. Furthermore, the variability of preferred personal distance was predicted by participants' age and gender; older people and women prefer greater distance to an acquaintance. Finally, variability of intimate distance was explained by age and temperature, indicating that older people and people in warmer countries prefer greater distance with people they consider close.

Compared with previous studies, the present design had six distinctive features: (a) our study involved a large-scale analysis among thousands of people; (b) all the participants answered the same questionnaire illustrated with graphic representation of interpersonal distance; (c) all the participants took part in the study in the same year (2013); (d) samples of populations were heterogeneous in terms of age, sex, and professions; (e) we considered five different regions of the world, also Africa, which was not included from previous analyses; and (f) we examined several environmental and sociopsychological variables that possibly could explain the variability in social distance. We also present up-to-date values of three categories of preferred interpersonal distances in different regions, which might be used as a reference data point in future studies. This data set is especially important given that cross-cultural comparison studies are becoming more popular in social sciences.

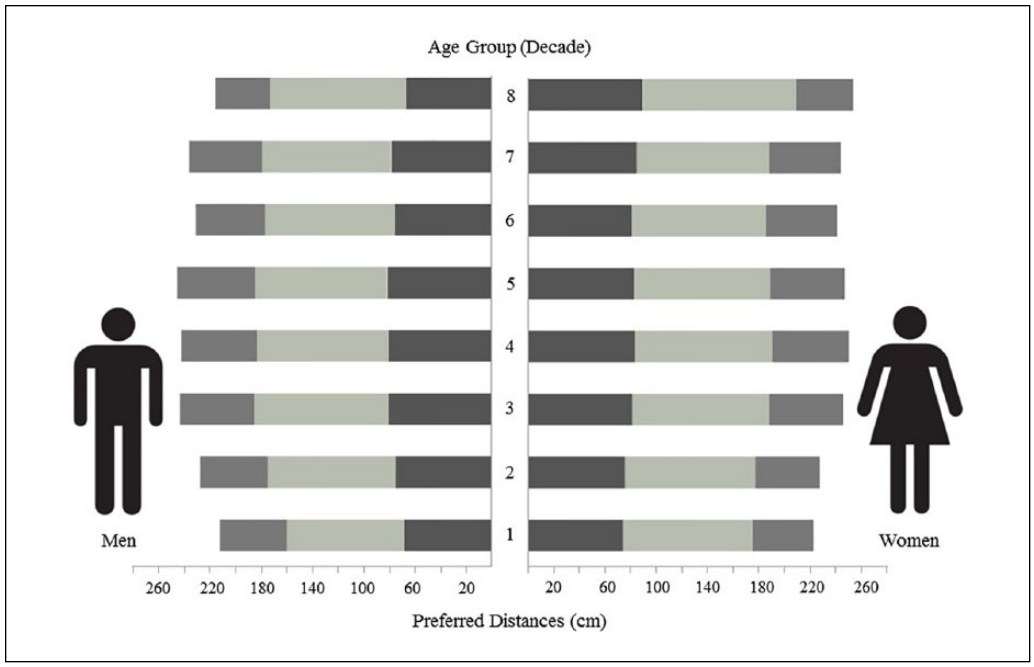

Figure 3. Mean values (cm) of social (gray), personal (light gray), and intimate distance (dark gray) for men and women in different age groups summed for all nations.

Cultural Differences in Proxemic Behaviors

Among *environmental factors*, our results regarding temperature are consistent with findings showing that climatic demands interact with wealth resources in influencing a variety of cultural tendencies (Fischer & Van de Vliert, 2011; Van de Vliert, 2013; Van de Vliert, Schwartz, Huismans, Hofstede, & Daan, 1999). However, we observed a meaningful association between distance preferences and mean temperature, without distinguishing between demanding winter cold and demanding summer heat. Thus, our results and previous research (Van de Vliert et al., 1999) suggest that the unipolar, mean temperature might be a reasonable predictor of some psychological variables that could be used instead, or in addition to the climatic demand variable (Fischer & Van de Vliert, 2011; Van de Vliert, 2013), depending on the hypotheses and study aims.

It is worth noticing that in our study, the direction of temperature effect differed for social and intimate distance. In warmer countries, people preferred to maintain closer distances toward strangers—but farther toward the intimate partners. The result regarding closer distance in hotter climates is consistent with the literature. IJzerman and Semin (2010) showed that compared with colder conditions, warmer conditions induced greater social proximity; even within the United States, people in warm latitudes were shown to exhibit a closer contact behavior with more touch than their counterparts in colder climates (Andersen, 1988). IJzerman and Semin (2010) explained their findings in the context of Lakoff and Johnson's (1999) embodied realism, that is, grounding the abstract idea (in this case—warmer feelings) in the physical situation (warmer temperature). Relatedly, other studies showed that social exclusion induces perceptions of lower temperature (Zhong & Leonardelli, 2008), and physical proximity of other people induce perceptions of higher temperature (IJzerman & Semin, 2010). However, in the case of intimate distance, the result of our study differed from those obtained previously. Perhaps, this outcome resulted from specificity of distancing preferences in colder

(and not in hotter) countries. Although both heat and cold are demanding environmental conditions (Fischer & Van de Vliert, 2011), it is possible that some negative effects of colder climate can be alleviated through closer intimate distances. Another explanation could be that although the increased temperatures might directly lead to smaller social distances, augmented parasite prevalence in hotter climates might also indirectly affect distance preferences in close relationships by increased risk of certain infections.

Overall, we found no direct effect of cultural-level parasitic stress (zoonotic and nonzoonotic parasite stress; Fincher & Thornhill, 2012), which seems particularly interesting, given that evolved disease-avoidance mechanisms and contemporary social cognition are indeed related (Faulkner, Schaller, Park, & Duncan, 2004). Therefore, perhaps other health-related variables would provide a better fit to our model, for example, prevalence of different infectious diseases. Also, the parasitic threat could play a more important role in real dyad behavior while being unrelated to preferences. Finally, as discussed above, it is probable that parasitic diseases would be good predictors of interpersonal distances as long as the strong, direct impact of temperatures was excluded. This hypothesis is consistent with previous research, showing that interactive impacts of climatic demands and income resources alleviate any effects parasitic stress might have on culture (Van de Vliert & Postmes, 2012).

In the group of *sociopsychological* factors, significant fixed effects revealed gender differences in preferred social and personal distance, with women generally preferring greater distances. However, the random effects showed in more detail that gender effect was especially pronounced in Switzerland, Malaysia, Saudi Arabia, Hong Kong, Brazil, Austria, and India for social distance, and Switzerland, Malaysia, China, Saudi Arabia, Brazil, Poland, and Nigeria for personal distance. As our study is a preliminary exploration of possible, cross-cultural determinants of preferred distances, it is hard to present any definite explanations of such findings. Generally, enforcing closer proximinity during dyad interactions conveys higher dominance (Burgoon, 1991). Dominance is typically related to male psychological characteristics, and behaviors consistent with such stereotype might be especially strong in some cultures. In addition, women in some cultures can be more sensitive to social situations and avoid dominant "invasions" of personal space of people they are not highly familiar with. This explanation would be consistent with the notion that the interpersonal distance people choose depends also on the degree of understanding of a social situation, that is, familiarity with social norms (Bogardus, 1954). Also, our findings might be partially due to the methodology used in our study—we did not specify the sex of an approaching individual, and it is possible that interaction distances might differ depending on the assumed sex of interlocutor.

Still, it needs to be remembered that higher distances preferred by women are inconsistent with most previous studies (Aiello, 1987; Horenstein & Downey, 2003; Ozdemir, 2008; Patterson & Edinger, 1987; Smith, 1981; Vranic, 2003), suggesting that women rather prefer closer interpersonal distances than men (but see Heshka & Nelson, 1972). There are some possible reasons as to why these differences emerged. First, many of the previous studies were conducted many years ago, and maybe the social norms related to dyadic interactions in these times were different than they are now. Furthermore, the differences may reflect the marked increase in globalization and increased internationalization over the last several decades. Finally, it is also unclear whether most previous findings refer to distances between strangers, acquaintances, or close persons (e.g., Gérin-Lajoie et al., 2006; Ozdemir, 2008; Smith, 1981; Webb & Weber, 2003). Perhaps the observed discrepancies result from a simple fact that in our study, the specified context influenced the declarations of participating men and women.

We also observed that age was a significant predictor of personal and intimate distance. As discussed in the introduction, our findings are consistent with previously observed outcomes (Aiello, 1987; Burgess, 1983; Gérin-Lajoie et al., 2006; Rapp & Gutzmann, 2000; Webb & Weber, 2003). Overall, younger people are more likely to engage in physical contact with others

(Rands & Levinger, 1979). Possibly, this result could be explained with changes in social norms across generations.

Limitations and Future Directions

Although the distinction proposed in our study provides a novel alternative for previous, geographic division on *contact* versus *noncontact* cultures, and the presented data might stimulate new research on proxemic behaviors, there exist some limitations of our findings.

First, perhaps, other variables, not analyzed in the current study, could also explain the interpersonal distance preferences. To create better and more exact models, future studies should include more predicting variables of various categories, including different individual-level variables, for example, height of interacting individuals, or their disease susceptibility.

Second, we concentrated on preferences for interpersonal distance and not on real choices. These two might be different, as shown, for example, by studies regarding mate preferences and mate choices (Sorokowski, Sabiniewicz, & Sorokowska, 2015; Todd, Penke, Fasolo, & Lenton, 2007). However, some of our findings are consistent with results of experimental studies regarding real dyadic interactions (Borisova & Butovskaya, 2004). Nevertheless, further studies should experimentally test the findings of our research.

Third, in our study, we measured distance preferences across three predefined categories of interpersonal distance (stranger, acquaintance, and a close person). It needs to be mentioned that descriptors of these categories ("a close relationship") could evoke some spatial associations ("close distance"). Also, simultaneous assessment of three types of distance could result in responses being slightly interdependent. Researchers in future works could control this factor by separating answer sheets for distance categories by some unrelated tasks, or by using a between-subject design, with each participant in each country assessing his or her preferences for one type of distance only.

Finally and ideally, in future studies, it could be tested how reliably the sample like ours represents the interpersonal distancing phenomena on a global level. Such an approach would allow researchers to be more precise in estimating generalizability of the findings. Still, in the case of our research, the participating sample represents many nations and the observed findings should be a close proxy of global preferences for interpersonal distances.

Acknowledgments

The authors thank Chinwe Frances Inogbo, Regina Cejudo de la Sierra, Maria Fernanda Morales Perez, Barbara Baranyai, Adrienn Bálint, Gabriella Kuch, Tímea Kiss, Emese Kozma, Margaréta Nagy, Zsófia Magyar, and Éva Virág for their help with data collection; they also thank Professors Corey L. Fincher and Randy Thornhill for kindly permitting them to use their data on parasite stress.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Czech Science Foundation GAČR P407/16/03899S grant to Jitka Fialová, Polish Ministry of Science and Higher Education: Iuventus Plus grant #IP2014 043773 and Scholarship to Agnieszka Sorokowska for years 2013-2016, Scholarships to Piotr Sorokowski for years 2012-2017, Polish National Science Centre ETIUDA scholarship #2013/08/T/HS6/00408 to Agnieszka Sorokowska, Deanship of Scientific Research at King Saud University Support to Ahmad M. Alghraibeh, and Grant Agency of Czech Republic GAUK 918214 grant to Jitka Fialová.

Supplemental Material

The supplementary materials can be accessed at http://journals.sagepub.com/doi/suppl/10.1177/0022022117698039.

References

Aiello, J. R. (1987). Human spatial behavior. In D. Stokols & I. Altman (Eds.), *Handbook of environmental psychology* (pp. 389-504). New York, NY: Wiley.

Aiello, J. R., & Jones, S. E. (1971). Field study of the proxemic behavior of young school children in three subcultural groups. *Journal of Personality and Social Psychology*, *19*, 351-356.

Andersen, P. (1988). Explaining intercultural differences in nonverbal communication. In L. A. Samovar & R. E. Porter (Eds.), *Intercultural communication: A reader* (5th ed., pp. 272-281). Belmont, CA: Wadsworth.

Anderson, C. A. (1987). Temperature and aggression: Effects on quarterly, yearly, and city rates of violent and nonviolent crime. *Journal of Personality and Social Psychology*, *52*, 1161-1173.

Baldassare, M., & Feller, S. (1975). Cultural variations in personal space. *Ethos*, *3*, 481-503.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2014). Package lme4: Linear mixed-effects models using Eigen and S4. *Journal od Statistical Software*, *67*, 1-48.

Beaulieu, C. (2004). Intercultural study of personal space: A case study. *Journal of Applied Social Psychology*, *34*, 794-805.

Bogardus, E. (1954). *Sociology*. New York, NY: Macmillan.

Borisova, L. V., & Butovskaya, M. L. (2004). Spatial behavior in modern Russian urban culture: Age and gender factors. In M. L. Butovskaya (Ed.), *Human ethology: Modern quantitative methods* (pp. 13-20). Moscow, Russia: Russian State University for Humanities.

Burgess, J. W. (1983). Interpersonal spacing behavior between surrounding nearest neighbors reflects both familiarity and environmental density. *Ethology and Sociobiology*, *4*, 11-17.

Burgoon, J. K. (1991). Relational message interpretations of touch, conversational distance, and posture. *Journal of Nonverbal Behavior*, *15*, 233-259.

Dean, L. M., Willis, F. N., & Hewitt, J. (1975). Initial interaction distance among individuals equal and unequal in military rank. *Journal of Personality and Social Psychology*, *32*, 294-299.

Epstein, Y. M., & Karlin, R. A. (1975). Effects of acute experimental crowding. *Journal of Applied Social Psychology*, *5*, 34-53.

Evans, G. W., & Howard, R. B. (1973). Personal space. *Psychological Bulletin*, *80*, 334-344.

Evans, G. W., Lepore, S. J., & Allen, K. M. (2000). Cross-cultural differences in tolerance for crowding: Fact or fiction? *Journal of Personality and Social Psychology*, *79*, 204-210.

Faulkner, J., Schaller, M., Park, J. H., & Duncan, L. A. (2004). Evolved disease-avoidance mechanisms and contemporary xenophobic attitudes. *Group Processes & Intergroup Relations*, *7*, 333-353.

Felipe, N. J., & Sommer, R. (1966). Invasions of personal space. *Social Problems*, *14*, 206-214.

Fenichel, E. P. (2013). Economic considerations for social distancing and behavioral based policies during an epidemic. *Journal of Health Economics*, *32*, 440-451.

Fincher, C. L., & Thornhill, R. (2012). Parasite-stress promotes in-group assortative sociality: The cases of strong family ties and heightened religiosity. *Behavioral & Brain Sciences*, *35*, 61-79.

Fischer, R., & Van de Vliert, E. (2011). Does climate undermine subjective well-being? A 58-nation study. *Personality and Social Psychology Bulletin*, *37*, 1031-1041.

Ford, J. G., & Graves, J. R. (1977). Differences between Mexican-American and White children in interpersonal distance and social touching. *Perceptual and Motor Skills*, *45*, 779-785.

Forston, R. F., & Larson, C. U. (1968). The dynamics of space: An experimental study in proxemic behavior among Latin Americans and North Americans. *Journal of Communication*, *18*, 109-116.

Gérin-Lajoie, M., Richards, C. L., & McFadyen, B. J. (2006). The circumvention of obstacles during walking in different environmental contexts: A comparison between older and younger adults. *Gait & Posture*, *24*, 364-369.

Goldstein, H., & Healy, M. J. (1995). The graphical presentation of a collection of means. *Journal of the Royal Statistical Society,. Series A (Statistics in Society)*, *158*, 175-177.

Hall, E. T. (1966). *The hidden dimension*. New York, NY: Doubleday.

Hayduk, L. A. (1983). Personal space: Where we now stand. *Psychological Bulletin*, *94*, 293-335.
Heshka, S., & Nelson, Y. (1972). Interpersonal speaking distance as a function of age, sex, and relationship. *Sociometry*, *35*, 491-498.
Hofstede, G. (1981). Culture and organizations. *International Studies of Management and Organizations*, *10*, 15-41.
Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions and organizations across nations*. Thousands Oaks, CA: Sage.
Horenstein, V. D. P., & Downey, J. L. (2003). A cross-cultural investigation of self-disclosure. *North American Journal of Psychology*, *5*, 373-386.
Human Development Report. (2013). Retrieved from http://hdr.undp.org/sites/default/files/reports/14/hdr2013_en_complete.pdf
IJzerman, H., & Semin, G. R. (2010). Temperature perceptions as a ground for social proximity. *Journal of Experimental Social Psychology*, *46*, 867-873.
Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh: The embodied mind and its challenge to western thought*. New York, NY: Basic Books.
Little, K. B. (1968). Cultural variations in social schemata. *Journal of Personality and Social Psychology*, *10*, 1-7.
Mazur, A. (1977). Interpersonal spacing on public benches in "contact" vs. "noncontact" cultures. *The Journal of Social Psychology*, *101*, 53-58.
Madanipour, A. (2003). *Public and private spaces of the city*. London, England: Routledge.
Olsson, M. J., Lundström, J. N., Kimball, B. A., Gordon, A. R., Karshikoff, B., Hosseini, N., & Lekander, M. (2014). The scent of disease human body odor contains an early chemosensory cue of sickness. *Psychological Science*, *25*, 817-823.
Özcan, B., & Bjørnskov, C. (2011). Social trust and human development. *The Journal of Socio-Economics*, *40*, 753-762.
Ozdemir, A. (2008). Shopping malls: Measuring interpersonal distance under changing conditions and across cultures. *Field Methods*, *20*, 226-248.
Patterson, M. L., & Edinger, J. A. (1987). A functional analysis of space in social interaction. In A. W. Siegman & S. Feldstein (Eds.), *Nonverbal behavior and communication* (pp. 523-562). Mahwah, NJ: Lawrence Erlbaum Associates.
Rands, M., & Levinger, G. (1979). Implicit theories of relationship: An intergenerational study. *Journal of Personality and Social Psychology*, *37*, 645-661.
Rapp, M. A., & Gutzmann, H. (2000). Invasions of personal space in demented and nondemented elderly persons. *International Psychogeriatrics*, *12*, 345-352.
Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. Thousand Oaks, CA: Sage.
R Core Team. (2014). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Available from http://www.R-project.org/
Regoeczi, W. C. (2008). Crowding in context: An examination of the differential responses of men and women to high-density living environments. *Journal of Health and Social Behavior*, *49*, 254-268.
Remland, M. S., Jones, T. S., & Brinkman, H. (1995). Interpersonal distance, body orientation, and touch: Effects of culture, gender, and age. *The Journal of Social Psychology*, *135*, 281-297.
Sawada, Y. (2003). Blood pressure and heart rate responses to an intrusion on personal space. *Japanese Psychological Research*, *45*, 115-121.
Schaller, M., & Murray, D. R. (2008). Pathogens, personality, and culture: Disease prevalence predicts worldwide variability in sociosexuality, extraversion, and openness to experience. *Journal of Personality and Social Psychology*, *95*, 212-221.
Schweon, S. J., Edmonds, S. L., Kirk, J., Rowland, D. Y., & Acosta, C. (2013). Effectiveness of a comprehensive hand hygiene program for reduction of infection rates in a long-term care facility. *American Journal of Infection Control*, *41*, 39-44.
Shuter, P. (1976). Proxemics and tactility in Latin America. *Journal of Communication*, *26*, 46-52.
Smith, H. W. (1981). Territorial spacing on a beach revisited: A cross-national exploration. *Social Psychology Quarterly*, *44*, 132-137.
Sommer, R. (1969). *Personal space: The behavioral basis of design*. Englewood Cliffs, NJ: Prentice Hall.

Sommer, R. (2002). Personal space in a digital age. In R. B. Bechtel & A. Churchman (Eds.), *Handbook of environmental psychology* (pp. 647-660). New York, NY: John Wiley.

Sorokowski, P., Sabiniewicz, A., & Sorokowska, A. (2015). The impact of dominance on partner's height preferences and height-related mate choices. *Personality and Individual Differences*, *74*, 220-224.

Sorokowski, P., Sorokowska, A., Onyishi, I. E., & Szarota, P. (2013). Montesquieu hypothesis and football: Players from hot countries are more expressive after scoring a goal. *Polish Psychological Bulletin*, *44*, 421-430.

Sussman, N. M., & Rosenfeld, H. M. (1982). Influence of culture, language, and sex on conversational distance. *Journal of Personality and Social Psychology*, *42*, 66-74.

Todd, P. M., Penke, L., Fasolo, B., & Lenton, A. P. (2007). Different cognitive processes underlie human mate choices and mate preferences. *Proceedings of the National Academy of Sciences*, *104*, 15011-15016.

Triandis, H., & Triandis, L. (1967). Some studies of social distance. In M. Fishbein (Ed.), *Readings in attitude theory and measurement* (pp. 199-206). New York, NY: John Wiley.

United Nations Report. (2015). *Population division*. Retrieved from http://esa.un.org/unpd/wpp/Excel-Data/population.htm

Van de Vliert, E. (2011). Climato-economic origins of variation in ingroup favoritism. *Journal of Cross-Cultural Psychology*, *42*, 494-515.

Van de Vliert, E. (2013). Climato-economic habitats support patterns of human needs, stresses, and freedoms. *Behavioral & Brain Sciences*, *36*, 465-480.

Van de Vliert, E., & Postmes, T. (2012). Climato-economic livability predicts societal collectivism and political autocracy better than parasitic stress does. *Behavioral & Brain Sciences*, *35*, 94-95.

Van de Vliert, E., Schwartz, S. H., Huismans, S. E., Hofstede, G., & Daan, S. (1999). Temperature, cultural masculinity, and domestic political violence. A cross-national study. *Journal of Cross-Cultural Psychology*, *30*, 291-314.

Vranic, A. (2003). Personal space in physically abused children. *Environment & Behavior*, *35*, 550-565.

Watson, O. M. (1970). *Proxemic behavior: A cross-cultural study*. The Hague, The Netherlands: Mouton.

Watson, O. M., & Graves, T. D. (1966). Quantitative research in proxemic behavior. *American Anthropologist*, *68*, 971-985.

Webb, J. D., & Weber, M. J. (2003). Influence of sensory abilities on the interpersonal distance of the elderly. *Environment & Behavior*, *35*, 695-711.

Williams, L. E., & Bargh, J. A. (2008). Experiencing physical warmth promotes interpersonal warmth. *Science*, *322*, 606-607.

Worchel, S., & Teddlie, C. (1976). The experience of crowding: A two-factor theory. *Journal of Personality and Social Psychology*, *34*, 30-40.

Yeeles, A. (2015). Weathering unrest: The ecology of urban social disturbances in Africa and Asia. *Journal of Peace Research*, *52*, 158-170.

Zhong, C. B., & Leonardelli, G. J. (2008). Cold and lonely does social exclusion literally feel cold? *Psychological Science*, *19*, 838-842.

Zuur, A. F., Ieno, E. N., Walker, N., Saveliev, A. A., & Smith, G. M. (2009). *Mixed effects models and extensions in ecology with R*. New York, NY: Springer.