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# A basis for bias in geographical judgments

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To determine why North Americans tend to locate European cities south of North American cities at similar latitudes (Tversky, 1981), we had observers provide bearing estimates between cities in the U.S. and Europe. Earlier research using latitude estimates of these cities has indicated that each continent has several subjective regions (Friedman & Brown, 2000a). Participants judged cities from two subjectively northern regions (Milwaukee–Munich), two subjectively southern regions (Memphis–Lisbon), and the two "crossed" regions (Albuquerque–Geneva; Minneapolis–Rome). Estimates were biased only when cities from the subjectively northern regions of North America were paired with cities from the subjectively southern region of Europe. In contrast to the view that biases are derived from distorted or aligned map-like representations, the data provide evidence that the subjective representation of global geography is principally categorical. Biases in numerical location estimates of individual cities and in bearing estimates between city pairs are derived from plausible reasoning processes operating on the same categorical representations.

Geographical information can be biased at one level yet veridical at another (e.g., Glicksohn, 1994; Hirtle & Jonides, 1985; Maki, 1981; McNamara, 1986; McNamara & Diwadkar, 1997; McNamara, Hardy, & Hirtle, 1989; Stevens & Coupe, 1978; Tversky, 1981, 1997). For example, North Americans believe that European cities, like Rome (42º latitude) and Madrid (40º latitude), are located to the south of U.S. cities with similar objective latitudes, like Chicago (42º latitude) and Philadelphia (40º latitude; Tversky, 1981). Yet, the same individuals who provide evidence for this geographical bias could undoubtedly place these cities correctly in their respective states, countries, and continents. Consequently, whereas metric location information about cities may be biased, categorical information, per se, usually is not. Nevertheless, the use of categorical information as a basis for making judgments about locations can lead to systematically biased performance (Friedman & Brown, 2000a, 2000b; Huttenlocher, Hedges, & Duncan, 1991; Huttenlocher, Hedges, & Vevea, 2000; Newcombe, Huttenlocher, Sandberg, Lie, & Johnson, 1999; Stevens & Coupe, 1978).

In the present article, we focus on the etiology of the bias to locate European cities south of their actual locations. In the classic view, this bias, and others like it, have been attributed to a seriously distorted subjective representation of the relative size, shape, and location of continents around the globe (e.g., Glicksohn, 1994; Tversky, 1981, 1997, 2000). The distortion is alleged to result from the operation of Gestalt principles of perceptual organization during the encoding of information from maps. For example, by the principle of proximity, Europe and North America should be remembered as being more aligned with each other than they actually are (Tversky, 1981, 2000). Judgments based on a representation formed from this kind of *alignment heuristic* should reflect a preference to place European cities south of North American cities that are at the same objective latitude (cf. Tversky, 1981, 2000).

We recently proposed an alternative account of geographical biases based on the finding that people's subjective representation of geography is principally categorical. In particular, the North American and European continents are subjectively divided into distinct subregions (e.g., northern vs. Mediterranean Europe), and people do not discriminate much among the locations of cities within the subregions (Friedman & Brown, 2000a, 2000b; see also Stevens & Coupe, 1978). Both the subregionalization of the continents and the absence of local discriminations within subregions may lead to biased judgments, even though the subregions themselves are correctly located in an ordinal sense (e.g., Friedman & Brown, 2000a; Stevens & Coupe, 1978).

In the present study, we set out to accomplish three goals. First, we set out to replicate Tversky's (1981) original finding of a bias to locate European cities south of their North American counterparts at similar latitudes, which we had conjectured was caused by the categorical nature of subjective geography (Friedman & Brown, 2000a, 2000b). In particular, we hypothesized that the *Chicago–Rome effect* was caused by the relative location of particular subregions in the representation(s) of both continents, together with the bias to locate cities in the southern U.S.

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and Mediterranean Europe far south of their actual locations and the functional association between these two regions. However, we never actually replicated the effect because the participants in our previous studies never compared any cities directly.

Our second goal was to delimit the range of the Chicago–Rome effect. That is, we wanted to provide evidence that the regionalization account of subjective geography predicts precisely the circumstances under which Tversky's (1981) finding can be replicated, as well as those under which it cannot. Because Tversky and others (Glicksohn, 1994) used comparative location judgments to make representational claims about the putative perceptual basis of geographic biases, we adopted this methodology in the present study in order to test our own representational claims. Thus, we used bearing estimates between cities in North America and Europe, together with the regional information provided by previously obtained numerical location judgments, to predict when the Chicago–Rome effect would be manifested and to provide evidence that our regionalization account is responsible for it.

The use of comparative location judgments enabled us also to accomplish our third goal: Because our previous work involved numerical estimates, it was possible that the kind of information used to make the judgments was in some way different from the kind of information that would be used in a comparative task in which both the stimulus and response modes are more evocative of map-like representations. That is, the nature of the numerical judgments themselves might have evoked the use of propositional (categorical) representations, rather than the kind of analogical (perceptually based) representations believed to underlie bearing estimates and map placements (Tversky, 1981; but see Holyoak & Mah, 1982). Consequently, it was important to determine whether categorical representations could be shown to drive performance in a task that permits a more continuous (and aligned) representation to be revealed if it is there. The data thus allowed us to distinguish between categorical and Gestalt-based explanations of geographical biases.

As noted above, a compass-bearing task provided the fundamental empirical evidence for the notion that geographical biases result from the operation of Gestalt principles. About 60% of American university students who were presented with five pairs of cities—one from the U.S. and one from Europe or north Africa—placed the Old World city to the south of the U.S. city when, in fact, the cities within each pair were located at about the same actual latitude (the European cities were actually an average of 2º north of the U.S. cities; Tversky, 1981). This was taken as evidence that the representation of the European continent *as a whole* is aligned with the representation of the North American continent.

In contrast to this view, the data we obtained when people estimated the absolute latitude of individual cities in the Old and New Worlds led us to conclude that the subjective representation of both North America and Europe was not unitary and that some subregions in each continent were accurately located, whereas others were not. For example, the cities in Figure 1 are arranged, left to right, from the subjectively most northern to the subjectively most southern city in each continent (Friedman & Brown, 2000a). The sharp discontinuities in these *subjective location profiles* served as the basis for identifying regions and subregions and for making the claim that the subjective representation of each continent is not unitary. It is obvious from the figure that there are at least four subregions in North America (one in Canada, a northern and a southern subregion in the U.S., and one in Mexico) and at least three, and possibly four, in the Old World (Northern Europe, represented by Oslo in Figure 1, Central Europe, Mediterranean Europe, and Africa). In addition, as mentioned earlier, there is not much discrimination among cities within even well-known subregions; in cases where there appeared to be some resolution among cities within a subregion (e.g., northern and central Europe), the correlation between the actual and estimated latitudes was actually either weak or nonexistent.

We have demonstrated the existence and functional importance of these particular regions several times across populations of individuals from distinctly different locations and of different nationalities (Friedman & Brown, 2000a, 2000b; Kerkman, Brown, & Wilson, 2000).[1] For the present study, in addition to the existence of the subregions themselves, three findings played a particularly important role in the logic of our predictions. First, the estimated location of subregions within a given hemisphere was adjusted independently as a function of new information (Friedman & Brown, 2000a, Experiment 2). We interpreted this to mean that the subregional level of representation plays a functional role in geographical judgments. Second, the Mediterranean subregion of Europe was associated with the southern subregion of the U.S. (i.e., they were adjusted in tandem by roughly similar amounts; Friedman & Brown, 2000b, Experiment 2). Third, and most important, the latitudes of cities in Mediterranean Europe and Africa were severely underestimated. Thus, it was not the case that all of Europe was estimated to be south of all of North America; rather, only cities in Mediterranean Europe were underestimated, and their estimated latitudes coincided with those for cities in the southern U.S.

The aggregate findings described above led us to argue that the etiology of the Chicago–Rome effect was likely to be in something other than the assumed general tendency to "align" the European and North American continents as a whole (cf. Tversky, 1981, 2000). Rather, we hypothesized that the original evidence for the bias lay in the serendipitous pairing of cities from the northern subregion of the U.S. and the southern subregion of Europe, or the southern subregion of the U.S. and the northern subregion of Africa. Indeed, this characterization describes four of the five original stimulus pairs (Philadelphia–Rome, Los Angeles–Algiers, Chicago–Monaco, Washington–Madrid, Seattle–Paris; Tversky, 1981).

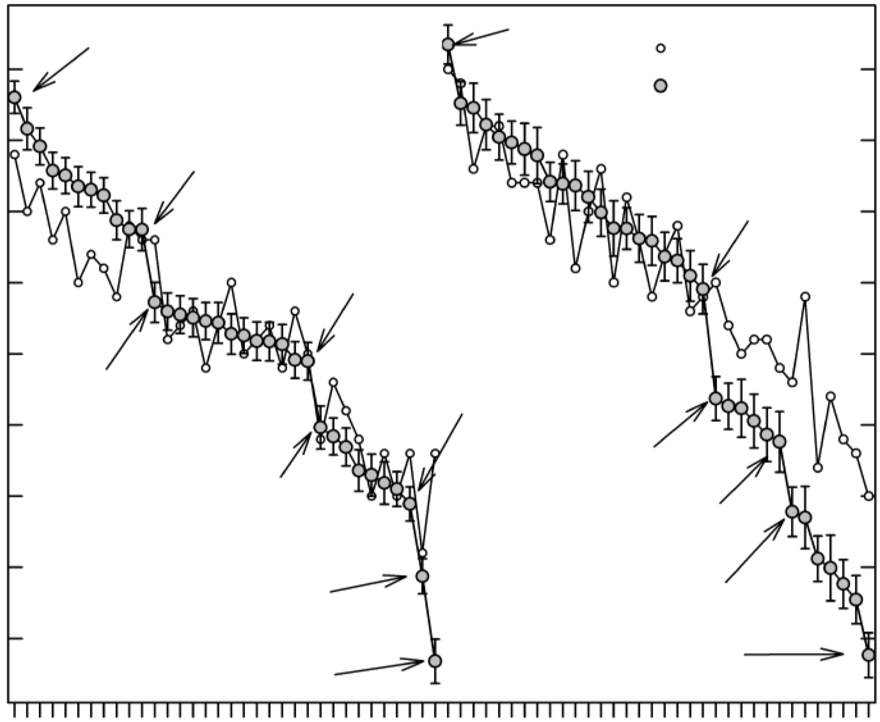

**Figure 1. Actual latitude and mean estimated latitude across 60 participants for cities in the Old and New Worlds (adapted from Friedman & Brown, 2000a, Figure 1). The data in each panel are organized from the subjectively most northern city at the left to the subjectively most southern city at the right.**

The present study tests whether the subjective representation implied by Figure 1 underlies performance in comparative geographical judgments. We conducted two experiments. In both of them, the participants were given the name of a North American city in the center of a circle and were asked to indicate the direction in which they would have to travel to get to a second city that was located in Europe.

In the first experiment, we controlled for the ordinal position of the regions as well as the factorial assignment of cities to conditions. In the second experiment, we controlled precisely the objective latitudes of the cities in two primary conditions of interest. The actual location of cities in the real world precluded controlling for both the ordinal position of regions and the objective latitude of the cities within them in the same experiment (see Figure 1).

In each experiment there were four types of stimulus pairs: Cities could come from either two subjectively northern subregions (e.g., Milwaukee and Munich), two subjectively southern subregions (e.g., Memphis and Lisbon), the southern subregion of U.S. and the northern subregion of Europe (e.g., Albuquerque and Geneva), or finally, the northern subregion of either the U.S. or Canada and the southern subregion of Europe (e.g., Minneapolis and Rome, or Halifax and Milan). If performance is based on the kind of subregionalization illustrated in Figure 1, only the last type of stimulus pair has items for which European cities should be placed farther south than North American cities. In contrast, if the representations of the continents are unitary and aligned with each other, European cities in general, not just those in southern Europe, should be judged to be south of North American cities that are at comparable objective latitudes. This is an important point: From the point of view of the operation of Gestalt principles, the well-known, solid land masses of North America and Europe should have no discontinuities in their representations. This is because there is nothing particularly obvious in the maps of North America and Europe that principles of perceptual organization could transform into discontinuous subregions *within* the representations of the two continents. Thus, whether the alignment between the continents is achieved by "moving" the representation of Europe south relative to its actual location, or by "stretching" Europe so that its upper and lower boundaries are the same as those of North America, the representation produced should have a more or less even distribution of cities within each continent. In this sense, both the existence of

**Table 1**
**Stimulus Cities, Actual Latitudes in Degrees, the Difference in Latitude for Each Pair, and the Percentage of Participants Choosing the European City as the More Northerly of Each Pair in Experiment 1**

| Subjective Region (NA–Europe) | NA City | European City | NA Latitude | European Latitude | Europe − NA Latitude Difference | % Participants Who Say Europe is North |
|---|---|---|---|---|---|---|
| North–North | Minneapolis | Vienna | 43 | 48 | 5 | 60.7 |
| | Milwaukee | Munich | 43 | 48 | 5 | 75.0 |
| | Boston | Budapest | 42 | 47 | 5 | 50.0 |
| | Detroit | Geneva | 42 | 46 | 4 | 82.1 |
| | Buffalo | Belgrade | 42 | 45 | 3 | 57.1 |
| | Salt Lake | Bucharest | 41 | 44 | 3 | 53.6 |
| | Chicago | Marseille | 41 | 43 | 2 | 57.1 |
| Mean | | | 42.0 | 45.9 | 3.9 | 62.2 |
| *SEM* | | | 0.3 | 0.7 | 0.7 | 4.5 |
| North–South | Minneapolis | Rome | 43 | 42 | −1 | 35.7 |
| | Milwaukee | Barcelona | 43 | 41 | −2 | 46.4 |
| | Boston | Porto | 42 | 41 | −1 | 42.9 |
| | Detroit | Madrid | 42 | 40 | −2 | 39.3 |
| | Buffalo | Lisbon | 42 | 39 | −2 | 28.6 |
| | Salt Lake | Athens | 41 | 38 | −3 | 32.1 |
| | Chicago | Granada | 41 | 37 | −4 | 46.4 |
| Mean | | | 42.0 | 39.7 | −2.3 | 38.8 |
| *SEM* | | | 0.3 | 0.7 | 0.4 | 2.6 |
| South–North | San Francisco | Vienna | 38 | 48 | 10 | 60.7 |
| | Reno | Munich | 38 | 48 | 10 | 89.3 |
| | Las Vegas | Budapest | 36 | 47 | 11 | 71.4 |
| | Albuquerque | Geneva | 35 | 46 | 11 | 92.9 |
| | Memphis | Belgrade | 35 | 45 | 10 | 53.6 |
| | Atlanta | Bucharest | 34 | 44 | 10 | 75.0 |
| | Los Angeles | Marseille | 34 | 43 | 9 | 75.0 |
| Mean | | | 35.7 | 45.9 | 10.1 | 74.0 |
| *SEM* | | | 0.6 | 0.7 | 0.3 | 5.3 |
| South–South | San Francisco | Rome | 38 | 42 | 4 | 46.4 |
| | Reno | Barcelona | 38 | 41 | 3 | 57.1 |
| | Las Vegas | Porto | 36 | 41 | 5 | 50.0 |
| | Albuquerque | Madrid | 35 | 40 | 5 | 57.1 |
| | Memphis | Lisbon | 35 | 39 | 4 | 50.0 |
| | Atlanta | Athens | 34 | 38 | 4 | 42.9 |
| | Los Angeles | Granada | 34 | 37 | 3 | 46.4 |
| Mean | | | 35.7 | 39.7 | 4.0 | 50.0 |
| *SEM* | | | 0.6 | 0.7 | 0.3 | 2.1 |

Note—NA, North America.

the subregions and their functional significance for task performance would be evidence in favor of the categorical nature of geographical representations.

It should be noted that two regions that occupy the same ordinal position do not necessarily have to have the same average estimated latitude across the cities within them. For example, it is apparent from Figure 1 that when both North American and European cities are included in the set of cities to be estimated, respondents were reasonably accurate in their (average) placement of cities in the northern and southern U.S., as well as in northern and central Europe. This implies that, on the whole, North American participants believe that most European cities are north of most U.S. cities. This is a belief about the relative location of the subregions; as such, it is a belief at the category level that should be inherited by the items within the category (cf. Friedman & Brown, 2000b). Thus, in the north–north condition, though the cities are actually matched for objective latitudes, the European cities in aggregate might be estimated to be north of the North American cities on the basis of beliefs about the absolute locations of the regions and subregions. This would be further evidence for the functional role played by subregional knowledge in geographical judgments.

## METHOD

### Stimuli and Design

We refer to the stimulus conditions by pairs of letters in which the first letter stands for the empirically derived subjective location of the North American city and the second letter stands for the subjective location of the European city. There were seven pairs in each of four stimulus conditions in each experiment: north–north (NN), north–south (NS), south–north (SN), and south–south (SS).

The estimated latitudes for most cities were obtained from Friedman and Brown (2000a). When we did not have an estimated latitude for a particular city (e.g., Porto, Portugal), that city was placed in the

**Table 2**
**Stimulus Cities, Actual Latitudes in Degrees, the Difference in Latitude for Each Pair, and the Percentage of Participants Choosing the European City as the More Northerly of Each Pair in Experiment 2**

| Subjective Region (NA–Europe) | NA City | European City | NA Latitude | European Latitude | Europe − NA Latitude Difference | % Participants Who Say Europe is North |
|---|---|---|---|---|---|---|
| North–North | Saskatoon | Warsaw | 52 | 52 | 0 | 76.7 |
| | Calgary | Amsterdam | 51 | 52 | 1 | 76.7 |
| | Winnipeg | Prague | 50 | 50 | 0 | 56.7 |
| | Vancouver | Paris | 49 | 49 | 0 | 73.3 |
| | Victoria | Vienna | 48 | 48 | 0 | 63.3 |
| | St. John's | Munich | 48 | 48 | 0 | 70.0 |
| | Montreal | Geneva | 46 | 46 | 0 | 66.7 |
| Mean | | | 49.1 | 49.1 | 0.1 | 69.0 |
| *SEM* | | | 0.8 | 0.8 | 0.1 | 2.8 |
| North–South | Halifax | Milan | 45 | 45 | 0 | 21.1 |
| | Toronto | Florence | 44 | 44 | 0 | 24.4 |
| | Detroit | Rome | 42 | 42 | 0 | 21.9 |
| | Chicago | Thessalonica | 42 | 41 | −1 | 23.3 |
| | New York | Naples | 41 | 41 | 0 | 18.6 |
| | Philadelphia | Madrid | 40 | 40 | 0 | 18.9 |
| | St. Louis | Lisbon | 39 | 39 | 0 | 19.2 |
| Mean | | | 41.9 | 41.9 | −0.1 | 21.1 |
| *SEM* | | | 0.8 | 0.8 | −0.1 | 0.9 |
| South–North | San Diego | Dublin | 33 | 53 | 20 | 96.7 |
| | Tucson | Copenhagen | 32 | 56 | 24 | 93.3 |
| | New Orleans | Kiev | 30 | 50 | 20 | 93.3 |
| | Houston | Lyon | 30 | 46 | 16 | 93.3 |
| | San Antonio | Budapest | 29 | 47 | 18 | 73.3 |
| | Orlando | Zagreb | 29 | 46 | 17 | 73.3 |
| | Miami | Brussels | 26 | 51 | 25 | 86.7 |
| Mean | | | 29.9 | 49.9 | 20.0 | 87.1 |
| *SEM* | | | 0.9 | 1.4 | 1.3 | 3.7 |
| South–South | Las Vegas | Bilbao | 36 | 43 | 7 | 66.7 |
| | Memphis | Porto | 35 | 41 | 6 | 50.0 |
| | Los Angeles | Granada | 34 | 37 | 3 | 70.0 |
| | Atlanta | Athens | 34 | 38 | 4 | 36.7 |
| | Phoenix | Gibraltar | 33 | 36 | 3 | 66.7 |
| | Dallas | Barcelona | 33 | 41 | 8 | 56.7 |
| | El Paso | Istanbul | 32 | 41 | 9 | 66.7 |
| Mean | | | 33.9 | 39.6 | 5.7 | 59.0 |
| *SEM* | | | 0.5 | 1.0 | 0.9 | 4.6 |

Note—NA, North America.

same subjective group as was another city from the same country that we did have an estimate for (e.g., Lisbon, Portugal). This is defensible because, as can be seen in Figure 1, there is virtually no discrimination among cities within subregions.[2] The cities used in each experimental condition, together with their actual latitudes, are shown in Tables 1 and 2. The 28 pairs in each experiment were presented in a different random order for each participant.

In Experiment 1, each of the cities in North America and Europe was seen twice during the experiment: once with a city in the coordinate subjective region (e.g., NN and SS) and once with a city in the noncoordinate subjective region (e.g., NS and SN). Thus, this experiment controlled for the factorial assignment of cities to conditions. Furthermore, this experiment controlled for the ordinal position of the regions, at the expense of matching precisely the objective latitudes between cities within pairs. That is, the northern U.S. and central European subregions were both in the second (from the north) ordinal position. Matching the ordinal position of the subregions as well as ensuring that the same cities were in the northern and southern subjective subregions in each condition made it impossible to precisely match objective locations of cities within pairs (see Table 1). In Experiment 2, therefore, each of the 56 cities used in the experiment was unique, which permitted us to match the objective latitudes of the pairs in the NN and NS conditions exactly (see Table 2). Experiment 2 therefore provided both a replication and a generalization of Experiment 1.

For both experiments, it was impossible to match the SN pairs on either subjective or objective latitudes. We matched cities within the SS pairs as carefully as possible on objective latitudes while ensuring that the Old World cities were selected from Europe rather than from north Africa. Northern Africa is both functionally independent of southern Europe and estimated to be much farther south than it actually is (Figure 1; Friedman & Brown, 2000a, Experiment 2).

## Procedure and Apparatus

Stimulus pairs were presented on a computer screen in a display that was similar to that used by Tversky (1981, Figure 3). For each trial, a circle was shown in the approximate center of the screen (radius = 308 pixels), with the letter N at the top and a dot at the center. The North American city was always shown at the center of the circle. A sentence frame was displayed at the bottom of the screen that said

"Where is (European city, country) with respect to (North American city, country)?"

The participants were instructed that they were to judge locations of cities in North America and Europe. The task was described as one in which they should imagine themselves as being in the North American city that was located at the center of the circle, facing north. They should then indicate, by clicking on the edge of the circle with a mouse, in which direction they would have to travel to get to the European city named in the sentence at the bottom of the display. There were four practice trials, one for each stimulus condition, followed by a period of questions and clarification, if necessary, followed by the 28 experimental trials.

### Participants

Twenty-eight and 30 Canadian-born volunteers from the University of Alberta participant pool provided data for Experiments 1 and 2, respectively.

## RESULTS AND DISCUSSION

The *x* and *y* pixel coordinates for each participant and city were converted into a categorical value that indicated whether the response was north of the imaginary line east of the city in the center of the circle. For each participant, we computed the percentage of the seven responses per condition for which the European city was placed north of the North American city. For each pair of items, we computed the percentage of participants who placed the European city farther north than the North American city. The mean percentages for each condition were thus identical for both participants and items, but the four stimulus conditions were within participants and between items in the respective analyses of variance. In both experiments, the condition effect was significant for participants [$F(3,81) = 18.79$, $MS_e = 345$, $p < .001$ for Experiment 1, and $F(3,87) = 39.99$, $MS_e = 474$, $p < .001$ for Experiment 2], as well as for items [$F(3,24) = 15.58$, $MS_e = 104$, $p < .001$ for Experiment 1, and $F(3,24) = 36.43$, $MS_e = 122$, $p < .001$ for Experiment 2].

Figure 2 shows the percentage of participants who placed the European city farther north than the North American city in each experiment, and Tables 1 and 2 show the data for individual city pairs. Tversky (1981) reported that across the five pairs of cities she used, an average of 60% of participants exhibited a bias to place the European city south of the North American city. This means, of course, that

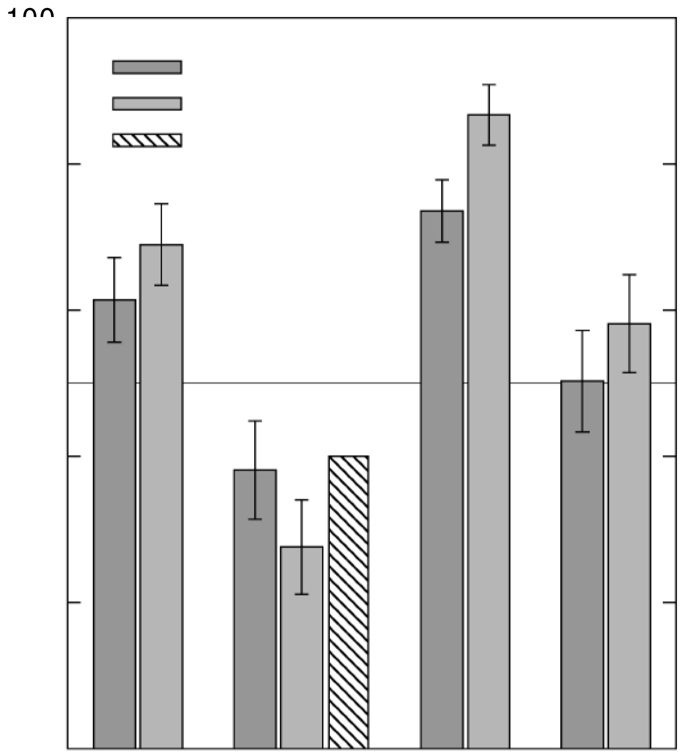

**Figure 2. Percentage of participants who placed the European city in a given pair north, relative to the North American city. The data were obtained across participants, separately for each of the 28 city pairs, and were then averaged over the 7 pairs in each of the conditions. Standard error bars are thus computed from the item means in each condition. The striped bar in the north–south condition was computed from Tversky (1981, Table 1).**

40% of the participants did not and, instead, placed the European city north of the North American city. As Figure 2 shows, 39% of participants in Experiment 1 and 21% of participants in Experiment 2 indicated that the European city was farther north than the U.S. city for the NS pairs. Thus, it appears that, given a North American city from one of the two subjectively northern subregions and a European city with a similar or identical latitude from the Mediterranean region, approximately 60% to 80% of responses will display an alignment bias and approximately 20% to 40% will not.

Importantly, the three other stimulus conditions provide evidence that the bias to place European cities south of their North American counterparts was confined to the NS pairs. In Experiment 1, the actual (Europe − North America) difference in latitudes for cities in the NN, NS, SN, and SS conditions was 3.9º, −2.3º, 10.1º, and 4.0º, respectively, whereas the percentage of participants who placed the European city farther north for these conditions was 62%, 39%, 74%, and 50%. For Experiment 2, the actual (Europe − North America) difference in latitudes for cities in the NN, NS, SN, and SS conditions was 0º, 0º, 20º, and 6º, respectively, whereas the percentage of participants who placed the European city farther north for these conditions was 69%, 21%, 87%, and 59%. The difference between the NN and NS conditions in Experiment 2 was particularly striking, because although these conditions were perfectly matched on actual latitudes, there was a 48% difference between them in terms of the percent of participants who placed the European city farther north.

For the NN condition, more than half the participants chose the European city as being farther north than the North American city (62% for Experiment 1 and 69% in Experiment 2), even though the objective latitudes for the pairs in this condition were similar (Experiment 1) or identical (Experiment 2). This suggests that absolute location information represented at the level of the subregion was used to make the bearing estimates. As mentioned earlier, the participants hardly discriminated among the locations of cities within subregions, but when cities from both continents were included in the set to be estimated, cities in northern and central Europe were generally estimated to be north of cities in the U.S. and some of Canada (see Figure 1). If participants were making bearing estimates on the basis of information at the level of the subregions, the fact that cities in these subregions were matched for exact latitudes is irrelevant; European cities will be placed farther north than North American cities from regions that occupy the same ordinal positions in the representation. We cannot make this argument unambiguously for the SS pairs at this time; the objective latitudes were not as well matched in this condition as in the NN condition because we wanted to avoid choosing cities from north Africa, which is a subregion in its own right that is biased even farther south than the Mediterranean subregion. Nevertheless, the suggestion that absolute location information at the subregional level is used in both absolute and relative geographical judgments is theoretically interesting and warrants further research.

To summarize, only the NS condition yielded bearing estimates in which European cities were consistently placed south of North American cities. Thus, only the NS stimulus pairs evoked judgments consistent with a representation of global geography in which the Old and New Worlds were unitary and aligned. In contrast, the estimates in all four conditions reflected the subjective representation of geography depicted in Figure 1 rather well.

## Conclusions

In the present study, we used information obtained from latitude estimates of individual cities (Friedman & Brown, 2000a, 2000b) to show for the first time that the regionalization observed in the subjective geography of the Old and New Worlds underlies performance in comparative geographical judgments and delimits the circumstances under which the Chicago–Rome effect (Tversky, 1981) is observed. Because the representations of the Old and New Worlds are not unitary, the bias to place European cities south of North American cities occurs only when cities are chosen from certain geographical subregions—in particular, when a city from one of two northern subregions in North America is compared with a city from Mediterranean Europe. Thus, the data validate the notion that categorical representations are responsible for the biases observed in both numerical location judgments of individual cities and comparative location judgments between pairs of cities in the Old and New World.

The data are consistent with a subjective geography in which the Old and New Worlds are divided into several subregions each. People have an accurate appreciation of the ordinal location of the subregions within each hemisphere, an accurate appreciation of the actual location of some subregions (e.g., northern Europe), and little discriminative knowledge about the location of cities within subregions. But where do the subregions come from? How are subregions, regions, and countries assigned to particular geographical categories? It is difficult to determine the exact nature of the similarities that cause people to associate and/or "align" distant geographic regions with one another (e.g., climate, physical attributes such as mountains, political sensibilities). In our previous work (Friedman & Brown, 2000b), because the southern European cities were placed at approximately the same latitude as cities in the southern U.S., both initially and after learning new information, we hypothesized that perceived similarities of climate among the regions in both continents contributed heavily to the subregionalization of both continents, and thus, to the latitude estimates. This is not unreasonable: There is a substantial correlation between actual latitude and actual climate (for the 67 cities used across the two experiments reported here, $r = .68$), and between estimated latitude and estimated climate.[3] Because temperature is highly predictive, we expect it to be a heavily weighed cue (Brown & Siegler, 1993) for any judgment involving relative north–south locations. Thus, we believe that climatic considerations probably play an important role in generating the subregions that underlie both latitude estimates and north–south bearing estimates. Indeed, the climate–

latitude correlations, together with the evidence that people underestimate the location of Mediterranean Europe (Friedman & Brown, 2000a, 2000b) and associate Mediterranean Europe with the southern U.S. (Friedman & Brown, 2000b), are what led us originally to hypothesize that the source of the reported bias to locate European cities to the south of North American cities (Tversky, 1981) was in the serendipitous pairing of cities from the northern subregion of the U.S. with those from the Mediterranean subregion of Europe.

Though climatic considerations are not relevant to longitudes, we have longitude estimates that show that the relative location of North and South America with respect to each other depends on what respondents are told about the location of the dateline at 180º (Friedman & Brown, 2000a, Experiments 3 and 4). Thus, the two continents are not necessarily represented as being aligned with one another in the north–south dimension. The mutability of performance on the basis of contextual considerations is additional evidence for the influence of conceptual information on geographical judgments. The present study provides evidence that latitude and bearing estimates are based on the same regional knowledge; we have every reason to believe that longitude estimates and many other kinds of geographical judgments are also based primarily on regional and subregional knowledge.

We are developing a general framework for understanding geographical reasoning that has developmental, cross-cultural, and educational implications as well as implications for cognitive theory (Brown & Friedman, 1999; Friedman & Brown, 2000a, 2000b; Kerkman et al., 2000). To date, all of this research has employed the same paradigm—absolute location judgments. These location judgments in conjunction with counterintuitive but predictable *seeding effects* (Brown & Siegler, 1993; Friedman & Brown, 2000a, 2000b) provided us with the grounds for making strong claims about representation in this domain. One implication of these claims led us to a reappraisal of Tversky's (1981) fundamental, seminal finding because that finding also led to strong representational claims, as well as to a consensus that geographical biases in general, and the Chicago–Rome effect in particular, were attributable to the operation of Gestalt processes on representations derived from maps (see also Tversky, 2000). We thus felt it was necessary to replicate this finding directly and to explain its occurrence on the basis of the categorical nature of subjective geography.

In addition to providing a replication and reinterpretation of a classic finding, the present results provide converging evidence, with the use of a very different task, for some of the main precepts of our theory. Therefore, the present work links our current research program to the classic literature in subjective geography and suggests that regional knowledge plays a fundamental role in geographical reasoning. If so, an important challenge for future research is to identify the principles—for example, cognitive, developmental, educational, and cross-cultural—that govern the formation of these regions.

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## NOTES

1. One might argue that familiarity underlies regionalization; however, we have observed no correlation between familiarity and the granularity of the regions. For instance, Canada is more familiar to our participants than is the U.S., yet Canada has only one clear subregion and the U.S. has two. Similarly, European cities are generally less familiar to our participants than are North American cities; yet, the two regions of Europe subsume many countries, whereas the two regions of the U.S. subsume one country. Such findings suggest that the subjective regions reflect a combination of objective features of the regions themselves (e.g., climate) and familiarity at the item level (Huttenlocher, Hedges, & Duncan, 1991).

2. It should be noted that the subjective region to which a city belongs can be influenced by a multitude of factors. For instance, as seen in Figure 1, both Marseille and Nice were estimated to be at approximately the

same latitude as Paris which, of course, is not correct. We attributed this type of result to inferences from beliefs about the immediate superordinate of a city to the city's location (see Friedman & Brown, 2000a, for details). In the present case, we assumed the same sort of *inheritance-based* inferences would be made. So, for instance, since our previous participants placed Lisbon in the subjectively southern region of Europe, we assumed that Porto would also be placed in that region (just as Marseille was placed in the subjectively northern region). It should be noted that if this assumption is not true, and Porto is subjectively north, the data would be biased against us.

3. To obtain these correlations, 50 participants estimated the latitudes of 100 cities (50 from the Old World and 50 from the New World), and a different 50 participants estimated the average temperature for the coldest month of the year for the same 100 cities. The rank-order correlations between mean estimated latitude and mean estimated temperature were −.94 for the Old World and −.92 for the New World, indicating that observers clearly associate the two dimensions.

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