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# Why Best Can't Last: Cultural Differences in Predicting Regression toward the Mean



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CULTURE AND REGRESSION

# Why Best Can't Last:

# Cultural Differences in Predicting Regression toward the Mean

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## Abstract

Four studies were conducted to investigate cultural differences in predicting and understanding regression toward the mean. We demonstrated, with tasks in such domains as athletic competition, health, and weather, that Chinese were more likely than Canadians to make predictions consistent with regression toward the mean. In addition, Chinese were more likely than Canadians to choose a regression-consistent explanation to account for regression toward the mean. The findings are consistent with cultural differences in lay theories about how people, objects, and events develop over time.

For many North American professors of statistics, the following anecdote will be familiar. An instructor tells a North American class of statistics students that Bob, a high school senior, achieved a SAT score of 760 out of a possible 800 points, when the average score was 480. Next the instructor poses a question: What score do you expect Bob to attain if he takes an alternative version of the test and there are no practice or learning effects? Most students assume that Bob would perform at least as well the second time. Few students possess an intuitive grasp of the concept of regression toward the mean even though there are several everyday expressions such as "law of averages", "things will even out" or "we are due for a good day after a string of bad ones". The concept was first used by Francis Galton (1886) in his paper "Regression towards Mediocrity in Hereditary Stature." Galton was interested in the relationship between the height of offspring relative to the height of their parents and found that tall parents tend to have tall children, but not usually as tall as they are. Short parents tend to have short children, but not usually as short as they are.

This regression toward the mean can be explained by the fact that measurements and scores always involve some chance factors such as error and luck. For example, many people who score extremely high will have guessed at some of the answers and been correct. The chances are low that they will be as lucky a second time. Similarly, some of those people who had low scores guessed wrong on many questions and next time are likely to have better luck and score higher. So whether luck is for or against them depends on whether their extreme score is extremely high or extremely low; regression toward the mean informs people about individual deviations from the group average.

More scientifically, a measure at any point in time comprises the true measure at that time plus measurement error. The true measure itself often undergoes temporary changes over time (Furby, 1973). The combination of temporary changes and measurement error fluctuates randomly over time, and the sum of these random fluctuations should equal zero (Clarke, Clarke, & Browne, 1959). For example, repeated measures of a person's reaction time fluctuate randomly, first because the person reacts differently at different times due to factors such as mood and fatigue, and second, because measurements contain random errors. Temporary changes and random errors are more likely to occur when a measure is extremely distant from the mean. If the measure is conducted again, the temporary changes and errors will be unlikely to contain the same number and magnitude of extreme random fluctuations in the same direction; therefore, the measure will most likely regress toward the mean. Consistent with this reasoning, the further a measure is from the mean, the more it will tend to regress toward the mean (Clarke et al, 1959).

Research with North American participants indicates that they both fail to anticipate and have difficulty understanding the concept of regression toward the mean (Clarke et al., 1959; Furby, 1973; Kahneman & Tversky, 1973; Tversky & Kahneman, 1974; Nisbett, Krantz, Jepson & Kunda, 1983; Karylowski, 1985). People do not anticipate regression in contexts where it should be expected; and when they do encounter regression, they often create erroneous explanations to account for it (Tversky & Kahneman, 1974). When making predictions, even students with training in statistics often fail to adjust sufficiently for regression toward the mean (Nisbett et al., 1983).

Contextual factors and expertise can influence research participants' appreciation of regression toward the mean. Andreassen (1987) found that people were less likely to predict

regression when an extreme outcome was accompanied with an explanation. For example, if individuals are told that an athlete is on an extraordinary winning streak because of a new training regimen, they are less likely to predict a regression toward the mean than if they are provided with no justification for the winning streak. Furthermore, certain people are more likely than others to expect regression (Nisbett et al., 1983). People with extensive experience in the domain of prediction are more likely to endorse regression-consistent explanations. For example, students who have participated in organized sports or theater are more likely to recognize a regression effect in a sports or an acting scenario respectively.

*Culture and lay theories of change*

When people fail to predict regression toward the mean, they do not expect much change to occur. People from different cultures may have different expectations for change. Ji and her colleagues demonstrated that Chinese and North Americans hold different lay theories of change (Ji, 2005; Ji, Nisbett & Su, 2001). Chinese tend to believe that people, objects, and events change constantly and often in a nonlinear fashion. Conversely, North Americans tend to assume that people, objects, and events that are at rest remain at rest (stability), and those that are changing continue to change in the same way (continuity or linear change). These cultural differences in lay theories of change are evident in such diverse domains as personal development, personal happiness across time, interpersonal relationships, and global events. For example, Ji et al. found that Chinese were more likely than North Americans to predict that an individual who was doing well would do poorly in the near future, and that two children who were fighting in kindergarten would become lovers one day. In addition, relative to Canadians, Chinese predicted more change in a person's traits, abilities, and behaviors over periods of 10, 20, and 30 years. When given one measure at a point of time, Chinese tended to predict change more than North Americans did;

when given a trend that is changing (increasing or decreasing) over a period of time, Chinese were more likely to predict reversals in the trend than North Americans, who were more likely to predict continuity in the trend.

*Present Research*

Given that North Americans expect stability and linear change, it is not surprising that there is evidence that they fail to predict regression toward the mean. Whether they are given an extreme measure at one point in time, a succession of extreme measures, or a trend that is progressing towards an extreme point, North Americans tend to predict a similar or more extreme value for a subsequent measure. In contrast, Chinese are more likely to expect change and reversals (i.e., non-linear change) over time: if given a trend that is progressing toward an extreme point, they tend to predict a less extreme result on a subsequent measure. Similarly, if given an extreme outcome at one point in time or a succession of extreme outcomes, Chinese tend to predict a subsequently less extreme outcome. Thus, in the present research, we predicted that Chinese would be more likely than North Americans to predict regression toward the mean (Note 1).

It is important to examine cultural differences in understanding regression toward the mean, because they could have significant practical implications. When regression-consistent phenomena take place, members of an international team may have different explanations for them. For example, a new intervention program may appear to be effective, whereas in fact the improvement or success is due entirely to regression toward the mean. A North American team member may choose to invest more resources in the program whereas a Chinese team member may insist otherwise. Likewise, a North American may suggest canceling a program that seems to have failed due to regression toward the mean, whereas a Chinese may disagree. These

differences may lead to unnecessary conflict among members and result in poorly executed decisions.

We conducted four studies to test the prediction that Chinese would reason more in line with regression toward the mean than would Canadians. In Study 1, we examined whether Chinese would be more likely than Canadians to predict an athlete's future performance to be consistent with regression toward the mean. Studies 2 and 3 aimed to replicate the results from Study 1 using different prediction tasks, one on human health, and one on weather. In Study 4, we examined whether Chinese and Canadians understood the rationale underlying regression toward the mean.

## Studies 1A and 1B

Participants read a description of the past performance (poor, average, or good in score or rank) of an individual in a gymnastic competition and predicted performance in a subsequent competition with the same competitors, while being told explicitly that the individual expended the same amount of effort in the two competitions. Participants then made predictions about either an individual's score (in Study 1A) or rank (in Study 1B). We expected no difference for the two performance measures, scores and ranks, and examined them in separate studies to ensure the generalizability of the hypothesized effect across both performance measures. We hypothesized that the Chinese participants would be more likely than their Canadian counterparts to offer predictions that reflect regression toward the mean: Chinese participants would predict that those who did poorly or very well previously would score or rank closer to the mean in the subsequent competition.

In both studies, we asked participants to estimate the range of likely scores or ranks of the target and hypothesized that the Chinese would estimate a larger range than the Canadians, due

to their greater belief in change (Ji et al, 2001). We also asked participants to indicate their confidence in their predictions. Such information would be used to address the alternative explanation that Chinese might not be as confident as Canadians about their own predictions, which then might result in a wider range of predictions by Chinese than by Canadians.

## Study 1A Method

### *Participants*

Sixty-four European Canadian students (48 women and 16 men) were recruited from Queen's University in Canada and 69 Chinese students (56 women and 13 men) were recruited from Huazhong Normal University in China. Canadian participants received course credit, and Chinese participants received a small gift for their participation.

### *Materials and procedure*

The study design was a 2 (Culture: Canadians versus Chinese) X 3 (Prior Performance: poor, average, or good) factorial between-participant design. The scenario described a gymnastic competition, as follows:

*"At a gymnastic competition held in Eastern Canada [or in Northern China for the Chinese participants] last year and this year, the same 20 athletes competed for individual medals. Their average level of performance remained about the same both years. The average score across all individuals each year was about 34 out of 40.*

*Peter performed in both competitions. Last year, Peter's total score was "X" out of 40 . He has spent the same amount of time and effort to prepare for this year's competition as he did for last year's".*(Note 2)

For the good performance condition, Peter's total score (X) was given as 38.10; for the average performance condition he scored 34.30; and for the poor performance condition, he scored 28.40.

In each country, participants were randomly assigned to one of the 3 conditions, and were asked to read a scenario appropriate to the condition.

Participants predicted the target's score or rank in the second year, and indicated how confident they were in these estimates on a scale ranging from 1 (not at all confident) to 8 (extremely confident). They also estimated the highest and lowest scores or ranks the target would be likely to achieve, based only on information provided in the scenario.

## Results

### *Predicted score changes*

For each participant, predicted score changes were computed as the difference between the predicted score and the score given in the scenario. A positive change indicated a prediction for improvement, whereas a negative change indicated a prediction for decline. Preliminary analyses revealed no gender effects. A 2 (Culture) X 3 (Prior performance) ANOVA for the predicted score changes showed no overall culture main effect, $F(1, 127) = .11$, *ns*, but revealed that participants' predictions were affected by the target's prior performance, $F(2, 127) = 16.91$, $p < .001$, partial $\eta^2 = .21$. Specifically, they predicted greater improvement for those with a poor prior performance ($M = 1.91$, $SD = 2.53$) than for those with an average prior performance ($M = .57$, $SD = 1.02$), and than for those with a good prior performance ($M = -.38$, $SD = 1.96$).

Most importantly however, the main effect was qualified by a significant Culture by Prior Performance interaction, $F(2, 127) = 6.35$, $p = .002$, partial $\eta^2 = .09$. As seen in Figure 1, following good prior performance, Chinese ($M = -.99$, $SD = 2.53$) predicted a decline whereas

Canadians predicted an improvement ($M$ = .21, $SD$ = .88), $F$(1, 45) = 4.74, $p$ = .03, partial $\eta^2$ = .10. The two groups did not differ in their predictions regarding average prior performance (Chinese, $M$ = .53, $SD$ = 1.13; Canadians, $M$ = .61, $SD$ = .89), $F$(1, 39) = .06, *ns.* Following poor prior performance, Chinese ($M$ = 2.70, $SD$ = 3.30) predicted more of an improvement than did Canadians ($M$ = 1.10, $SD$ = .79), $F$(1, 43) = 4.91, $p$ = .03, partial $\eta^2$ = .10. Therefore, supporting our hypothesis, Chinese predictions were more consistent with a regression toward the mean than were Canadian predictions.

*Range estimates*

Chinese participants ($M$ = 6.38, $SD$ = 3.40) predicted a larger range, overall, than did Canadian participants ($M$ = 5.20, $SD$ = 2.80), $F$(1, 127) = 6.29, $p$ = .01, partial $\eta^2$ = .05 (as seen in Figure 3). In addition, there was a significant main effect of Prior Performance, $F$(2, 127) = 21.30, $p$ < .001, partial $\eta^2$ = .25. Participants predicted a significantly greater range of scores following a poor prior performance ($M$ = 7.98, $SD$ = 3.09) than following an average prior performance ($M$ = 4.81, $SD$ = 2.71), $F$(1, 84) = 25.32, $p$ < .001, partial $\eta^2$ = .23., and following a good prior performance ($M$ = 4.61, $SD$ = 2.52), $F$(1, 90) = 32.99, $p$ < .001, partial $\eta^2$ = .27. The interaction between Culture and Prior Performance was not significant, $F$ (2, 127) = .04, *ns.*

*Confidence in estimates*

The two culture groups did not differ in the confidence ratings for their predictions ($M$ = 5.12, $SD$ = 1.54 for Chinese and $M$ = 5.36, $SD$ = 1.36 for Canadians), $F$(1, 130) = .91, *n.s,*.

## Study 1B Method

Study 1B was conducted in a similar way as Study 1A with one change: Instead of predicting an athlete's subsequent score, participants were asked to predict the target's subsequent rank. We did not expect that the performance index would make a difference, and

included Study 1B to ensure that the results be generalized beyond a single performance measure.

*Participants*

Sixty-six European Canadian students (54 women and 12 men) were recruited from Queen's University in Canada and 66 Chinese students (50 women and 15 men; 1 participant did not indicate gender) were recruited from Huazhong Normal University in China. Canadian participants received course credit, and Chinese participants received a small gift for their participation.

*Materials and procedure*

The material and procedure were identical to Study 1A, except that instead of predicting the athlete's score, participants were asked to predict the athlete's rank in the next competition after learning about the rank for the same athlete in the previous competition. The modified scenario was as follows:

*"Peter performed in both competitions. Last year, Peter ranked "Y" out of 20 . He has spent the same amount of time and effort to prepare for this year's competition as he did for last year's".*

For the good performance condition, Peter's ranking (Y) was 3rd; for the average performance condition he ranked 9th; and for the poor performance condition, he ranked 18th.

Participants predicted the target's rank in the second year, and indicated how confident they were in these estimates on a scale ranging from 1 (not at all confident) to 8 (extremely confident). They also estimated the highest and lowest ranks the target would be likely to achieve, based only on information provided in the scenario.

## Results

*Predicted ranking changes*

For each participant, predicted ranking changes were computed as the difference between the rank given in the scenario and the predicted rank. A positive change indicated a prediction for improvement, whereas a negative change indicated a prediction for decline. A 2 (Culture) X 3 (Prior performance) ANOVA for the predicted ranking changes showed that there was no significant main effect of culture, $F$ (1, 126) = .74, *ns*. The main effect of prior performance was significant, $F$(2, 126) = 10.38, $p < .001$, partial $\eta^2 = .14$. Overall, participants predicted a greater improvement for those with a poor prior performance ($M$ = 1.61, $SD$ = 3.73) than for those with an average prior performance ($M$ = -.19, $SD$ = 2.07), and than for those with a good prior performance ($M$ = -.83, $SD$ = 2.15).

Again however, the main effect was qualified by a significant interaction between Culture and Prior Performance, $F$ (2, 126) = 5.62, $p$ = .005, partial $\eta^2 = .08$. As shown in Figure 2, Chinese ($M$ = -1.50, $SD$ = 2.69) predicted a significantly greater decrease in rank following good prior performance than did Canadians ($M$ = -.10, $SD$ = .97), $F$(1, 40) = 4.85, $p$ = .03, partial $\eta^2 = .11$. No culture differences were found when the previous rank was average (Chinese $M$ = -.09, $SD$ = 2.62; Canadian $M$ = -.29, $SD$ = 1.35), $F$(1, 41) = .09, *n.s.*. When prior performance was poor, the Chinese ($M$ = 2.90, $SD$ = 5.00) predicted significantly greater improvement than did the Canadians ($M$ = .48, $SD$ = 1.36), $F$(1, 45) = 5.41, $p$ = .02, partial $\eta^2 = .11$. Therefore, supporting our hypothesis, Chinese participants made rank predictions that were more consistent with a regression toward the mean than did Canadian participants.

*Range estimates*

Chinese participants ($M$ = 8.51, $SD$ = 4.03) predicted a larger range, overall, than did Canadian participants ($M$ = 6.59, $SD$ = 4.81), $F$(1, 125) = 6.17, $p$ = .01, partial $\eta^2 = .05$ (as seen

in Figure 4). The interaction between Culture and Prior Performance was not significant, $F$ (2, 125) = .69, *ns.*

*Confidence in estimates*

The two culture groups did not differ in the confidence ratings for ranks ($M$ = 5.17, $SD$ = 1.38 for Chinese and $M$ = 5.03, $SD$ = 1.50 for Canadians), $F$(1, 130) = .30, *n.s.*

Summary of Studies 1A and 1B

The overall results from Studies 1A and 1B supported our hypotheses. Compared with the Canadians, the Chinese participants predicted greater improvement in both ranks and scores following poor prior performance and greater decline in both ranks and scores following good prior performance, indicating that the Chinese predictions were more in line with regression toward the mean than the Canadian predictions. There were no cultural differences in predictions after average prior performance. In addition, the Chinese always estimated a wider range of rankings than did Canadians, consistent with Ji et al (2001). Lastly, despite these differences in predictions, the two culture groups reported similar levels of confidence for their predictions.

## Study 2

Study 1 demonstrated that Chinese participants were more likely than Canadian participants to make predictions (especially in ranking) consistent with a regression toward the mean. However, there were alternative explanations for the results. For example, one may argue that Chinese might endorse incremental theory (i.e., belief that a person can change) more and entity theory (i.e., belief that a person can not change) less than North Americans (even though there is no empirical evidence on this), which would lead to the same results as obtained in Study 1. Thus, it is important to replicate the results with other events in other domains. Study 2 was designed to examine the culture differences in anticipation of a regression towards the mean

using a different scenario, a research project designed to improve cholesterol levels. We hypothesized that Chinese predictions would be closer to the mean than Canadian predictions.

## Method

### *Participants*

Sixty-six European Canadian students (54 women, 12 men) were recruited in Canada and 139 Chinese students (68 women and 64 men; 7 did not report gender) were recruited in China. Canadians received course credit and Chinese received a small gift for participating.

### *Materials and procedure*

Participants read the following scenario in the high condition:

*A medical research team is testing a new drug that is hypothesized to lower LDL cholesterol levels (bad cholesterol). The research team measured cholesterol levels in an initial large sample of people, and then selected the 100 people with the highest LDL levels for the study. For one year, 50 of the 100 people then got the new drug and the other 50 did not get the drug. Throughout this year, the researchers regularly interviewed the 100 people to ensure there were no major lifestyle differences that would affect cholesterol levels, apart from the drug given to half of the people.*

*Range of possible LDL levels in humans: Minimum = 40 units and Maximum = 160 units.*

*Average LDL level for the initial large sample of people: 100 units.*

*Average LDL level for the 100 people (with highest LDL levels) before beginning the study: 140 units*

The scenario in the low condition was identical, except that the drug was hypothesized to raise HDL cholesterol levels (good cholesterol), and the average HDL level for the 100 people (with lowest HDL levels) before beginning the study was 60 units.

The participants predicted the average cholesterol level after the study separately for both the 50 people in the control condition and the 50 people who received the drug. Lastly, participants indicated their confidence in their predictions, along a scale ranging from 1 (not confident at all) to 9 (extremely confident). We predicted that consistent with Study 1, in the no drug condition Chinese would be more likely than Canadians to predict that the cholesterol levels would regress toward the mean. There was no reason to expect that Chinese and Canadian participants would predict different drug effects, therefore we predicted no cultural difference in the drug condition.

## Results and Discussion

No gender or age differences were found for any of the results and were not considered further.

### *Control Condition*

In this analysis, there was no significant culture main effect, $F(1, 201) = 1.11$, *n.s.* As expected, a main effect of condition indicated that participants in the high condition predicted higher cholesterol levels ($M = 127.38$, $SD = 25.28$) than did participants in the low condition ($M = 70.56$, $SD = 20.88$), $F(1, 201) = 299.39$, $p < .001$, partial $\eta^2 = .60$. The Culture x Condition interaction was significant, $F(1, 201) = 4.59$, $p = .03$, partial $\eta^2 = .02$, indicating that Chinese participants predicted lower cholesterol levels in the high condition, and higher cholesterol levels in the low condition, when compared with Canadian participants (see Figure 5). In other words, given a group of people selected for having extremely high or low cholesterol levels, and who

did not receive any drug or behave in any obvious way that would improve such cholesterol levels, Chinese predicted that their cholesterol levels would be closer to the mean upon a second measurement, compared with Canadians. There was no significant difference in the confidence scores (Chinese, $M = 5.86$, $SD = 2.20$; and Canadian, $M = 5.64$, $SD = 1.63$), $F(1, 200) = .55$, n.s. Therefore, the culture differences in predictions could not be explained by differences in confidence levels.

*Drug Condition*

Lastly, as expected, there were no significant culture effects found in this analysis. Specifically, Chinese participants (low condition: $M = 95.41$, $SD = 20.95$; high condition: $M = 101.14$, $SD = 24.47$) and Canadian participants (low condition: $M = 96.67$, $SD = 29.84$; high condition: $M = 102.58$, $SD = 18.96$) both made predictions close to the average cholesterol level of the initial pre-study large sample (100 units). In other words, participants from both cultures predicted that the drug would be effective, restoring the average cholesterol level of the drug group after the study to the level of the large, initial, pre-study sample of people.

## Study 3

Studies 1 and 2 demonstrated that Chinese participants were more likely than the Canadian participants to make predictions consistent with a regression toward the mean. However, there was one potential alternative explanation in Study 2. That is, lowering bad cholesterol in the high condition and increasing good cholesterol in the low condition are both desirable, and Chinese participants might have predicted more change than Canadians because they are more optimistic and hopeful in such a context (see Ji, Zhang, Usborne & Guan, 2004). In addition, both scenarios in the first two studies were related to people, the first focusing on athletic performance and the second on health. To address these concerns, Study 3 was designed

to examine culture differences in anticipation of a regression towards the mean using a non-human scenario, a weather pattern.

## Method

### *Participants*

Seventy-five European Canadian students (44 women, 11 men; 20 did not report gender) were recruited in Canada and 70 Chinese students (46 women and 21 men; 3 did not report gender) were recruited in China. Canadians received course credit and Chinese received a small gift for participating. Five Canadians and 2 Chinese were excluded from the analysis because they misunderstood the task (e.g., they mistook the average (180 days) as one year's information) as indicated by their explanations. One other Chinese participant was excluded because he offered his lucky number as his prediction.

### *Materials and procedure*

Participants read the following scenario:

*On average, city X in some country, has about 180 sunny days per year. Last year, city X had 220 (or 140 in the low condition) sunny days.*

Participants were asked to predict the number of sunny days that city X would have this year and to indicate their confidence levels in their predictions, along a scale ranging from 1 (not confident at all) to 9 (extremely confident).

## Results and Discussion

No gender or age differences were found for any of the results. A 2 (Culture) x 2 (Condition) analysis variance was conducted on the number of sunny days participants predicted that city X would have this year. The overall culture main effect was not significant, $F(1, 133) = .86$, *n.s.* There was an overall significant condition main effect, such that participants in the

high number condition predicted more sunny days ($M$ = 194.37, $SD$ = 19.35) than did those in the low condition ($M$ = 165.80, $SD$ = 17.10), $F(1, 133) = 84.95$, $p < .001$, partial $\eta^2 = .39$. Supporting our hypothesis, a culture x condition interaction effect was significant, $F(1, 133) = 4.46$, $p = .04$, partial $\eta^2 = .03$, such that Chinese predicted a higher number of sunny days in the low number condition, and predicted a lower number of sunny days in the high number condition, in comparison with Canadians (see Figure 6). In other words, following an extremely high or low number of sunny days from the previous year, Chinese predicted that the number of sunny days would be closer to the mean in the following year, compared with Canadians.

We also measured participants' confidence levels in their predictions, and found no significant culture differences, thus, replicating results from Studies 1 and 2, Chinese ($M$ = 5.03, $SD$ = 1.58) and Canadian participants ($M$ = 5.17, $SD$ = 1.59) reported similar levels of confidence in their predictions, $F(1, 132) = .29$, *n.s.*

## Study 4

Studies 1 to 3 demonstrated that Chinese were more likely than Canadian participants to make predictions consistent with regression toward the mean. However, making predictions consistent with the phenomenon does not necessarily imply that people understand the rationale underlying regression toward the mean. Therefore, Study 4 was designed to address this question. Participants were presented with a scenario in which a regression toward the mean seems to have occurred and asked them to choose one reason from a total of five to explain it. Only one explanation was consistent with the logic underlying the regression.

### Method

*Participants*

Fifty-eight European Canadian students (42 women and 16 men) in Canada and 64 Chinese students (43 women and 19 men; 2 did not report gender) in China were recruited. Canadians received course credit and Chinese received a small gift for participating.

*Materials and procedure*

Participants read the following scenario taken from Nisbett et al (1983):

*Susan is the artistic director of a ballet company. One of her jobs is auditioning and selecting new members of the company. She says the following of her experience: "Every year we hire 10–20 young people on a 1-yr contract on the basis of their performance at the audition. Usually we're extremely excited about the potential of 2 or 3 of these young people – a young woman who does a brilliant series of turns or a young man who does several leaps that make you hold your breath. Unfortunately, most of these young people turn out to be only somewhat better than the rest."*

Participants were then provided with a list of 5 plausible explanations (see details in Appendix A) of Susan's observation and asked to choose one they preferred. The only explanation consistent with a regression toward the mean read, "The brilliant performances at audition are not typical of those actors' general abilities. They probably just made some dance moves at the audition that were much better than usual for them." This explanation recognizes the temporal change (or variability) and random error in the audition. Chinese participants, who presumably believed more in change and fluctuation, should appreciate such an explanation more than North Americans.

Next, the participants indicated the degree to which they agreed with each of the explanations on a scale, ranging from -4 (strongly disagree) to +4 (strongly agree). Finally, participants were asked to define the term "regression toward the mean."

## Results and Discussion

*Preferred explanation*

Three Chinese participants did not indicate their preferred explanation, thus they were not included in this part of the analysis. Supporting our hypothesis, more Chinese (29 of 61, 47.5%) than Canadian (14 of 58, 24.1%) participants chose the regression-consistent explanation, $\chi^2(1, N = 119) = 7.06$, $p = .007$, Cramer's V = .24. In contrast, more Canadian (26 of 58, 44.8%) than Chinese (13 of 61, 21.3%) participants chose an explanation suggesting that Susan mistakenly exaggerated the brilliance of the performance at the audition, $\chi^2(1, N = 119) = 7.46$, $p = .005$, Cramer's V = .25. There were no significant cultural differences for the remaining three explanations.

*Ratings of explanations*

As Figure 7 shows, the Chinese endorsed the regression-consistent explanation ($M$ = 1.44, $SD$ = 2.19) more than did the Canadians ($M$ = .07, $SD$ = 2.25), $F(1, 120) = 11.6$, $p = .001$, partial $\eta^2 = .09$. Canadians endorsed the explanation that Susan exaggerated the brilliance of the performance ($M$ = 1.43, $SD$ = 1.50) more than Chinese did ($M$ = .84, $SD$ = 1.84), $F(1, 120) = 3.68$, $p < .06$, partial $\eta^2 = .03$. In comparison with the Chinese ($M$ = -1.47, $SD$ = 2.21), the Canadians were more likely to disagree with the explanation that the brilliant dancers may slack off in order not to arouse envy ($M$ = -2.41, $SD$ = 1.80), $F(1,120) = 6.63$, $p = .01$, partial $\eta^2 = .05$. No significant cultural differences were found for the other two explanations.

*Previous knowledge of the term "regression toward the mean"*

At the end of the study, participants were asked to define the term "regression toward the mean." The finding that the Chinese participants were more likely than Canadian participants to choose a regression-consistent interpretation was apparently not due to cultural differences in

explicit knowledge of the concept. Two bilingual coders checked the definitions supplied by these participants against the correct one. If a response indicated some kind of shifting or changing toward the mean or average, then it was considered correct. The coders were in agreement with each other for all items (Only 16 Canadians and 2 Chinese attempted to provide a definition for the term whereas all the other participants indicated that they were not sure what the term meant). A greater proportion of Canadian participants (11 out of 58, 19.0%) than Chinese participants (1 out of 64, 1.6%) provided the correct definition, $\chi^2$ (1, N = 122) = 10.39, $p$ = .001. However, the Canadian participants did not use their knowledge of regression to endorse the regression-consistent explanation. Among the 11 Canadians who supplied the correct definition, only two Canadians chose the regression consistent explanation to explain the scenario.

In summary, we found that the Chinese participants preferred and endorsed a regression consistent explanation more than the Canadians did, suggesting that the Chinese participants had a better understanding of the phenomenon, despite the fact that they were not as familiar with the term "regression toward the mean" as Canadian participants were.

## Discussion

Regression toward the mean is a phenomenon that few North Americans predict and many have difficulty comprehending. Our studies demonstrated that cultural differences exist in predicting and understanding regression toward the mean. Sampling various domains, Studies 1 to 3 showed that the Chinese were more likely than the Canadians to make predictions consistent with regression toward the mean. In Study 1, compared with the Canadians, the Chinese participants predicted greater improvement in both scores and ranks following poor prior performance and greater decline in both scores and ranks following good prior performance

when the same amount of time and effort were assumed in preparation. In addition, the Chinese always estimated a wider range of rankings than the Canadians. In Study 2, compared with the Canadians, Chinese participants predicted lower cholesterol levels in the high condition, and higher cholesterol levels in the low condition, when no intervention was assumed. In Study 3, following an extremely high or low number of sunny days from the previous year, Chinese predicted that the number of sunny days would become closer to the mean in the following year, compared with the Canadians. In Study 4, the Chinese were more likely than the Canadians to choose a regression-consistent explanation to account for the phenomenon. Thus, the Chinese participants were more likely to make predictions in accordance with regression toward the mean and to understand why such predictions should be expected.

One explanation for the cultural differences in anticipating and understanding regression toward the mean is that Chinese may be less confident in their estimates and therefore may predict a larger range of values. The larger range would thus be more likely to include the regression-consistent predictions. However, there were no cultural differences in confidence in any of the studies. The Chinese expressed just as much confidence in their regression-consistent predictions as the Canadians did in their regression-inconsistent predictions. A second alternative explanation is that Chinese may be more likely to possess an explicit understanding of regression toward the mean. However, Study 4 demonstrated that the Chinese participants were significantly less likely than Canadians to provide the correct definition for the term.

We propose that cultural differences in appreciating and understanding regression toward the mean relate to people's lay theories of change. A linear theory of change leads to a belief in constancy and continuation, whereas a non-linear theory leads to anticipation of change and reversals. As a result, Chinese expect single extreme measures to become less extreme, whereas

North Americans tend to expect single extreme measures to remain extreme. Similarly, Chinese tend to expect increasingly extreme trends to become less extreme, whereas North Americans expect stability.

The present findings, with adult participants, are consistent with what has been found with older children. Ji (2008) asked Chinese and Canadian children (aged 7, 9, and 11 years) to make predictions about future performance, relationships, happiness, and parental incomes based on a series of scenarios. Overall, the Chinese participants predicted greater change than did the Canadian participants, indicating that they believed more in change than did the Canadians. Moreover, cultural differences increased significantly with age: In comparison with their Canadian counterparts, Chinese children made no more change predictions at age 7, made slightly more change predictions at age 9, and made significant more change predictions at age 11. For questions starting with an extremely positive or negative state, Chinese 11-year-olds predicted greater change (thus regression toward the mean) than their Canadian counterparts.

The finding that Chinese are more likely to predict and reason consistently with regression toward the mean suggests that culturally transmitted beliefs can affect people's response to some situations. Hastie (1984) found that when peoples' expectations are violated, they tend to search for a causal explanation. Lay theories of change likely serve as one source of such expectations. North American students expect consistency over time, and thus they search for or invent spurious explanations to account for a regression toward the mean, whereas Chinese expect change over time and thus readily accept a regression toward the mean. Interestingly, Chinese might search for an explanation when a phenomenon consistently remained extremely distant from the mean, rather than regressing. On a more practical note, cultural differences in appreciating regression toward the mean may lead to different decisions and behaviors. Ji, Zhang

and Guo (2008) compared stock market decisions of Canadian and Chinese university students and found that Canadian participants were more willing to sell and less willing to buy the falling stock than were Chinese participants. But when the stock price was increasing, the opposite effect occurred: compared with the Chinese, the Canadians were more willing to buy and less willing to sell.

Such decision-making patterns may be pervasive in the two cultures. Thus, a Canadian manager evaluating an individual's decline after a prior extremely positive performance may attribute the reduction to a lack of effort; a Chinese manager may expect change under these same circumstances. Consequently, the two managers may make quite different recommendations for hiring, firing, and promotion decisions. It is important to note that hasty decisions may cut short any tendencies of results to regress toward the mean. If a program is cut prematurely, or an employee is fired prematurely, people may not have the opportunity to observe the regression toward the mean phenomenon.

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Note

1. In the studies reported in this paper, we presented participants with one extreme measure at one point of time and asked them to predict for the future. We would make the same culture predictions for participants' responses to a trend progressing to the extreme.

2. We ran another version of the same study in which participants predicted a team's future performance based on its past performance, and found that participants made similar predictions as they did with individuals, as reported here.

Appendix A

Participants were given the following explanations (A, B, C, D, or E) in Study 4:

A. _____ Susan was probably mistaken in her initial opinion. In her eagerness to find new talent, she exaggerates the brilliance of the performances she sees at the audition.

B. _____ The brilliant performances at the audition are not typical of those actors' general abilities. They probably just made some dance moves at the audition that were much better than usual for them.

C. _____The actors who did so well at the audition probably could coast through the season on their talent alone and don't put out the effort necessary to transform talent into consistently excellent performance.

D. _____The actors who did so well at the audition may find that other actors are jealous. They may slack off so as not to arouse envy.

E. _____The actors who did so well at the audition are likely to be people with other interests. These interests would distract them from putting all their energies into the performance.

Figure Captions

*Figure 1.* Mean predicted changes in scores (+ SE) by Canadians and Chinese for poor, average, and good prior performance (Study 1).

*Figure 2.* Mean predicted changes in ranks (+ SE) by Canadians and Chinese for poor, average, and good prior performance (Study 1).

*Figure 3.* The estimated range of likely scores by Canadians and Chinese (Study 1).

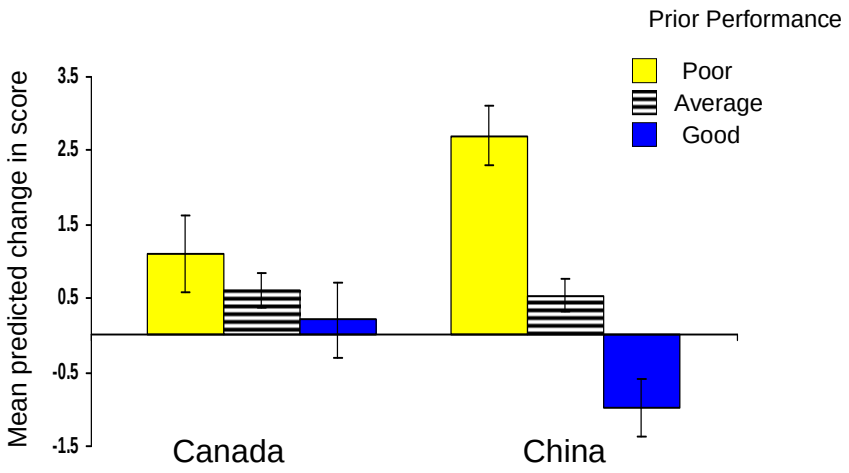
*Figure 4.* The estimated range of likely ranks by Canadians and Chinese (Study 1).

*Figure 5.* Predicted cholesterol levels (+SE) by Canadians and Chinese (Study 2).

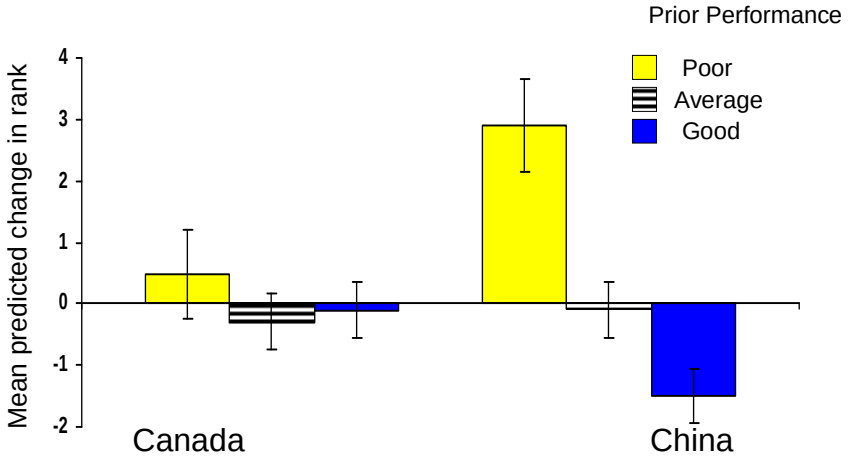
*Figure 6.* Predicted number of sunny days (+SE) by Canadians and Chinese (Study 3)

*Figure 7.* Canadians' and Chinese' average ratings of the five explanations (+ SE). The regression consistent explanation is B.

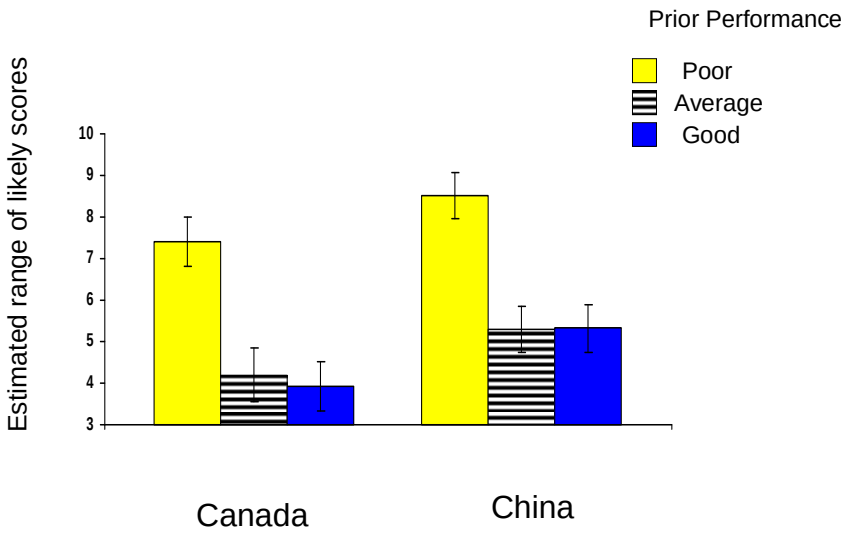
Culture and Regression
**Figure 1**



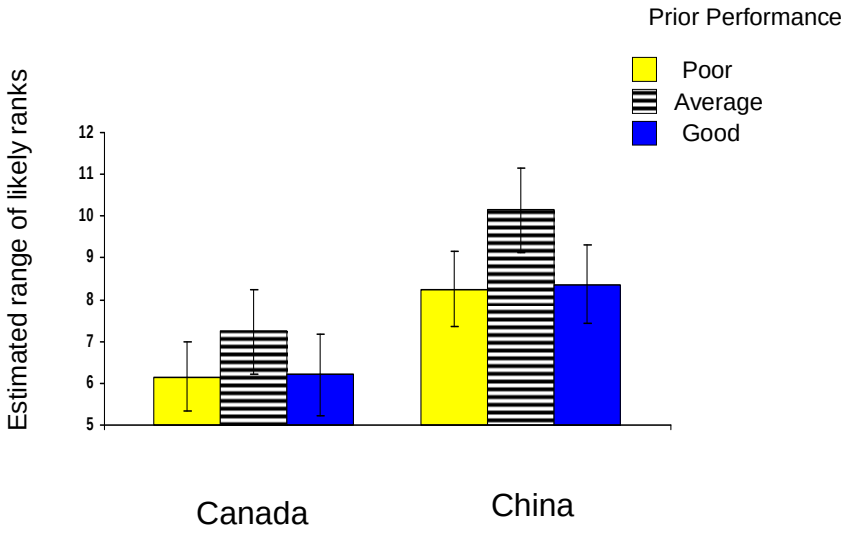

Culture and Regression
**Figure 2**



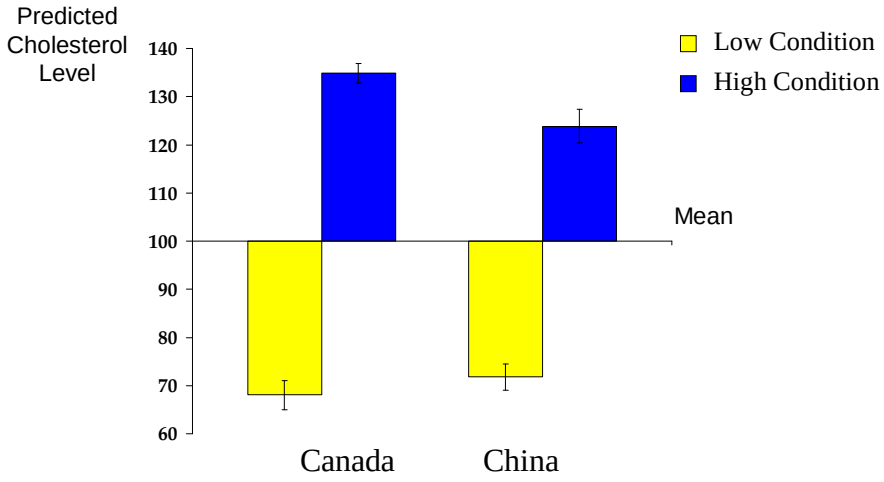
Culture and Regression
**Figure 3**



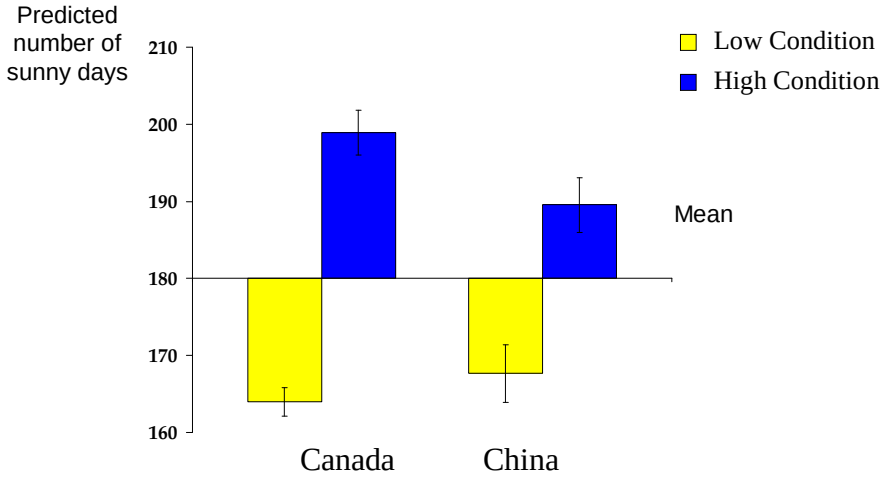

Culture and Regression
**Figure 4**



Culture and Regression
**Figure 5**




Culture and Regression
**Figure 6**



Culture and Regression
**Figure 7**