Hindsight Bias Around the World

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Abstract. Hindsight bias refers to the tendency to overestimate in hindsight what one has known in foresight, Recently, two experiment:, extended the research to include samples from different cultures (Choi & Nisbett, 2000; Heine & Lehman,. 1996). Asking their participants what they would have guessed before they knew the outcome ("hypothetical design"), Choi and Nisbett (2000) found that Koreans, in comparison to North Americans, exhibited more hindsight bias. Heine; and Lehman (1996),: however, reported that Japanese people in comparison to Canadians showed marginally less hindsight bias. In: a second study, in which participants were asked to recall what they had estimated before they knew the outcome ("fnemory design"), the latter authors found no difference in hindsight bias between Japanese people and Canadians. We extended these studies with 225 Internet participants, in a hypothetical design, from four different continents (Asia, Australia, Europe, and North America).: Hindsight bias was large and similar for all samples except for (ierman and Dutch participants who showed no hindsight bias at all. While the latter effect may be based on peculiarities of the materia! and of the participants, the former underscores the worldwide stability of the phenomenon. In addition a follow-up surprise rating (paper and pencil) in China (35 participants) and Germany (20 participants) revealed that only less surprising items led to hindsight, bias while more surprising ones did not. We suggest that the basic cognitive processes leading: to hindsight bias are by-products of the evolutionary-evolved capacity of adaptive learning. On top of these basic processes, individual meta-eognitions (e.g., elicited by surprise) or motives (e.g., a self-serving motive) may further moderate the amount of bias, thus explaining the diverging results of Choi and Nisbett (2000), Heine and Lehman (1996), and ourown study.

Key words: memory, judgment, hindsight bias, culture, surprise, self

Hindsight bias describes the tendency to adjust one's memory about earlier given estimates towards intermediately presented outcome information (Fischhoff, 1975). If, for example, a person answered the question of "How many bones does a human have?" with an estimate of "450," but later received the correct solution, namely "214," he or she may then erroneously recall to have given an estimate of "350." This would represent a shift of the original estimate towards the solution of 42.4% [= 100 x (450-350)/(450-214)] and thus indicate hindsight bias (as defined by Hell, Gigerenzer, Gauggel, Mall, & Muller, 1988). The described procedure represents the "memory" design, which is different from the "hypothetical" design in which the task is not to recall one's earlier given estimate, but rather to generate an estimate either in the presence of the solution (experimental group) or in its absence (control group). The experimental group in the hypothetical design is instructed to answer the question as if they did not know the solution (hence the term "hypothetical"). Several researchers reported that hindsight bias was larger in the hypothetical than in the memory design (Campbell & Tesser, 1983; Davies, 1992; Fischhoff, 1977; Fischhoff & Beyth, 1975; Heine & Lehman, 1996; Hertwig, Gigerenzer, & Hoffrage 1997; Powell, 1988; Wood, 1978, Exp. 2).

The phenomenon of hindsight bias appears to be very robust (see Christensen-Szalanski & Willham, 1991, and Hawkins & Hastie, 1990, for reviews) and has been demonstrated in numerous studies over a period of more than 25 years (as examples for more recent studies, see Dehn & Erdfelder, 1998; Erdfelder & Buchner, 1998; Hardt & Pohl, in press; Hertwig et al., 1997; Hoffrage & Hertwig, 1999; Hoffrage, Hertwig, & Gigerenzer, 2000; Louie, 1999; Pohl, 1998, 2000; Pohl & Gawlik, 1995; Pohl & Hell, 1996; Schwarz & Reips, 2001; Stahl-

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berg, Eller, Maas, & Frey, 1995; Wurman, Juslin, & Bjorkman, 1998).

In explaining hindsight bias, most researchers agree that cognitive processes are responsible for the observed systematic shift in recall. However, it is still under debate whether encoding the solution already leads to an irreversibly changed knowledge representation (e.g., Fischhoff, 1975; Hoffrage et al., 2000; Pohl, Eisenhauer, & Hardt, in press) or whether the solution only serves as a biasing retrieval cue when trying to reconstruct a forgotten estimate (e.g., Stahlberg & Maass, 1998; Strack & Mussweiler, 1997). In addition, some authors claimed that the amount of hindsight bias might be influenced by individual differences (see, e.g., Musch, in press; Stanovich & West, 1998). These differences may refer to cognitive style (Davies. 1992), ego involvement (Campbell & Tesser, 1983; Stahlberg, Eller, Romahn, & Frey, 1993), or certain motives (Campbell & Tesser, 1983; Verplanken & Pieters, 1988). However, the results in these studies were generally of small effect size, sometimes contradictory, and other studies failed to replicate them (e.g., Kohnert, 1996; Leary, 1981, 1982; Pohl, 2000; Pohl & Eisenhauer, 1995; Synodinos, 1986).

Nevertheless, the individual-differences approach to hindsight bias has recently received renewed attention and coverage when it was extended to encompass cultural differences (Choi & Nisbett, 2000; Heine & Lehman, 1996). Because the existence of such an influence would have important consequences for the explanation of hindsight bias, we decided to further explore the impact of culture on the amount of hindsight bias by using the current Internet possibilities, which make cultural comparisons easier than ever before. Theoretically, however, we question the existence of cultural differences on hindsight bias, because we assume that hindsight bias reflects basic features of the human information-processing system that have adaptively evolved to meet the needs of a common world so that hindsight bias should be the same in every culture.

Cultural Differences

Research on cultural differences concerning cognitive phenomena (like hindsight bias) has substantially increased in recent years (see Choi & Nisbett, 2000, for examples). Western and East Asian cultures especially have been contrasted in their different ways of thinking, learning, and problem solving. While the East Asian culture is assumed to have fostered a *holistic* way of thinking, Westerners are supposed to proceed rather *analytically*. The latter cognitive style focuses on the mere problem and favors a single, optimal solution derived from the properties of the problem itself. In contrast, the former, holistic style includes the field in which the problem is embedded and attributes causality to an interaction between the field and the problem (Choi & Nisbett, 2000). Corresponding to these considerations, several differences between Western and East Asian samples have been obtained. Due to their more holistic thinking, East Asians were, for example, less prone to the fundamental attribution error (Choi & Nisbett, 2000) and Japanese participants showed a smaller self-serving bias (Markus & Kitayama, 1991). Chinese participants also preferred dialectical proverbs that accept rather than deny a contradiction, whereas Americans chose nondialectical terms that reflect the rule of noncontradiction. In addition, Chinese participants sought dialectical or compromise solutions to avoid conflicts, preferred arguments based on holistic thinking to ones based on formal logic, and could accept two contradicting arguments to be both true (Peng & Nisbett, 1999). Similarly, Chinese participants were found to anticipate more changes from an initial state than Americans did, and people who predicted change were perceived as wise by Chinese more than by American participants (Ji, Nisbett, & Su, 2001).

In addition to the different ways of thinking (holistically vs. analytically), Eastern and Western cultures may also differ with respect to their predominant self-concept (Heine & Lehman, 1996; Markus & Kitayama, 1991). While the self of a typical representative of an Asian society is embedded in social relationships and thus rather *interdependent,* the self of a typical representative of a Western society is seen as more distinct and *independent* from others. In other words, the former strives more to "fit in" while the latter desires to "stick out." As a consequence, self-serving biases appear more apt in Western than in Eastern cultures, where they may even have negative implications, if they isolate the individual from his or her social network. This corresponds to the observation that Japanese participants showed a smaller self-serving bias than Americans (Markus & Kitayama, 1991). Another finding that supports this view came from Davies (1992). In two experiments studying individual differences within the same culture (Great Britain), he found that field-dependent persons produced a larger hindsight bias than field independent ones.[1] In accordance with this as well as their own results, Choi and Nisbett (2000) assumed that the interdependent self includes a higher degree of field dependence, as, for example, indicated by paying more attention to the

[1] Pohl and Eisenhauer (1995), however, failed to find a significant correlation between degree of field dependence and amount of hindsight bias using the memory design in a German sample.

social circumstances or to significant others. The episodes that they had used as materials in their experiments made explicit reference to this type of self-concept, thereby evoking any cultural differences that may exist.

Cross-Cultural Hindsight-Bias Studies

With respect to hindsight bias, we know of only two studies investigating cultural differences (Choi & Nisbett, 2000; Heine & Lehman, 1996).

Choi and Nisbett (2000) predicted that, compared to North Americans, Koreans should be less surprised by the unexpected outcome of an episode (because it quickly appears more natural and inevitable) and also show more hindsight bias (because the outcome is more readily accepted and integrated). This prediction is consistent with previous results on the relation between surprise and hindsight bias. Several studies have shown that hindsight bias was reduced, eliminated, or even reversed when the solution was perceived as highly surprising (Guerin, 1982; Hoch & Loewenstein, 1989; Kahneman, 1992; Kohnert, 1996; Mazursky & Ofir, 1990, 1996; Ofir & Mazursky, 1997; Schwarz & Reips, 2001; Verplanken & Pieters, 1988). In these cases, participants might have experienced a meta-cognition like "I would never have known that" (instead of "I knew it all along") and accordingly reconstructed an estimate further away from the given solution than they would have done otherwise (however, see the critical comments of Mark & Mellor, 1994).

In their Experiment 1, Choi and Nisbett (2000) asked 60 Korean and 60 North American students to assign probabilities to one of two possible outcomes (A and B) of a given episode after having received either Outcome A, Outcome B, or no outcome (cf. Fischhoff, 1975; Fischer & Budescu, 1995; Mazursky & Ofir, 1996; Stahlberg et al., 1995, Exp. 1). The episode, however, was constructed in such a way that one of the outcomes was highly improbable. As predicted by the authors, the results showed that the Koreans were less surprised by the unexpected outcome and exhibited more hindsight bias, that is, they assigned a higher probability to the unexpected outcome if it was given than when it was not. The North Americans, in contrast, were more surprised by the unexpected outcome and showed no hindsight bias at all. Experiment 2 replicated these findings with a different episode and different samples of Korean and North American students. Choi and Nisbett (2000) interpreted these results as indicating the postulated higher acceptance of contradictions by Koreans.

Heine and Lehman (1996) compared 82 Japanese with 82 Canadian students with respect to the veracity ratings that they assigned to 80 difficult assertions. The authors employed a hypothetical as well as a memory design within the same participants. The results showed that both samples (Japanese and Canadians) showed the same amount of hindsight bias in the memory design, but that the Canadians in comparison to the Japanese showed a marginally larger bias in the hypothetical design. The authors concluded from the first result that cultural differences are less likely to be observed for biases that solely (or primarily) rely on cognitive processes, while the second result was interpreted as showing the influence of a self-serving bias which was supposedly stronger for Canadians than for Japanese, as has been discussed above (Markus & Kitayama, 1991). This self-serving bias might have been evoked in the hypothetical design only because there it pays off to appear more knowledgeable, while its use would be disadvantageous in the memory design, in which the experimenter can easily compare the recalled estimates to the original ones. In line with these considerations, Musch (in press) reported larger effects of individual differences in the hypothetical than in the memory design.

In sum, the results of Heine and Lehman (1996) in the memory design suggest that the cognitive processes leading to hindsight bias are not culture-specific. This conforms to our view that hindsight bias reflects basic (in the sense of automatic) processes that are not easily (if at all) influenced by culturally learned strategies of thinking. The robustness of the bias (Christensen-Szalanski & William, 1991; Hawkins & Hastie, 1990) as well as all those unsuccessful attempts to reduce it (see, e.g., Fischhoff, 1982; Pohl & Hell, 1996) provide support for this position. However, depending on the material and the design, certain motives or meta-cognitions may be evoked thereby further modifying the amount of hindsight bias. In the hypothetical design, a stronger self-serving bias may inflate hindsight bias in Western cultures (Heine & Lehman, 1996), while for unexpected outcomes participants from Eastern cultures may be less surprised due to their holistic thinking and thus show more hindsight bias (Choi & Nisbett, 2000). But apart from these influences, the basic processes leading to hindsight bias should be the same all over the world.

Adaptive Learning and Memory

Several authors expressed the idea that hindsight bias is nothing but a by-product of an otherwise very useful function of human information processing, namely adaptive learning (see, e.g., Hoch

Loewenstein, 1989; Hoffrage & Hertwig, 1999; Hoffrage et al., 2000; Winman et al., 1998). In most situations we are well advised (1) to update our knowledge as soon as more reliable information is available (like the solution to a difficult question or the actual outcome of an episode) and (2) to forget our earlier estimates or predictions, which are known to be wrong (Schacter, 1996). The first process guarantees continuous learning, and the second that our memory will work more efficiently (Bjork & Bjork, 1988, p. 283): "The efficient retrieval of currently relevant information is facilitated by the loss of access to out-of-date information." There are, however, situations (like in hindsight studies or in eyewitness reports) in which veridical access to an earlier state of mind would be advisable. But these cases might be rare in reality, or as Bartlett (1932/1995) has put it, commenting on the schematic distortions of recall: "In a world of constantly changing environment, literal recall is extraordinarily unimportant." (p. 204)

If, then, hindsight bias were indeed caused by a mechanism of adaptive learning and remembering, we would expect that it should be difficult (if not impossible) to influence these basic processes by culturally acquired ways of thinking.

The Present Study

In order to further clarify the role of cultural differences in hindsight bias (Choi & Nisbett, 2000; Heine & Lehman, 1996), we employed a hypothetical design with numerical almanac questions as material (cf. Erdfelder & Buchner, 1998; Hell et al., 1988; Kohnert, 1996; Pohl, 1998; Pohl & Gawlik, 1995; Pohl & Hell, 1996). Christensen-Szalanski and Willham (1991) reported in their meta-analysis that hindsight bias was generally larger for almanac questions than for episodic material. This may in part explain (in addition to the high level of surprise) why Americans failed to show any hindsight bias in the Choi and Nisbett (2000) study.

In order to reach participants from all over the world, we decided to implement the experiment on the Internet. Possible advantages and disadvantages of this approach have been thoroughly discussed by Reips (2000, 2002). We will take up these points wherever appropriate. Probably the most important problem concerns the self-selection of participants, depending on their opportunities to have access to the Internet and on their language capacities. It is thus rather doubtful that a representative sample of a certain culture could be reached via the Internet. Conclusions from such studies should therefore be drawn with care.

To our knowledge, only one hindsight-bias study has used the Internet before (Schwarz & Reips, 2001), albeit only for a German sample. Their main result was that hindsight bias emerged only if both the level of surprise and the individual dismay were low. With respect to the role of surprise, this result fits nicely with the others cited above (Choi & Nisbett, 2000; Guerin, 1982; Hoch & Loewenstein, 1989; Kahneman, 1992; Kohnert, 1996; Mazursky & Ofir, 1990, 1996; Ofir & Mazursky, 1997; Verplanken & Pieters, 1988).

Method

Participants

Participants were recruited all over the world by contacting colleagues from different universities with a short letter explaining the aim of our study and asking them to forward the Internet address of our experiment to their students. We hoped that this procedure would increase the sample size and reduce the drop-out rate. Altogether, our server counted 589 visits to the experiment's Internet page and received 274 protocols of the experiment. The return rate of 47% thus was only marginally higher than had been found in other Internet studies (Batinic & Bosnjak, 1997). Of the received protocols, 47 were excluded from the analysis for the following reasons: Nine protocols were empty; 12 contained only one, two, or three of the requested 20 estimates (all remaining protocols contained between 11 and 20 estimates); 14 protocols were complete duplicates of other ones (i.e., were sent twice); six were partial duplicates (i.e., they contained estimates to the first 6 to 18 items of the questionnaire and were sent again from the same IP address a few minutes later, including the same estimates plus additional ones); three protocols were test files from the authors (as could be identified by having the word "test" in the commentary field); two protocols failed to provide the country of the participant; and one participant indicated that she was only 10 years old. Depending on their declaration of which country they had lived in most of their live, the remaining 227 participants were assigned to one of four continents (Asia, Australia, Europe, and North America). In a few ambiguous cases, preference was given to the country in which most of the first ten years of life were spent. There were no participants from Africa and only one each for South America (Chile) and Middle America (Mexico). These two were not included, thus leaving 225 participants in the final pool. Table 1 shows the frequencies for specific countries with more than five participants. Altogether, 124 participants (55.1%) were female and 101 male (44.9%) and their ages ranged from 16 to 72 years (with $M = 26.7$,,

SD = 9.8, *Mdn* = 23.0, *IQR* = 7.0 years). Two participants did not indicate their age.

Our main hypothesis was that hindsight bias would be the same for all cultural regions. By setting a = .20, the given sample size (IV = 225) was sufficient to detect a medium interaction effect (*f* = .25; Cohen, 1988) between continent (Asia, Australia. Europe, and North America) and condition (experimental vs. control) with a high power of 1-(3 = .97 (as computed by "G"Power"; Erdfelder, Faul, & Buchner, 1996).

Material

We selected 20 difficult numerical almanac questions from a pool of 224 items that were used in our lab and elsewhere (e.g., Erdfelder & Buchner, 1998; Hell et al., 1988; Pohl, 1998; Pohl & Hell, 1996). A question was considered difficult if it was answered correctly by less than three percent of the participants in earlier studies. In selecting the set of 20 questions, we avoided items that required any specific geographical or cultural knowledge about a region or a country. In addition, we consulted persons from different cultural backgrounds (Spanish, American, and Chinese) in an informal discussion and tried to jointly choose those questions that appeared to be most culturally fair to all of us. Examples were "How many bones does a human have?" or "How many prime numbers are contained in the interval between 1 and 1,000?"

The final selection of 20 questions was randomly ordered in a questionnaire and that order was kept constant for all participants. There were, however, two versions of the questionnaire. Version A contained the solutions to all questions with odd numbers, and Version B to all questions with even numbers. As a consequence, each questionnaire contained 10 experimental and 10 control items, that is, with and without solutions, respectively. The solutions were presented in a complete sentence right after the corresponding question. For example, "How many different kinds of insects inhabit the Antarctic? The correct answer is 52. What would have been your estimate if you had not known the solution?" The two versions of the questionnaire were alternately assigned to consecutive participants so that both versions were used equally often. From the 225 participants, 110 had filled out Version A and 115 Version B.

At the bottom of the questionnaire, a few demographic questions asked about sex, age, country of birth, country in which the first ten years of life were spent (indicating the number of years in case of more than one country), and other countries in which more than one year were spent after the age of 10. An additional commentary field allowed the participants to provide further information if they wished. Several participants used this field to evaluate the experiment (like "very interesting" or "too difficult questions") or to express their interest in the theoretical background or the current results. At the end of the questionnaire, we thanked all persons for their participation and promised to provide more information on the experiment as well as its results under the same URL in the near future. Our e-mail addresses were given on all pages.

The complete questionnaire was made available in English (as the default version) and in Spanish and can be inspected under the following URL: http://www.iim.uni-giessen.de/cross-cultural-hb). Only seven participants (five from Spain, one from Germany, and one from the Netherlands) used the Spanish version. Having not provided more language versions of the questionnaire might have resulted in a second self-selection (in addition to the selection due to the Internet accessibility; Reips, 2000, 2002). As a consequence, the resulting sample of participants could have been more Western oriented than intended, thus diminishing or even disguising any true cultural differences.

Procedure

The questionnaire was transformed into a HTML-based Web page using "SurveyWiz" (Birnbaum, 2000; URL: http://psych.fullerton.edu/mbirnbaurn/programs/surveyWiz.htm) and placed on a local server of the Justus-Liebig University Giessen. We checked the appearance und functionality with different computer systems (Windows 95, 98, 2000, and Mac OS 9.0 and 9.1) and different browsers (Internet Explorer and Netscape Communicator). The experiment was accessible worldwide from November 8, 2001, to February 27, 2002; that is, for about three and a half months. In addition to the participants' estimates, demographic data, and possible comments, the server also recorded the version of the questionnaire (A or B), the date, the time, the chosen language version, and the IP number of the sending computer. We made no attempts to automatically control for multiple submissions from the same IP address. In several cases, identical IP numbers were used repeatedly by different participants.

Analysis

The 225 protocols contained a total of 4,305 estimates. In 195 cases (4.3%), an estimate was missing. We excluded extreme estimates for each question

that were outside the median plus or minus three times the interquartile range (Tukey, 1977). According to this criterion, 193 estimates (4.5%) were considered too extreme and thus excluded. The remaining estimates as well as the solutions were then standardized separately for each question.

Design

The two independent variables in this experiment were the type of item (experimental vs. control) and the participant's continent (Asia, Australia, Europe, and North America). As dependent variable we computed the mean distance of the participant's estimates from the solutions.

Results

Internet study

Figure 1 presents the mean distances of the participant's estimates from the solutions for experimental and control items for the four continents considered here. The difference between these scores indicates the amount of hindsight bias. An ANOVA across the type of item (experimental vs. control) and the participant's continent (Asia, Australia, Europe, and North America) revealed a strong hindsight bias. The mean distance from the solutions was significantly

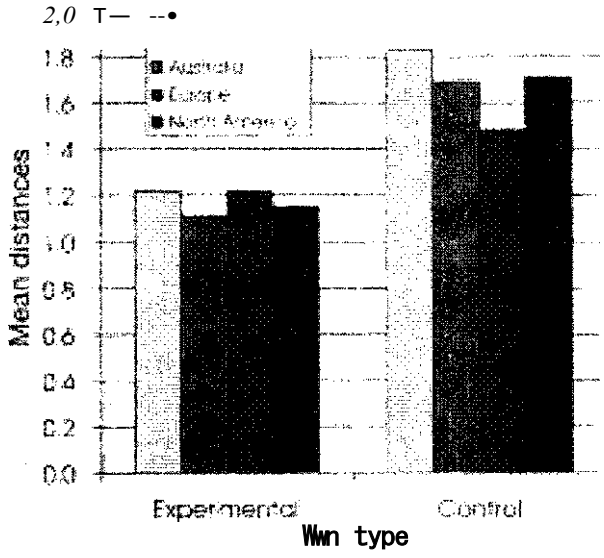

Figure 1. Mean distances of standardized estimates from solutions for experimental and control items (i.e., with and without solution, respectively) for participants from different continents.

smaller for experimental than for control items, namely 1.20 and 1.65, respectively, $F(1, 221) = 34.619$, $p < .0001$. The continents variable showed a main effect, too, $F(3, 221) = 1.212$, $p = .0001$, and, more importantly, the interaction between item type and continent came close to the conventional level of significance, $F(3, 221) = 2.545$, $p = .06$. While the amount of hindsight bias was highly similar for three continents, participants from European countries showed a much smaller bias.

Table 1 includes more detailed data for specific countries together with separate one-tailed i-tests and the effect size *d*. The overall effect size was large ($d = 0.72$) according to the norms suggested by Cohen (1988). Closer inspection of the data of the European sample revealed that participants from Germany ($N = 46$) and the Netherlands ($N = 6$) showed no hindsight bias at all (with effect sizes of $d = 0.08$ and 0.01, respectively), while those of Spain ($N = 7$), the United Kingdom ($N = 6$) and the remaining European countries ($N = 30$) showed the typical effect (with effect sizes of $d = 0.73$, 0.84, and 0.95, respectively), albeit not always statistically significant due to the small sample size. When Germany and the Netherlands were excluded from the overall ANOVA, the interaction effect completely vanished, $F(3, 169) = 0.078$, $p = .97$. The mean distances from the solution for the remaining European sample were 1.10 and 1.63 for experimental and control items, respectively, which represented a highly significant difference, $t(42) = -4.212$, $p < .0001$ (one-tailed), of a large effect size, $d = 0.91$.

For participants from Germany and the Netherlands, the mean estimates for experimental and control items were 1.33 and 1.37, respectively, while they amounted to 1.16 and 1.73 for all other countries. According to these data, it appeared that the main difference between the two samples lay in the control condition. Computing separate effect sizes for experimental and control items confirmed this impression with values of $d = 0.32$ and 0.78, respectively. In other words, compared to participants from other countries, German and Dutch participants gave much better estimates in the control condition, but more similar estimates in the experimental condition.

Looking at single countries of other continents revealed that the observed values were highly similar for control as well as for experimental items (see Table 1), that is, that the amount of hindsight bias was identical in all these countries with large effect sizes from $d = 0.54$ to 1.46. The one-tailed r-tests (in Table 1) were, of course, not always significant because the sample size for some countries was not large enough to detect effects of the given size.

In order to specifically test the replication of the results of Choi and Nisbett (2000) and Heine and Lehman (1996), we computed a restricted ANOVA

Table 1. Mean Distances of Standardized Estimates Towards Solutions for Participants from Countries with More Than Five Participants for Experimental and Control Items and Results of One-Sided /-Tests *(df=N-* 1) Together with Effect Size *d*

Countries	*N*	Items Exp.	Ctr.	*t*	*p*	*d*
Asia	65	1.22	1.83	-5.379	< .0001	0.94
China	42	1.26	1.84	-3.969	< .0001	0.87
India	13	1.14	1.81	-2.552	.01	1.00
Pakistan	6	1.26	1.84	-1.695	.08	0.98
Other countries	4	1.04	1.72	-2.063	.07	1.46
Australia	9	1.11	1.69	-2.045	.04	0.96
Europe	95	1.22	1.48	-2.993	<.01	0.34
Germany	46	1.32	1.37	-0.379	.35	0.08
Netherlands	6	1.33	1.33	-0.048	.52	0.01
Spain	7	1.00	1.54	-1.375	.11	0.73
United Kingdom	6	1.15	1.65	-1.447	.10	0.84
Other countries	30	1.11	1.64	-3.660	<.001	0.95
North America	56	1.15	1.71	-4.990	<.0001	0.94
Canada	41	• 1.11	1.75	-4.975	<.0001	1.10
USA	15	1.27	1.59	-1.486	.08	0.54
Total	225	1.20	1.65	-7.677	<.0001	0.72

across only two continents (North America vs. Asia) and item type (experimental vs. control). Again, mean distances from the solutions were significantly smaller for experimental than for control items, $F(\text{\textbackslash}, 199) = 53.063$, $p < .0001$, but there was no sign of an interaction with continents whatsoever, $F(\text{\textbackslash}, 119) = 0.111$, $p = .74$. In addition, the effect sizes of hindsight bias (see Table 1) were exactly the same for the Asian sample *(d* = 0.94; *N* -- 65) and for the North American sample *(d* = 0.94; 7Y = 56).

In the Asian sample, 33 people came from Hong Kong which may have flawed the comparison of the Asian and the North American sample, because the people from Hong Kong were possibly more Western oriented than other Asians, thus diminishing cultural differences. We therefore split the Asian sample into one group with participants from Hong Kong (IV = 33) and one with the remaining Asians *(N* = 32). The mean distances from the solutions for the Hong Kong sample then were 1.24 and 1.86 for experimental and control items, respectively, f(32) = -3.607,/? < .001 (one-tailed), $d = 0.89$. The corresponding means for the remaining Asian sample were 1.21 and 1.80, <32) = -4.004, $p < .001$ (one-tailed), $d = 1.00$. A two-factorial ANOVA accordingly found a strong effect of item type (experimental vs. control), that is, hindsight bias, F(1, 63) = 28.461. $p < .0001$, but neither a main effect of the sample (Hong Kong vs. remaining Asia) nor an interaction between sample and type of items, both *Fs* < 1. Thus, both subsamples of the Asian continent showed the same amount of hindsight bias.

Surprise ratings

In a follow-up study, we collected surprise ratings with two independent samples from Germany (20 students of the Justus-Liebig University Giessen) and China (35 students of the Panyu Polytechnic). None of the participants had taken part in our Internet-based experiment or other hindsight studies before. Each participant received a questionnaire listing the 20 questions that we had used in the Internet study together with the solutions. Following each question was a rating scale with the end points labeled as "not at all surprising" (0) and "highly surprising" (10). The participants were asked to indicate, for each question, how surprised they were when they read the solution. The questionnaires were written in German for the German students and translated into Chinese (by a native speaker of Chinese) for the Chinese students.

Germans gave a mean surprise rating of 4.30 *(SD* = 0.68; *Mdn* = 4.40; *IQR* = 1.20) and Chinese participants a highly similar one of 4.24 *(SD* = 1.24; *Mdn* = 4.20; *IQR* = 1.60), r(53) = 0.113, $p = .91$. Looking at single questions, however, revealed significant differences for five of the 20 questions. Interestingly, three of these five questions received significantly higher surprise ratings from German than from Chinese students (which thus corresponds to the situation in the Choi & Nisbett, 2000, study), while the pattern was reversed for the remaining two. Analyzing the amount of hindsight bias (as revealed by the estimates of the 46 German and 42 Chinese

participants in the Internet study) for these five questions with opposite ratings of surprise led to the following results (see Figure 2).

Independent from the specific sample (German or Chinese), hindsight bias was larger if the solution was considered less surprising than when it was considered more surprising. An overall ANOVA was unfortunately not possible due to missing cells, but two separate ANOVAs and subsequent r-tests confirmed the described pattern. A 2 x 2 ANOVA for items that were rated as *more* surprising by German than by Chinese students subjects found a marginally significant interaction between sample (German vs. Chinese) and condition (experimental vs. control), *F(l,* 82) = 2.956, p = .09. German participants showed no hindsight bias for these items, f(43) = -1.177, p = .25, d = 0.25, while Chinese participants showed a large hindsight bias for the same items, ?(39) = -2.759, p = .01, d = 0.62. The reversed pattern was found for questions that were considered *less* surprising by German than by Chinese participants. Again, a 2 x 2 ANOVA found a marginally significant interaction, F (1, 83) = 2.958, p = .09. But now German participants showed a strong hindsight bias for these items, r(43) = -3.667, p = .001, d = 1.12, while Chinese participants did not, *t(40)* = -0.972, p = .34, d = 0.29. Both interactions are illustrated in Figure 2.

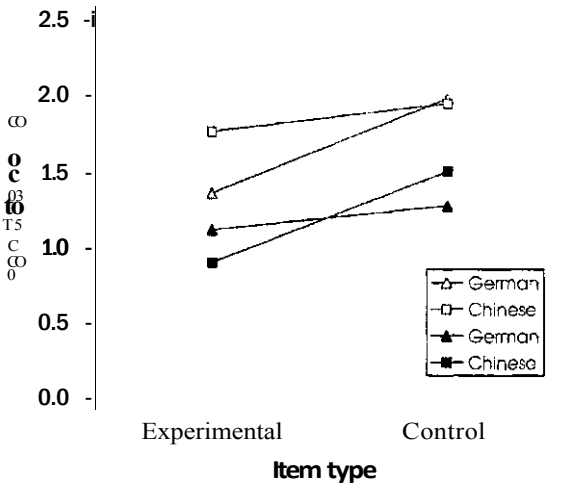

Figure 2. Mean distances of standardized estimates from solutions for German and Chinese Internet participants with items that were considered *less* surprising by German than by Chinese students (open symbols) and items that were considered *more* surprising by German than by Chinese students (filled symbols).

Next, we looked at the three least and the three most surprising items (with identical surprise ratings from German and Chinese students). The estimates in the Internet study showed hindsight bias only for the least surprising items, but not for the most surprising ones. A 2 x 2 ANOVA unfortunately failed to find a significant interaction between surprise (least vs. most) and condition (experimental vs. control), *F(l,* 80) = 0.948, p = .33. Separate f-tests nevertheless suggested that only the least surprising items elicited hindsight bias, £(82) = -3.350, p = .001, d = 0.22, while the most surprising ones did not, *t(S5)* = -0.424, p = .67, d = 0.11. Of course, the missing interaction and the not too different effect sizes qualify this result.

Discussion

Our Internet study assessed the amount of hindsight bias in four different continents (Asia, Australia, Europe, and North America) by using a hypothetical design with 20 numerical almanac questions and a total of 225 participants. The results showed identical amounts of hindsight bias for Asian, Australian, and North American participants, but a smaller one for the European sample. The surprising result for Europe was solely caused by German and Dutch participants, who showed no hindsight bias at all on average, while participants from the other European countries were prone to the same hindsight bias as the samples from the other continents. In other words, hindsight bias was identical for all countries (except two) from four continents thus corresponding to the memory-design results of Heine and Lehman (1996) and underscoring the robustness of hindsight bias (Christensen-Szalanski & Willham, 1991; Hawkins & Hastie, 1990). However, we neither replicated the Heine and Lehman (1996) hypothetical-design result of a marginally larger hindsight bias for North American students as compared to a Japanese sample nor the Choi and Nisbett (2000) finding of a significantly larger hindsight bias for Korean students as compared to a North American sample. We will return to these issues further below.

Missing hindsight bias

To our surprise, German and Dutch participants (with N = 46 and 6, respectively) showed no hindsight bias at all; that is, they produced nearly the same mean estimates independent of whether the solution was present (experimental condition) or not (control condition). Compared to other countries, they generated similar estimates in the experimental condition, but relatively better ones in the control condition. It thus appears that German and Dutch participants were no less influenced by the solution _

than others, but that they were simply more knowledgeable than others with regard to the almanac questions.

There are at least three explanations for this unexpected finding; namely a random result, a biased item selection, and experienced participants from our own university.

The first idea is that the missing hindsight bias just represents an exceptional, yet random result, especially for the small Dutch sample, as hindsight bias has been shown reliably with the same or similar materials for German participants in numerous studies (see, e.g., Dehn & Erdfelder, 1998; Erdfelder & Buchner, 1998; Hell et a1, 1988; Kohnert. 1996; Pohl, 1998; Pohl & Hell, 1996).

A second possible explanation is that the item selection may not have been as culturally fair as we had intended it to be. Possibly, we (as Germans) had preferred items from our own culture, that is, items that we felt more familiar with. But this may, of course, suggest that persons from our own cultural region were also more knowledgeable about these questions resulting in better estimates (cf. Pohl, 1992). A better procedure would have been to let people from all over the world name questions and then to combine these into a joint questionnaire that would certainly be more balanced than the present one. (As an aside it may be noted that Choi and Nisbett, 2000, too, failed to find hindsight bias for their North American participants using episodes that were rather Western oriented.)

A third reason for the missing hindsight bias (with respect to the German sample) could be that many German participants could have been students from our own university, because we had advertised the experiment quite intensively there (e.g., announcing it in psychology lectures). But many of these students may already have participated in earlier studies on hindsight bias using the same or similar materials (see, e.g., Pohl, 2000). In fact, 17 of the 20 questions of the present experiment had been used in other experiments from us before. As a consequence, such experienced students may have remembered a few of the solutions to the questions in the present experiment, thus changing alleged "control" items to experimental ones resulting in an unplanned hindsight bias for control items. We checked for this possibility in two ways, namely by inspecting the submitting IP addresses and by separately analysing the three items that should have been new to all participants.

Only two of the 225 protocols were sent from within the university, so that it made no sense to make these two participants responsible for the good estimates in the control condition. But. of course, other students may have used external providers with different IP numbers, which we could not detect. It might have been better to ask the participants in our Internet questionnaire about their profession and, if they indicated "student," to ask for their affiliation. But these questions might have resulted in an increased reluctance to press the submit button at the bottom of the page that contained both the almanac and the personal information questions.- Analysing the three questions that we had not used before, we found, in comparison to the German results for the whole set (see Table 1), a somewhat larger difference between estimates in the control (M = 0.96) and in the experimental condition (M = 0.83), which was, however, still far from significant, #44) = -0.861, p = .39, d = 0.17. The remaining world showed a significant hindsight bias for these items, ?(178) = -8.632, p < .0001, of medium effect size, d = .45.

In sum, it remains unfortunately open at the time what exactly caused the absence of hindsight bias for the German and Dutch participants in our study. As mentioned before, numerous other studies have shown that the same or similar material reliably elicited hindsight bias.

Cultural differences

Let us now return to the comparison of our results with those of the other two cross-cultural hypothetical-design studies on hindsight bias (Choi & Nisbett, 2000; Heine & Lehman, 1996). In contrast to these two studies, hindsight bias was absolutely identical for Asian and North American participants in our study. Even splitting the Asian sample into participants from Hong Kong, who might be more Western oriented in their thinking, and those from other Asian countries (India, Pakistan, and others) revealed no difference at all. This result corresponds to the memory-design results of Heine and Lehman (1996) and supports our view that hindsight bias is caused by basic cognitive processes that are not influenced by culturally acquired ways of thinking.

Differences may, however, be observed when individual motives or meta-cognitions come into play, as was probably the case with the highly surprising outcome in the episodes that Choi and Nisbett (2000) employed in their study. Their material elicited different levels of surprise that were negatively correlated to the degrees of hindsight bias. More specifically, hindsight bias was absent for the more surprised sample (in this case, the Canadian students), but present for the less surprised one (in this case, the Korean students). The degree of surprise might have determined whether or not specific meta-cognitions (like "I would never have known that!") are evoked which then counteract a biased construction of one's estimate.

These cognitive strategies may well reflect individual (or cultural) ways of thinking (Ji, Nisbett, & Su,

2001; Peng & Nisbett, 1999), but the present data suggest that this may be highly item specific. The analysis of hindsight bias with respect to the items' surprise (as collected in our follow-up survey) revealed that only less surprising items led to hindsight bias while more surprising ones did not. This pattern of results perfectly conforms to the findings of Choi and Nisbett (2000) and many other studies (Guerin, 1982; Hoch & Loewenstein, 1989; Kahneman. 1992; Kohnert, 1996; Mazursky & Ofir, 1990, 1996; Ofir & Mazursky, 1997; Verplanken & Pieters, 1988).

In addition, we found that this pattern does not only hold between samples from different cultures, but also within the same culture (in this case, Germany and China). Thus, our results argue against particular cultural influences on hindsight bias. If someone is highly surprised (for whatever reason), he or she will be less likely to exhibit hindsight bias (cf. Brigham & Wasserman, 1999; Ofir & Mazursky, 1997). Of course, cultural aspects may determine whether someone experiences surprise or not.

Heine and Lehman (1996) argued that their finding of a larger hindsight bias for Canadian students, in comparison to Japanese ones, might have been caused by a larger self-serving motive. Again, this motive is supposed to act on top of the "regular" cognitive processes leading to hindsight bias, just as the feelings of surprise do. But while surprise reduced the amount of hindsight bias, the self-serving motive apparently inflated it. In contrast to Heine and Lehman (1996), however, we detected no hindsight-bias difference between Asian and North American participants in our study, despite using the same hypothetical design and even similar material (almanac questions). From that we may conclude that a self-serving motive was not effective in our study, or at least not differently effective for the observed samples.

One major deviation, however, -was that we used the Internet to collect our data, while Heine and Lehman (1996) did this in introductory psychology classes in a face-to-face fashion. The latter situation might have fostered self-serving motives much more strongly than participation in the Internet study, in which participants and experimenters were complete strangers to each other, didn't have direct contact with each other, and probably expected to never "meet" again. These different situational characteristics might then account for the different arousal of individual motives and subsequently different amounts of hindsight bias. But this interpretation also underlines that the Internet is limited with respect to the investigation of certain phenomena.

Returning to the main finding of our study of no difference in hindsight bias worldwide, cne may, of course, argue that the effect of cultural ways of thinking was too small to be reliably detected by a sample of the given size. However, the sample size was sufficient to detect effects of at least medium size (according to the norms suggested by Cohen, 1988) and the actually observed hindsight-bias effects were, moreover, large and identical for Asian and North American participants (d = 0.94). In other words, there was no hint of even a small difference that could have reached statistical significance with a larger sample. One key problem, however, could be that the self-selection of our participants, due to their access to the Internet as well as their language capacities (English), led to samples that were not really representative of their own culture but generally too similar to each other (and possibly also too much Western oriented). This, in turn, could have reduced or even eliminated any "true" cultural differences (Reips, 2000, 2002). One should therefore be careful in drawing too strong conclusions from the present study.

Functions of hindsight bias

Although this study was not explicitly designed to test the genesis of hindsight bias, the results are in accordance with our claim that hindsight bias reflects basic features of the human information-processing system and can be understood as a side effect of adaptive learning (Hoch & Loewenstein, 1989; Hoffrage & Hertwig, 1999; Hoffrage et al., 2000; Winman et al., 1998). The possible architecture and details of these processes have been laid out in a recently proposed cognitive process model named "SARA" (Selective Activation and Reconstructive Anchoring; Pohl, Eisenhauer, & Hardt, in press). According to this model and as implied by its name, two processes are responsible for hindsight bias. One is the encoding of the solution, a process that alters the associative structure in long-term memory thereby changing the retrieval probabilities of stored information (cf. Fischhoff, 1975; Hoffrage et al., 2000). The other is the reconstruction of a forgotten estimate, a process that may involve a biased memory search if the solution functions as a retrieval cue (cf. Stahlberg & Maass, 1998; Strack & Mussweiler, 1997).

But such "failures" of our cognitive system may be more than just an unavoidable by-product of adaptive learning. Some authors discussed the possibility that these "errors and biases" have evolved adaptively, too; that is, that they themselves possess an adaptive function (cf. Anderson, 1991a, 1991b; Anderson & Schooler, 1991; Bjork & Bjork, 1988; Campbell & Tesser, 1983; Hoch & Loewenstein, 1989; Schacter, 1996). The following examples illustrate this claim.

Hoch and Loewenstein (1989), for example, argued that persons might benefit from feedback in a hindsight study despite its distorting effects on memory. They showed that feedback (about the true solutions in 2-alternative forced-choice questions) allowed extracting diagnostic information concerning the difficulty of the material. This information could in turn be used to assess population base-rates as well as to calibrate one's personal knowledge. More evidence came from hindsight studies using true or false assertions as material (see, e.g., Davies, 1992; Fischhoff, 1977; Fischhoff & Beytfi, 1975: Hasher, Attig, & Alba, 1981; Sharpe & Adair, 1993; Wood 1978). Hindsight bias was frequently larger for true than for false assertions in these studies (cf. Christensen-Szalanski & Willham, 1991), This asymmetry has been explained by assuming a reiteration effect that increased the perceived truth o^ true and false assertions alike (Hertwig et al., 1997). One may, however, speculate whether this mechanism reflects an adaptive function, because it appears highly useful that humans tend to ascribe more trash to repeatedly observed events. Discrimination of what is real (in the sense of lawful and thus predictable) and what is random certainly was an important precondition in learning to form abstract representations of the world (Gigerenzer, 1998).

Whether the cognitive processes responsible for hindsight bias are just by-products of our capacity of adaptive learning or have evolved due to some adaptive value of their own (like in the case of "sprandels", Gould, 1991), is still an open question. But it should be clear that our finding that hindsight bias appears to be similar all over the world (at least for the countries included in our study) lends strong support to the assumption of a universal cognitive "error" that is part of our evolutionary heritage.

Whatever the true evolutionary role of hindsight bias might be, we believe that it is necessary to consider these possible functions in future research, because that would allow to embed hindsight bias (as well as other "distortions" and "errors") in a broader field of research (see also Gigerenzer, 1998; Tooby & Cosmides, 1992). Hoffrage et al. (2000), for example, argued that one function of the processes leading to hindsight bias mk^ht be to prevent our memory from overload. By continuously adjusting past information to more recent one, capacity problems will be efficiently avoided (Bjork & Bjork, 1988; Schacter, 1996). Furthermore, due to this adjustment, the experience of hindsight bias may also improve our inferences over time (Hoch & Loewenstein, 1989; Hoffrage et al.. 2000). We thus propose that it will be a fiuitful enterprise to investigate these questions as we are com meed that a functional approach may represent the key to a deeper understanding of hindsight bias.

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