

Title

A cross-cultural study of hindsight bias and conditional probabilistic reasoning

Authors

Hiroshi Yama

Department of Psychological and Behavioral Sciences, Kobe College
Nishinomiya 662-8505, JAPAN

Ken I. Manktelow

School of Applied Sciences, University of Wolverhampton
Wulfruna Street, Wolverhampton, WV1 1LY, UK

Hugo Mercier

Philosophy, Politics and Economics Program, University of Pennsylvania
313 Cohen Hall, 249 south 36th street, 19104 Philadelphia, Pennsylvania, USA

Jean-Baptiste Van der Henst

Institut de Sciences Cognitives
69675 Bron, FRANCE

Kyung Soo Do

School of Social Sciences, Sung Kyun Kwan University
53 Myungryundon-3ga, Seoul 110-745, KOREA

Yayoi Kawasaki

Humanities and Sciences, Nihon University
Sakurajosui 3-25-40, Setagaya, Tokyo 156-0045, JAPAN

Kuniko Adachi

Department of Biochemistry and Molecular Pathology, Osaka City University Medical School
Abeno, Osaka 545-8585, JAPAN

Short title: Hindsight bias and conditional reasoning

Correspondence to:

Hiroshi Yama

Email address: yama@mail.kobe-c.ac.jp

Postal address and telephone:

Department of Psychological and Behavioral Sciences, Kobe College

Nishinomiya 662-8505, JAPAN

+81 (0) 798 51 8665

Acknowledgement

This research has been supported by a CHORUS grant from the French Ministry of Research and the Japanese Society for the Promotion of Science and by a grant-in-aid from the Japanese Society for the Promotion of Science (No. 19202012; The project leader is Yukinori Takubo). We thank Mike Oaksford, Yukinori Takubo, Incheol Choi, Linden Ball, and Hartmut Blank for their comments on this research. We also thank Junichi Taniguchi and Masasi Hattori for their arrangement of running parts of this experiment. Furthermore, we thank Jonathan St. B. T. Evans, Shira Elqayam, and an anonymous reviewer for their comments on our draft.

Abstract

Hindsight bias is a mistaken belief that one could have predicted a given outcome once the outcome is known. Choi and Nisbett (2000) reported that Koreans showed stronger hindsight bias than Americans and explained the results using the distinction between analytic cognition (Westerners) and holistic cognition (Easterners). The purpose of the present study was to see whether hindsight bias is stronger among Easterners than among Westerners using a probability judgment task, and to test an ‘explicit-implicit’ hypothesis and a ‘rule-dialectics’ hypothesis. We predicted that the implicit process is more active among Easterners to generate hindsight bias, and that Easterners are more dialectical thinkers, whereas Westerners are more rule-based thinkers. French, British, Japanese, and Korean participants were asked to make probabilistic judgments in a Good Samaritan scenario (Experiment 1) and in a scenario including conditional probabilistic judgment (Experiment 2). In both Experiments, we presume that the implicit revision of causal models is made just by being given unexpected outcome information, and that explicit revision is made by being asked to point out possible factors for an unexpected outcome. In the results, Easterners showed greater hindsight bias generally and it was greater in the Good Samaritan scenario. We conclude that the reason why hindsight bias was lower among Westerners is primarily that they tried to follow a rule to suppress the bias.

Over the last two decades, many cross-cultural studies have revealed cultural differences in cognition between Westerners and Easterners. Nisbett (2003; Nisbett, Peng, Choi, & Norenzayan, 2001) reviewed these studies and argued that Westerners are more likely to engage in analytic cognition, whereas Easterners are more likely to engage in holistic cognition. According to his definition, analytic cognition involves detachment of the object from its context, a tendency to focus on attributes of the object to assign it to a category, and a preference for using rules about the categories to explain and predict the object's behavior. In contrast, holistic cognition has an orientation to the context or the field as a whole, attention to relationships between a focal object and the field, and a preference for explaining and predicting events on the basis of such relationships (e.g., Masuda & Nisbett, 2001).

The distinction between analytic and holistic cognition is one of the important distinctions that dual process theories (e.g. Chaiken, & Trope, 1999; Evans, 2007; Evans & Over, 1996; Sloman, 1996; Stanovich, 1999), which propose that human thinking has two types of processes, have emphasized. According to dual process theorists, the properties of the evolutionarily old heuristic system are implicit, automatic, fast, intuitive, contextual, associative, and etc., whereas the properties of the evolutionarily recent analytic system are explicit, controlled, slow, reflective, abstract, rule-based, and so on. However, Nisbett (2003; Nisbett et al., 2001) did not discuss dual process theories, and his claims have not yet been fully discussed by dual process theorists. The distinctions between analytic and holistic cognition that Nisbett (2003; Nisbett et al., 2001) acknowledges correspond to some extent to those between the two types of processes that dual process theories describe. One possible reason why Nisbett did not refer to dual process theories is that it is implausible to hold that Westerners use an evolutionarily recent system whereas Easterners utilize an evolutionarily old system.

According to one recent version of dual process theories (Stanovich, 2009), although the evolutionarily old system, which Stanovich calls the autonomous mind, and the evolutionarily recent system, which he calls the algorithmic mind, are immutable, he argues that the disposition to use the algorithmic mind can be affected by personality, education, culture, etc. This usage is mutable, and, therefore, the distinctions between analytic and holistic cognition identified by Nisbett (2003; Nisbett et al., 2001) can be related to the differences in style of using the algorithmic mind indicated by Stanovich. This is compatible with the fact that cognitive styles can readily be changed between analytic and holistic. For example, Kühnen and Oyserman (2002) demonstrated that people who were asked to think of 'we' (cultural priming) were better at tasks that required holistic cognition, while Koo and Choi (2005) found that Korean students who learned oriental medicine were more likely to engage in holistic cognition than those who learned psychology.

Buchtel and Norenzayan (2009) examined whether the cultural definitions of analytic

and holistic styles appear to parallel the properties of the two distinct systems of dual process theories. In the case of rule-based reasoning, Norenzayan, Smith, Kim, and Nisbett (2002) demonstrated that Americans preferred formal reasoning more than Koreans did. They discussed whether this preference of Americans could reflect the analytic cognition of Westerners. It corresponds to rule-based reasoning by the evolutionarily recent system. However, it is unrealistic to presume that Westerners primarily use the evolutionarily recent system whereas Easterners use the evolutionarily old system. Rather, it is more reasonable to regard these differences as reflecting people's preferences. Furthermore, Peng and Nisbett (1999) reported that Chinese people were less sensitive to contradiction in proverbs and thus more tolerant of proverbs with contradiction than were Americans. They argued that this was because the Chinese preferred dialectical thinking to rule-based reasoning.

One of the problems, which is pointed out by Buchtel and Norenzayan (2009), is the distinction between explicit and implicit processing. According to dual process theorists, analytic cognition needs explicit processing, whereas holistic cognition entails implicit processing. However, in cross-cultural studies of causal attribution, which consists of an initial dispositional attribution stage (analytic cognition) followed by a situational correction stage (holistic cognition), Knowles, Morris, Chiu, and Hong (2001) reported that Westerners made dispositional attributions automatically (implicitly) whereas Easterners did this effortfully (explicitly); however, Westerners made situational corrections effortfully whereas Easterners did this automatically. In short, Easterners employ holistic cognition implicitly, whereas Westerners employ analytic cognition implicitly. This means that culturally trained modes of thinking can be effortless, automatic, and implicit. On the other hand, Kim (2002) reported that although the performance of Korean Americans was impaired by thinking aloud, that of European Americans was not. This suggests that the thinking of Easterners is less mediated by explicit verbal processes. Therefore, it is still an open question whether Easterners' cognition is more implicit than Westerners'.

Hindsight bias is a promising phenomenon in addressing this question. This is because the process that produces this bias is assumed to be implicit (Hawking & Hastie, 1990), the process can be interpreted as dialectical thinking that can contrasted with rule-based inference, and cultural differences in this bias have been reported by Choi and Nisbett (2000). The bias consists of a mistaken belief that one could have predicted a given outcome once the outcome is known (Fischhoff, 1975). Hence it is a false meta-judgment on one's former judgment; it is also called the "knew-it-all-along effect". It can be characterized as an inability to retrieve pre-outcome explanatory perspectives.

The bias has been explored by two kinds of paradigms. The method that Fischhoff (1975) used was a *hypothetical* design in which participants are asked to generate estimates from a

scenario. The participants in the experimental group are given the outcome information, but they are asked to suppose hypothetically that they do not know it. The other is called the *memory* design, in which participants are asked to answer several questions such as ‘In what year did Goethe die?’, and to recall their original answers after they are told the correct answers. Hindsight bias is defined as the effect of the outcome information on the answers.

Hindsight bias had been assumed to be universal among humans. However, using the hypothetical design, Choi and Nisbett (2000) reported that Koreans showed greater hindsight bias than Americans. In their experiment, Korean and American participants were asked to estimate the probability that a victim would be helped by a religious, generous, and helpful man in a Good Samaritan scenario (Darley & Baston, 1973). (The vignette in Experiment 1 of the present study was based on this scenario and is shown in the Appendix.) People usually expect the man to help the victim. Half of the participants were given the outcome that he actually did not help. When Korean participants knew the unexpected outcome, they estimated a lower probability of help than Americans did, even though they were asked to do so supposing hypothetically that they did not know the outcome. This decrease in estimated probability is the measure of hindsight bias, and thus it was inferred that Koreans showed greater hindsight bias. In other words, Koreans felt more strongly that they could have predicted the outcome. Choi and Nisbett (2000) proposed that these tendencies among the Koreans were due to their having more complex models for events than the Americans did.

The term ‘complex model’ is included in the concept of holistic cognition that is contrasted with analytic cognition. However, regarding cultural differences in hindsight bias, the explanation of Choi and Nisbett (2000) that Koreans had more ‘complex models’ for an unexpected outcome is insufficient. This explanation can be unpacked into two more detailed hypotheses. One is a hypothesis based on the distinction between explicit and implicit processes, and the other is one based on the distinction between rule-based thinking and dialectical thinking. These correspond to the two dimensions of dual process theories that Buchtel and Norenzayan (2009) pointed out.

The results on cultural differences in hindsight bias reported by Choi and Nisbett (2000) can be interpreted in terms of the following two hypotheses. The ‘explicit-implicit’ hypothesis claims that Easterners are more likely than Westerners to employ implicit processing. The first ground for this hypothesis is that the process producing hindsight bias is implicit (Hawkins & Hastie, 1990), and that the bias is stronger for Koreans than for Americans (Choi & Nisbett, 2000). The second ground is based on the results that Kim (2002) reported, where she suggested that the thought of Easterners is less mediated by explicit verbal processes than is that of Westerners.

Secondly, the ‘rule-dialectics’ hypothesis claims that Westerners prefer rule-based

thinking, whereas Easterners prefer dialectic thinking. This hypothesis is based on the results of Norenzayan et al. (2002), who demonstrated that Easterners were less likely to perform rule-based inferences than Westerners in categorization, conceptual structuring, and deductive reasoning, and on the results of Peng and Nisbett (1999) who indicated that Chinese participants preferred dialectics compared to Americans. This hypothesis can be applied to the results of Choi and Nisbett (2000). The participants could suppose a rule based on the scenario that, if a person is very religious and generous, then (s)he is very likely to help a victim. The given antecedent is true in the scenario, hence the probability that (s)he helped the victim is high. But, although the outcome information that (s)he did not help the victim was given, the participants were asked to suppose hypothetically that they did not know the outcome in the outcome condition. If participants stick to the rule, this supposition gets stronger, and thus, the hindsight bias is small, whereas if the participants use dialectics and consider both the rule and the outcome information, the hindsight bias increases.

Before describing more detailed predictions from the two hypotheses, it is necessary to refer to cognitive theories of hindsight bias. Blank and Nestler (2007) grouped them into three categories. All the theories focus on the original memory representation constructed by a scenario or a context, and its updating process following added information. Rather than discuss the differences among these models, we propose possible models that can be applied to explain the cultural differences in hindsight bias reported by Choi and Nisbett (2000). Our theoretical models are based on CMT (causal model theory; Hawkins & Hastie, 1990; Nestler, Blank, & von Collani, 2008), which aims to explain hindsight probability judgment for event outcomes in the hypothetical paradigm. According to this idea, an initial model is constructed when people are given a scenario. The initial model is just for the most plausible outcome from the situation described by the scenario. When information that the plausible outcome did not actually occur is given, people search for causal factors that might explain the unexpected outcome, which they add to the models to be revised. In general, a process such as searching for causal factors should be conscious and effortful. However, Hawkins and Hastie (1990) argue that the process in the case of hindsight bias is automatic and implicit: people do not notice the revision consciously, and therefore, hindsight bias occurs. Fischhoff (1975) describes the influence of outcome information as 'creeping determinism'. This means immediate and automatic integration of the outcome information with a person's knowledge about the target events preceding the outcome, so that the new outcome information is effortlessly embedded in knowledge structures.

In short, we suggest two reasons for the low level of hindsight bias in the American participants' results reported by Choi and Nisbett (2000). Using the terms of CMT (Hawkins & Hastie, 1990), according to the 'explicit-implicit' hypothesis, one possibility is that Westerners do not search implicitly for causal factors that might explain the unexpected outcome, hence

they do not revise their initial causal model. As for the ‘rule-dialectics’ hypothesis, we suggest two possibilities. In the first case, Westerners do not revise their initial causal models even if outcome information is given. In the second case, although Westerners revise the initial causal models implicitly or explicitly, they try to be hypothetical following the rule that they suppose, and hence they adjust (re-revise) the revised causal models.

The purpose of this study was to test the ‘explicit-implicit’ hypothesis and the ‘rule-dialectics’ hypothesis. We manipulated implicitness and explicitness in the following paradigm in order to make distinct predictions from the two hypotheses. The first step followed previous studies of hindsight bias that used the hypothetical design (Choi & Nisbett, 2000; Fischhoff, 1975). Participants received information about a target event. Participants in the non-outcome condition were asked to estimate the probability of the plausible target event based on the information. Participants in the outcome condition were informed of the outcome that the target event did not actually occur, but were then asked to estimate the probability of the originally expected target event as if they had not received the outcome information. The hindsight effect is defined as the difference in probability estimation between the non-outcome condition and the outcome condition, and we propose that implicit access to the causal models is achieved so that the revised causal models more strongly predict the unexpected consequence (Hawkins & Hastie, 1990). In the second step, all the participants were asked to suppose that the outcome is that the target event did not occur, and to point out possible causal factors for why it did not occur. This is the repeated statement of the unexpected outcome for the participants in the outcome condition. This manipulation establishes explicit causal links between the original information and the unexpected outcome, which we assume makes it possible to have explicit access to the causal models (e.g., Arkes, Faust, Guilmette, & Hart, 1988). In the third step, the participants are asked to judge the probability that the expected outcome occurred thinking back to the time when they had not been yet been informed of the outcome. The difference in probability estimation between the first step and the third step may also be regarded as explicit hindsight bias. However, in order to avoid confusion about the definition of hindsight bias in previous studies (e.g., Fischhoff, 1975), we do not call it hindsight bias.

Insert Table 1 about here.

We propose three possible pattern models of ‘revision of causal models’, as shown in Table 1. They are based on CMT (Hawkins & Hastie, 1990), and used in order to make distinctive predictions from the two hypotheses. Firstly, the ‘rule-based without revision’ model supposes that the rule-based tendency is so strong that the outcome information and causal factors for the unexpected outcome are neglected. Hence, according to this model, the original

causal models are kept as they are, so the estimated probability of the target event is high in all conditions, as shown in Table 1. Furthermore, we include an additional possibility for the rule-based inference. It is possible that, although the original causal models are revised, the revised models are adjusted (re-revised) so that people can stick to their rule. It is also predicted that the estimated probabilities will be high in all the conditions from the additional possibility.

Secondly, the ‘rule-based with explicit revision’ model supposes that the initial causal models are not revised by the outcome information. The outcome information does not make the causal information available implicitly, and thus does not revise the causal models, but after pointing out possible causal factors for the unexpected outcome, the models are revised explicitly so that the estimated probability of the target event decreases. Hence the estimates will be lower in the final judgment in both the conditions.

The third is the ‘implicit revision’ model, which is equivalent to the ‘dialectics’ model. It supposes implicit revision of causal models by the outcome information, hence the estimate of probability of the initial judgment in the outcome condition will be lower. However, because the models have already been revised by the outcome information, the models are not revised any more after pointing out causal factors for the unexpected outcome. On the other hand, the causal models are revised by explicit access to the causal information in the non-outcome condition. Hindsight bias is predicted only by this model.

We used British and French participants as samples of Westerners, and Koreans and Japanese as samples of Easterners. Before we state which model is the best fit to the data of Westerners and of Easterners, we need to note that in some cross-cultural studies of hindsight bias cultural differences between Westerners and Easterners are not always observed. For example, Heine and Lehman (1996), using both the hypothetical design and the memory design, found that both Japanese and Canadian participants showed hindsight bias, and that the Canadians even showed a marginally greater bias in one case. The authors inferred that this was because a self-serving bias is stronger for Canadians than for Japanese people. They had already found that Westerners, including Canadians, were likely to evaluate themselves more highly than Easterners, including Japanese, do (Heine & Lehman, 1995). This self-serving bias makes people believe that they are more able than they are so that they keep self-esteem high, and hindsight bias can work so that people appear more knowledgeable. Heine and Lehman (1996) inferred that Canadians show slightly greater hindsight bias for this reason. Pohl, Bender, and Lachmann (2002) report that while hindsight bias was weaker for European people, using the memory design, it was not weak for North Americans (from Canada and the United States) or for Asians. Thus it is still uncertain whether hindsight bias is generally stronger for Easterners than for Westerners, and it is clear that many factors might affect this bias.

Many of the previous cross-cultural studies of the differences between Westerners and

Easterners used samples just from two countries: a Western country and an Eastern country (e.g., Choi & Nisbett, 2000). But it is sometimes risky to regard the differences found in such studies as representative of the contrast between Westerners and Easterners. We gathered data in four countries: France, the UK, Japan, and Korea. Overall, we expected that the French and British would show the pattern that we predict to be typical of Westerners, whereas the Koreans and Japanese would show the predicted pattern of Easterners.

Experiment 1

Experiment 1 involved an adaptation of Choi and Nisbett's materials: the Good Samaritan scenario. Participants are asked to estimate the probability that a religious, generous, and helpful seminary student helps a victim (see Appendix). One of the purposes of Experiment 1 was to test whether the findings that hindsight bias is greater for Easterners than for Westerners would be replicated among British, French, Japanese, and Korean participants. We also set out to test the two hypotheses: the 'rule-dialectics' hypothesis and the 'explicit-implicit' hypothesis. Both hypotheses predict that the Easterners' estimated probabilities that the target person helps the victim would be lower in the outcome condition than in the non-outcome condition in the initial judgment, and that Easterners in the non-outcome condition would revise their causal models after they point out causal factors as to why the target person did not help the victim. Thus their estimated probabilities should decrease in the final judgment, whereas, in the outcome condition, they would not revise their causal models even after they pointed out causal factors because their models have already revised by the outcome information. In a nutshell, it is predicted that the response patterns of Japanese and Koreans would fit the 'implicit revision' model. However, the 'explicit-implicit' hypothesis predicts that, although Westerners' causal models are not revised by the outcome information, they are revised after causal factors for not helping become explicit, and thus their estimated probabilities would decrease in the final judgment. In contrast, the 'rule-dialectics' hypothesis predicts that Westerners do not revise their causal models even after pointing out causal factors, and that even if they revise their causal models, they adjust their revised models to stick to the rule. Therefore, according to the 'rule-dialectics' hypothesis, the response patterns of British and French would fit the rule-based without revision model, whereas, according to the 'explicit-implicit' hypothesis, they would fit the 'rule-based with explicit revision' model.

Method

Design The design was 4 (nationality: French, British, Japanese, Koreans) by 2 (outcome:

non-outcome, outcome) by 2 (trial: initial, final) in each task. “Nationality” and “outcome” were between-subjects factors.

Participants Ninety-three British university students at the University of Wolverhampton majoring in psychology participated. However, 24 of them had grown up in ethnic minority, mainly South Asian, cultures in Great Britain, and so 33 in the non-outcome condition and 36 in the outcome condition were used for the ANOVA. The means of the ethnic minority participants are shown in footnote 2. Ninety-seven French university students at the Catholic University of Lyon majoring in psychology participated (three participants had missing data, hence 46 in the non-outcome condition and 48 in the outcome condition were used for statistical analysis), along with 114 Japanese university students at Kobe College and Kyoto Gakuen University majoring in psychology (57 in the non-outcome condition and 57 in the outcome condition), and 102 Korean university students at Sung Kyung Kwan University majoring in psychology (52 in the non-outcome condition and 50 in the outcome condition). About 70 percent of the participants were female in each sample.

Materials The same Good Samaritan scenario as that used in Choi and Nisbett (2000) was used, as shown in the Appendix. The participants were asked to estimate the probability that John helped the victim. The materials were initially written in English. They were translated to French, Japanese, and Korean. Each was back-translated to English in order to check that all the translated versions had the same contents.

Procedure The experiment was run in regular classes in the respective universities. Materials were printed in booklets. Each participant was assigned to one of the two conditions: the non-outcome condition or the outcome condition. They were given a booklet containing the Good Samaritan scenario as shown in the Appendix, and were asked to estimate the probability that John helped the victim on the first page. Half of the participants received information that he had not helped the victim before the probability judgment (the outcome condition), whereas the other half did not (the non-outcome condition). The participants in the outcome condition were asked to judge the probability supposing that they did not know the outcome. On the next page, all the participants were informed that he did not actually help the victim, and they were asked to point out possible reasons for not helping, in four minutes. On the final page, they were asked to estimate the probability that John had helped the victim thinking back to the time when they were not yet informed of the outcome.

Results and Discussion

The mean estimated probabilities in each condition are shown in Table 2. An ANOVA was conducted using a 4 (nationality) by 2 (outcome) by 2 (trial) design. The main effects of

nationality ($F(3,371)=1.49, n.s.$) and outcome ($F(1,371)=.15, n.s.$) were not significant. The main effect of trial was significant ($F(1,371)=80.63, p<.01$). The estimated probabilities were generally lower in the final judgment.

Insert Table 2 about here

The interaction between nationality and outcome was significant ($F(3,371)=5.25, p<.01$). Hence the following analyses were performed. The simple main effect of outcome in the French data was not significant ($F(1, 742)=1.75, n.s.$). The simple main effect of outcome in the British data was significant ($F(1, 742)=13.02, p<.01$); the estimated probabilities were higher in the outcome condition. The simple main effect of outcome in the Japanese data was significant ($F(1, 742)=6.42, p<.05$); the estimated probabilities were lower in the outcome condition. The simple main effect of outcome in the Korean data was significant ($F(1, 742)=5.40, p<.05$); the estimated probabilities were lower in the outcome condition.

The interaction between outcome and trial was significant ($F(1,371)=16.11, p<.01$). The simple main effect of outcome of initial judgment was significant ($F(1, 742)=4.10, p<.05$); the estimated probabilities were generally lower in the outcome condition. The simple main effect of outcome of final judgment was not significant ($F(1, 742)=1.97, n.s.$).

The interaction between nationality and trial ($F(3,371)=.77, n.s.$), and the three-way interaction ($F(3,317)=.77, n.s.$) were not significant.

Summing up these results, hindsight bias in the hypothetical paradigm appeared only among the Japanese and Koreans, and not among the French and British. Our results are compatible with the claim of Choi and Nisbett (2000), which makes it possible to postulate that the cultural difference in hindsight bias is not only between Americans and Koreans, but between Westerners and Easterners generally. Furthermore, the outcome by trial interaction was found in every nationality. The data patterns of Japanese and Korean participants fit the prediction of both hypotheses, that the Easterners' estimated probabilities are lower in the outcome condition than in the non-outcome condition in the initial judgment, and that, in the non-outcome condition, their estimated probabilities decrease in the final judgment. The model that best fits the data is the 'implicit revision' model. It means that they revised their causal models when they were given the outcome information, hence they did not revise their models further even after they pointed out possible causal factors.

However, the data patterns of the French and British did not fit the predictions of either of the hypotheses. There was no best fit model. They did not show hindsight bias, although the decrease in estimated probability from the initial to the final judgment was less in the outcome condition than in the non-outcome condition. It is quite likely that they revised their causal

models after pointing out possible factors in the non-outcome condition. However, how should we interpret the result that the estimated probabilities did not decrease in the final judgment in the outcome condition? If there is no effect of the outcome information, the pattern in the outcome condition is the same as that in the non-outcome information. A possible interpretation is that, when the outcome information was given, the causal models were revised implicitly, but in order to be hypothetical, our participants adjusted their revised models again, and this adjustment was kept even after they pointed out possible factors. We do not infer that the first revision of the causal models was explicit, because, if it is explicit, it entails explicit causal factors for why the target person did not help the victim, and thus the estimated probabilities decrease, as did those in the final judgment in the non-outcome condition. Neither, do we infer that the adjustment process is explicit. If it were explicit, this adjustment would be made not only in the outcome condition, but in the non-outcome condition after pointing out possible factors. Hence, we should have predicted that the estimated probabilities would be high in all the conditions, as the ‘rule-dialectic’ hypothesis originally predicted. However, this prediction was not borne out. Therefore, we infer that our participants revised their causal models implicitly when the outcome information was given. But, they implicitly adjusted their revised causal models so that they appeared to reason hypothetically. This adjustment was kept even in the final judgment.

Which hypotheses does our interpretation support? It is more compatible with the ‘rule-dialectics’ hypothesis than the ‘implicit-explicit’ hypothesis, because, although the data pattern of the French and British did not fit the ‘rule-based without revision’ model, as the ‘rule-dialectics’ hypothesis originally predicted, we infer that the French and British implicitly revised their causal models when they were given the outcome information, and adjusted them for hypothetical reasoning. In short, the implicit revision is universal, but the French and British tried to engage in rule-based reasoning by making the adjustment.

Experiment 2

As shown in Table 1, a new model is added to the three models based on the results of Experiment 1. The ‘rule-based with implicit revision’ model supposes that the reason why hindsight bias disappears is because, although implicit access to the causal information and implicit revision is made just by the outcome information, people adjust their revised causal models. We infer that this adjustment is made implicitly, because people are not aware of the revision of the initial causal models: they do not adjust them explicitly even if they try to be hypothetical. This adjustment is kept even after pointing out possible factors because people are not aware of this, hence the final estimated probability will be high in the outcome condition.

However, the final estimated probability becomes lower in the non-outcome condition for the same reason as the ‘rule-based with explicit revision’ model mentions. French and British data patterns fitted this model in Experiment 1.

In Experiment 2 we asked participants to undertake a conditional causal reasoning task, in order to examine whether conditional causal reasoning facilitates people’s hypothetical rule-based reasoning. Conditionals can be grouped into two categories: indicative and deontic (Manktelow & Over, 1991). Conditionals of an indicative form codify common sense, scientific knowledge, or arbitrary rules, whereas those of a deontic form express laws, social agreement, moral rules and so on. When an indicative conditional is stated, people often posit a causal relationship between the antecedent p and its consequent¹ q . We use indicative conditionals here. Regarding causality, Cummins (1995; Cummins, Lubart, Alksnis, & Rist, 1991) argued that causal inference is sensitive to two factors: alternative causes (ACs) and disabling conditions (DCs). An AC is a cause that is not the one cited in the causal rule but is capable of evoking the effect cited in the rule. A DC is an event that could prevent an effect from occurring in the presence of a cause. Our proposed concept of ‘causal models’ expresses these conditions.

We set two kinds of tasks. In the *probability judgment of consequent task*, we presented an indicative conditional with its antecedent satisfied, and asked our participants to estimate the probability of the consequent. Half of the participants received information on the outcome, that the consequent did not occur, before the probability judgment (the outcome condition), whereas the other half did not (the non-outcome condition). Next, all of the participants were informed that the consequent did not actually occur, and they were asked to point out possible DCs. This manipulation corresponds to the one asking the participants to point out possible factors for why the target person did not help the victim. Finally, they were asked to judge the probability that the consequent occurred returning to the time when they had not yet been informed of the outcome. In the *probability judgment of antecedent task*, our participants were given an indicative conditional with satisfied consequent, and were asked to judge the probability of the antecedent. The procedure was the same as that of the *probability judgment of consequent task* except for the type of inference. These two kinds of tasks were set not as an experimental factor but for counterbalancing.

The ‘rule-dialectics’ hypothesis, which is amended based on the results of Experiment 1 so that it accepts that rule-based inference can be done by the adjustment of causal models, predicts that the data patterns of British and French participants could fit one of the three rule-based models, whereas the data patterns of the Japanese and Koreans would fit the ‘implicit revision’ model. The ‘explicit-implicit’ hypothesis predicts that the data patterns of the British and French could fit either the ‘rule-based without revision’ model or the ‘rule-based with explicit revision’ model. On the other hand, the data patterns of the Japanese and Koreans may

fit either the ‘rule-based with implicit revision’ model or the ‘implicit revision’ model. Since participants were asked to undertake a conditional causal reasoning task in Experiment 2, it is plausible that people’s hypothetical reasoning would be facilitated. If so, the rule-based models fit the data better, and if people’s tendency towards implicit revision is suppressed, the ‘rule-based without revision’ model or the ‘rule-based with explicit revision’ model would be preferred, although no data pattern fitted these models in Experiment 1.

Method

Design The design was 4 (nationality: French, British, Japanese, Koreans) by 2 (outcome: non-outcome, outcome) by 2 (trial: initial, final) in each task. ‘Nationality’ and ‘outcome’ were between-subjects factors.

Participants Eighty-six French university students at the University of Lyon 2 majoring in psychology (44 in the non-outcome condition and 42 in the outcome condition), 98 British university students at the University of Wolverhampton majoring in psychology (49 in the non-outcome condition and 49 in the outcome condition)², 100 Japanese university students at Kobe College, Ritsumeikan University, and Osaka International University majoring in psychology, sociology, or environmental sciences (51 in the non-outcome condition and 49 in the outcome condition)³, and 95 Korean university students at Sung Kyung Kwan University majoring in psychology (46 in the non-outcome condition and 49 in the outcome condition) participated in this experiment. About 70 percent of the participants were female in each sample.

Materials Cummins (1995) asked her participants to generate possible DCs and ACs of given indicative conditionals. The more DCs, the weaker is the perceived causality from the antecedent to the consequent. The more ACs, the more likely it seems that the consequent occurs without the antecedent. Based on the mean generation counts of Cummins’ data, we chose two kinds of conditionals (slightly revised so that natural scenarios were created). We created Scenario A with the conditional “if a student studies hard, then (s)he will pass the exam”(Mean AC=3.9; Mean DC=4.4) and Scenario B with the conditional “if fertilizer is put on the plants, then they will grow quickly”(Mean AC=4.2; Mean DC=3.4). The mean counts were moderate in Cummins’ (1995) data. The two conditions were chosen so that any bias by a specific situation could be counterbalanced with almost same level of causality. The scenarios are shown in the Appendix. All the materials were initially written in English. They were translated to French, Japanese, and Korean. Each was back-translated to English in order to check all the translated versions had the same contents.

Procedure Materials were printed in booklets. Each participant was assigned to one of the

two conditions: the non-outcome condition or the outcome condition. He or she was given a booklet of either the *probability judgment of antecedent task* or the *probability judgment of consequent task* with either Scenario A or B. The participants who were given the *probability judgment of antecedent task* were given an indicative conditional with the information that the consequent occurred, and were asked to indicate their estimated probability that the antecedent was satisfied by marking a number along a horizontal line from zero to 100 percent on the first page of the booklet. Numbers were at intervals of five. Half of the participants received information on the outcome that the antecedent had not been satisfied before the probability judgment (the outcome condition), whereas the other half did not (the non-outcome condition).

The participants in the outcome condition were asked to judge the probability supposing that they did not know the outcome. On the next page, all the participants were informed that the antecedent was not actually satisfied, and were asked to point out possible ACs in four minutes. On the final page, they were asked to indicate their estimated probability that the antecedent had been satisfied again thinking back to the time when they were not yet informed of the outcome. The participants who were given the *probability judgment of consequent task* were given an indicative conditional with satisfied antecedent, and were asked to indicate their estimated probability that the consequent would occur, on the first page. The procedure of this task is almost the same as that of *probability judgment of antecedent task*. Half of the participants received information on the outcome that the consequent did not occur before the probability judgment (the outcome condition), whereas the other half did not (the non-outcome condition). On the next page, all the participants were informed that the consequent did not actually occur, and they were asked to point out possible DCs in four minutes. On the final page, they were asked to judge the probability of the consequent thinking back to the time when they were not yet informed of the outcome. The experiment was run in regular classes in French, British, Japanese, and Korean universities. The time was controlled by an experimenter, so that the participants were not allowed to move to the next page unless the experimenter instructed.

Results and Discussion

The mean estimated probability of each condition set by the design of 4 (nationality) by 2 (outcome) by 2 (trial) is shown in Table 3. Before conducting an ANOVA of this design, we conducted an ANOVA following a design including the factor of two kinds of tasks. Only the main effect of task was significant ($F(1, 363)=9.35, p<.05$). Although a causal conditional is very likely to be interpreted as biconditional and counted ACs and DCs were controlled so that they were almost the same (Cummins, 1995), our participants estimated the probability higher

in the *probability judgment of consequent task* than in the *probability judgment of antecedent task*. We also examined the effects of scenario between Scenarios A and B, but they were all non-significant. Because we found no important differences between the *probability judgment of consequent task* and the *probability judgment of antecedent task*, we analyzed both sets of data together.

Insert Table 3 about here

An ANOVA was conducted using a 4 (nationality) by 2 (outcome) by 2 (trial) design. The main effect of nationality was significant ($F(3,371)=2.84, p<.05$): the estimated probabilities were lower in the British and French samples. The main effect of outcome was significant ($F(1,371)=7.83, p<.01$): the estimated probabilities were higher in the outcome condition than in the non-outcome condition. The main effect of trial was significant ($F(1,371)=33.19, p<.01$): the estimated probabilities were lower in the final judgment.

The interactions between nationality and outcome ($F(3,371)=1.95, n.s.$) and nationality and trial ($F(3,371)=1.22, n.s.$) were not significant. The interaction between outcome and trial was significant ($F(1,371)=30.59, p<.01$). Furthermore, the three-way interaction between nationality, trial and outcome was significant ($F(3,317)=3.11, p<.05$).

In order to interpret the three-way interaction, a sub-analysis was conducted for each nationality. For French participants, the simple main effect of outcome was not significant ($F(1,371)=3.56, n.s.$), the simple main effect of trial was significant ($F(1,371)=16.75, p<.01$) and the simple interaction was not significant ($F(1,371)=.79, n.s.$). These results show that the French participants did not show hindsight bias. Further, the outcome information did not make them revise their causal models. They only revised their causal models after pointing out the DCs or ACs. This might not be compatible with the data of previous studies (e.g., Fischhoff, 1975) that demonstrated hindsight bias for Westerners. The response patterns of the French fit the ‘rule-based with explicit revision’ model.

With the British, the simple main effects of outcome ($F(1,371)=1.49, n.s.$) and trial ($F(1,371)=2.98, n.s.$) were not significant. The simple interaction was significant ($F(1,371)=26.03, p<.01$). The simple-simple main effect of outcome was not significant in the initial judgment ($F(1,742)=2.32, n.s.$), whereas it was significant in the final judgment ($F(1,742)=13.18, p<.01$). Estimated probabilities were higher in the outcome condition than in the non-outcome condition. This pattern fits the ‘rule-based with implicit revision’ model. We infer that the participants’ causal models were implicitly revised just by the outcome information, but the estimated probabilities were adjusted so that they followed the original rule of the conditional. This compensation worked also in the final judgment, resulting in the higher

estimated probabilities in the outcome condition.

Statistically, the pattern of the Japanese data was almost the same as that of the British. The simple main effect of outcome was not significant ($F(1,371)=3.77, n.s.$). The simple main effect of trial was significant ($F(1,371)=5.85, p<.05$). The simple interaction was significant ($F(1,371)=8.56, p<.01$). The simple-simple main effect of outcome was not significant in the initial judgment ($F(1,742)=2.38, n.s.$), whereas it was significant in the final judgment ($F(1,742)=12.26, p<.01$). Estimated probabilities were higher in the outcome condition than in the non-outcome condition. Therefore, the data pattern also fits the ‘rule-based with implicit revision’ model.

In the Koreans, the simple main effect of outcome was not significant ($F(1,371)=.17, n.s.$). The simple main effect of trial was significant ($F(1,371)=10.23, p<.01$). The simple interaction was significant ($F(1,371)=10.53, p<.01$). The simple-simple main effect of outcome was significant in the initial judgment ($F(1,742)=4.00, p<.05$), whereas it was not significant in the final judgment ($F(1,742)=1.64, n.s.$). The pattern of the Koreans fits the ‘implicit revision model’. They exhibited hindsight bias. It means that, when the outcome information was given, implicit access was made to revise their causal models. Hence, because their models had already been revised, they did not change their models even after pointing out the DCs or ACs.

No data pattern fitted the ‘rule-based without revision’ model as in Experiment 1. Two differences in results are apparent between those of Experiment 1 and Experiment 2. The first is that the best fit model of the French data was the ‘rule-based with explicit revision’ model. The second is that the best fit model of the Japanese data was the ‘rule-based with implicit revision’ model. These differences are viewed as the effect of using conditional reasoning. This effect is not so strong because the best fit models of the British and Koreans were the same as those in Experiment 1. But, this effect appeared as suppressing the implicit revision in the case of the French sample, and as facilitating the adjustment of the revised causal models to reason hypothetically in the case of the Japanese sample. As for hindsight bias, it disappeared in the Japanese data. This may be compatible with the results of Heine and Lehman (1996), where Japanese participants showed less hindsight bias than Canadians, although we are not sure about their explanation in terms of differences in self-serving bias. It is clear that the Japanese results show hindsight bias to be sensitive to the situation.

The difference between Experiment 1 and Experiment 2 is that we used a story about a seminary student who was very likely to help others with a no-help outcome in Experiment 1, whereas we used conditionals in Experiment 2. Is a possible reason why the British and Japanese, who were affected by the outcome information, did not show hindsight bias because they took the task as one of conditional reasoning and thus were primed to engage in hypothetical thinking? Generally speaking, people are enjoined to assume the truth of the

premises in logical reasoning tasks. Hence, the British and Japanese participants might *suppose* that the premise was highly probable, and *suppose* that they did not know the unexpected outcome when estimating the probability. Furthermore, in the case of Experiment 2, although we gave participants not only the *probability judgment of consequent task* but also the *probability judgment of antecedent task*, we presupposed that the hypothetical reasoning would be facilitated only in the former task at first, and this facilitation might be reduced in the latter task. However, the data patterns of the two tasks were almost the same. We infer that it was because we used the conditional with moderate and approximately equal numbers of ACs and DCs (Cummins, 1995), and thus the conditionals might have been interpreted as biconditionals.

The hypothesis of cultural differences based on the distinction between explicit and implicit processing was not fully supported. It can be inferred that the British used implicit revision in Experiment 2 again. Although the French did not seem to use it, implicit revision may be universal to some extent. The ‘rule-dialectics’ hypothesis was not completely supported either. The data pattern of the Japanese fits the ‘rule-based with implicit revision’ model.

General Discussion

The purpose of this study was to decompose the ‘analytic-holistic’ hypothesis proposed by Nisbett (Nisbett, 2003; Nisbett et al., 2001) into the ‘explicit-implicit’ hypothesis and the ‘rule-dialectics’ hypothesis, and test the two hypotheses. We constructed four possible models based on CMT (Hawkins & Hastie, 1990; Nestler, et al., 2008) and the results of Experiment 1, and we tested the hypotheses by judging which model fitted the data pattern of each nationality. The summarized results were as follows. In the case of the natural scenario (Good Samaritan) case (Experiment 1), Easterners (Koreans and Japanese) showed hindsight bias. On the other hand, although Westerners (French and British) were affected by the outcome information, they did not show hindsight bias. In the case of conditional reasoning (Experiment 1), only the Koreans showed hindsight bias. However, although the British and Japanese did not show hindsight bias, we infer that their judgment was affected by the outcome information. French participants did not show hindsight bias, and were not affected by the outcome information.

Insert Table 4 about here.

In Table 4, the best fitting model is assigned to each condition of Experiments 1 and 2. The ‘rule-dialectics’ hypothesis predicts that the data patterns of the British and French would fit one of the three rule-based models, whereas the data patterns of the Japanese and Koreans would fit the ‘implicit revision’ model only. The ‘explicit-implicit’ hypothesis predicts that the

data patterns of the British and French would fit one of the models that do not suppose implicit revision, whereas the data patterns of the Japanese and Koreans would fit either the ‘rule-based with implicit revision’ model or the ‘implicit revision’ model. Therefore, the results of Experiment 1 could be explained by the ‘rule-dialectics’ hypothesis. However, the results of Experiment 2 could not be completely explained by either the ‘rule-dialectics’ hypothesis or the ‘explicit-implicit’ hypothesis.

Hindsight bias can be caused by the implicit revision of causal models (Hawking & Hastie, 1990). This was inferred to be made not only by Easterners but also by Westerners based on the results that the estimated probabilities did not decrease in the outcome condition in some groups. Only the French data of Experiment 2 fitted the model that does not suppose implicit revision. This may be consistent with the ‘explicit-implicit’ hypotheses, but this model fit case was only one as shown in Table 4. The Japanese data and the Korean data in Experiment 1 fit the prediction about Easterners based on both hypotheses. In other cases, in which the ‘rule-based with implicit’ model was the best fit, although the participants were inferred to be affected by the outcome information implicitly, they did not show hindsight bias, presumably because of adjusting their revised causal models. These cases mean that implicit revision is universal to some extent, especially since the data of Experiment 1 show that both French and British participants did it. The reason why they did not show hindsight bias is inferred to be that they adjusted their revised causal models so that they followed a rule originally induced from the scenario. These results support the ‘rule-dialectic’ hypothesis more strongly than the ‘explicit-implicit’ hypothesis.

In this sense, the fact that hindsight bias shown by Korean people was greater than that of Americans by Choi and Nisbett (2000) can be viewed as the consequence of Koreans not adjusting their revised causal models following a rule. It is very plausible that Americans might implicitly revise their causal models by the outcome information to decrease their probability in some cases, but could adjust them again so that they could follow the rule. Furthermore, this interpretation is compatible with many studies of hindsight bias, which show that even Westerners are susceptible to this bias. For example, Fischhoff (1975) used a task in which his participants were asked to give confidence ratings for possible outcomes of the 19th-century war between the British and the Gurkhas of Nepal. The participants of an experimental group were given the actual outcome. It is likely that they implicitly revised their model for predicting the unexpected outcome. Hindsight bias occurs if they do not need to be strongly hypothetical in rating the possible outcome. In short, if they do not strongly need to think ‘hypothetically’ as if they do not know the outcome information, they do not readjust or suppress the implicitly revised model, and thus hindsight bias occurs.

Whether people adjust their revised causal models to follow a rule is sensitive to the task

demands. Comparing the results of Japanese participants in Experiments 1 and 2, they made this adjustment when conditionals were used, whereas they did not when the Good Samaritan scenario was used. We interpret the differences as showing that their adjustment was more encouraged in Experiment 2, because they were instructed to think following the conditional they were given. It is likely that they believed that they should think hypothetically when they were given a conditional. The difference between Experiments 1 and 2 is also reflected in the data of the French participants. The outcome information did not influence the judgment of the French even at the implicit level in Experiment 2. We infer that the pressure to ignore the outcome information was strong enough in the context of conditional reasoning to override even implicit revision of their causal models.

Another possible explanation for why estimated probability did not decrease in the outcome condition even after pointing out the reasons in some conditions is that the participants might find it difficult to generate reasons for the unexpected outcome. The difficulty means that the unexpected outcome cannot be the consequent in any way, and hence they inferred that the probability of the expected outcome is high even if they were informed that the expected outcome did not occur (Sanna, Schwarz, & Small, 2002; Sanna, Schwarz, & Stocker, 2002). If this explanation is valid, can we infer that Westerners find it more difficult to generate possible reasons than Easterners, especially Koreans? We do not think so because the numbers of reasons that were listed were almost the same in the four samples (around four to five). Furthermore, we did not find qualitative differences among them.

The ‘explicit-implicit’ hypothesis was not as strongly supported as the ‘rule-dialectics’ hypothesis. The pattern fitted the implicit revision model in three of the four cells of the French and British samples in Table 4. This implies that implicit revision may be universal to some extent except for the case where people are strongly cued to think hypothetically, as by conditional reasoning in Experiment 2. The hypothesis based on the distinction between explicit and implicit processes fits a very general model based on dual process theories.

The results of this study give answers to the questions that Buchtel and Norenzayan (2009) posed. As to the distinction between rule-based reasoning and dialectic inference, we infer that, generally speaking, Westerners are more inclined to use rule-based reasoning, whereas Easterners’ cognition is more dialectic, but with some exceptions. However, as to the distinction between explicit and implicit processing, we infer that even French and British people engaged in implicit cognition in revising their causal models, except for the French case of conditional reasoning. Therefore, implicit cognition is inferred to be culturally universal to some extent. These suggestions are compatible with recent versions of dual process theories (Stanovich, 2009). Stanovich proposes that the effects of culture are on the disposition or style of using the algorithmic mind, which is the evolutionarily recent system. Hence, the distinction

between rule-based inference and dialectic inference can be attributed to the usage of the algorithmic mind. On the other hand, the difference between explicit processing and implicit processing was not so affected by culture. Rather, we infer that the distinction between explicit and implicit corresponds to the one between the evolutionarily recent system processes and the evolutionarily old system processes (e.g., Evans & Over, 1996).

As for the ‘rule-based with implicit revision’ model, which is the best fit model in four cells in Table 4, this indicates that the cognitive style of rule-based inference is implemented by implicit adjustment process that are assumed to be in the evolutionarily old system. However, is the implicit process truly rooted in the evolutionarily old system? Yama, Nishioka, Horishita, Kawasaki, and Taniguchi (2007) discuss the differences between dual process theories and the distinction between analytic and holistic cognition (Nisbett et al., 2001). They use a distinction between hardware (related to gene-installed goals) and software (related to meme-installed goals) in both the evolutionarily older system and the newer system (Stanovich, 2004), and argue that cultural differences in thought are not at the hardware level but at the software level. They mean that the difference between analytic and holistic cognition depends upon how the evolutionarily enlarged capacity, which is in the evolutionarily recent system, is used under the constraints of culture. The results of this study are also compatible with their idea. Furthermore, the implicit adjustment process can be the process for meme-installed goals in the evolutionarily old system.

Norenzayan and Heine (2005) proposed three levels of universals, which can also be applied to cultural differences: difference in tools (non-universals), difference in function of the tool (existential universals), and difference in accessibility (accessibility universals). To which level of difference does each hypothesis correspond? The ‘rule-dialectics’ hypothesis presupposes that Westerners use rules whereas Easterners use dialectics. However, in the case of the Japanese, whether they engaged in rule-based reasoning was sensitive to the situation. Hence, this difference is inferred to be at the level of accessibility. The ‘explicit-implicit’ hypothesis was not strongly supported, and it is inferred that implicit cognition can be to some extent universal. It is at none of the three levels.

In conclusion, the ‘rule-dialectics’ hypothesis explained the cultural differences in hindsight bias better than the ‘explicit-implicit’ hypothesis. However, it cannot fully explain all the results. In particular, the data pattern of the Japanese in Experiment 2 fitted the ‘rule-based with implicit revision’ model. It may be situational factors that influence whether people try to think hypothetically. Implicit revision may be universal to some extent, but the data pattern of French participants did not fit models that suppose implicit revision, and the use of conditionals suppressed implicit thinking.

References

- Arkes, H. R., Faust, D., Guilmette, T. J., & Hart, K. (1988). Eliminating the hindsight bias. *Journal of Applied Psychology, 66*, 252-254.
- Buchtel, E. E. and Norenzayan, A. (2009). Thinking across cultures: Implications for dual processes. In J. St. B. T. Evans and K. Frankish (eds.), *In two minds: Dual processes and beyond*. Oxford: Oxford University Press, Pp. 217-238.
- Chaiken, S. and Trope, Y. (1999). *Dual process theories in social psychology*. New York: Guilford Press.
- Choi, I. and Nisbett, R. E. (2000). Cultural psychology of surprise: Holistic theories and recognition of contradiction. *Journal of Personality and Social Psychology, 79*, 890-905.
- Cummins, D. D. (1995). Naïve theories and causal deduction. *Memory and Cognition, 23*, 646-658.
- Cummins, D. D., Lubart, T., Alksnis, O., & Rist, R. (1991). Conditional reasoning and causation. *Memory & Cognition, 19*, 274-282.
- Darley, J. M. & Baston, C. D. (1973). From Jerusalem to Jericho: A study of situational and dispositional variables in helping behavior. *Journal of Personality and Social Psychology, 27*, 100-119.
- Evans, J. St. B. T. (2007). *Hypothetical thinking*. Hove, UK: Psychology Press.
- Evans, J. St. B. T., & Over, D. E. (1996). *Rationality and reasoning*. Hove, UK: Psychology Press.
- Fischhoff, B. (1975). Hindsight \neq foresight: The effect of outcome knowledge on judgment under uncertainty. *Journal of Experimental Psychology: Human Perception and Performance, 1*, 288-299.
- Fischhoff, B. (1982). For those condemned to study the past: Heuristics and biases in hindsight. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), *Judgment under uncertainty: Heuristics and biases*. New York: Cambridge University Press, pp. 332-361.
- Hawkins, S. A. & Hastie, R. (1990). Hindsight: Biased judgments of past events after the outcomes are known. *Psychological Bulletin, 107*, 311-327.
- Heine, S. J., and Lehman, D. R. (1995). Cultural variation in unrealistic optimism. Is the West more invulnerable than the East? *Journal of Personality and Social Psychology, 68*, 595-607.
- Heine, S. J. & Lehman, D. R. (1996). Hindsight bias: A cross-cultural analysis. *Japanese Journal of Experimental Social Psychology, 35*, 317-323.
- Kim, H. S. (2002). We talk, therefore we think? A cultural analysis of the effect of talking on thinking. *Journal of Personality and Social Psychology, 83*, 828-842.
- Knowles, E. D., Morris, M. W., Chiu, C. Y., & Hong, Y. Y. (2001). Culture and the process of

- person perception: Evidence for automaticity among East Asians in correcting for situational influences on behavior. *Personality and Social Psychological Bulletin*, 27, 1344-1357.
- Koo, M., & Choi, I. (2005). Becoming a holistic thinker: Training effect of oriental medicine on reasoning. *Personality and Social Psychology Bulletin*, 31, 1264-1272.
- Kühnen, U., & Oyserman, D. (2002). Thinking about the self influences thinking in general: Cognitive consequences of salient self-concept. *Journal of Experimental Social Psychology*, 38, 492-499.
- Manktelow, K. I., & Over, D. E. (1991). Social roles and utilities in reasoning with deontic conditionals. *Cognition*, 39, 85-105.
- Masuda, T., & Nisbett, R. E. (2001). Attending holistically versus analytically: Comparing the context sensitivity of Japanese and Americans. *Journal of Personality and Social Psychology*, 81, 922-934.
- Nestler, S., Blank, H. & von Collani, G. (2008). Hindsight bias doesn't always come easy: Causal models, cognitive effort, and creeping determinism. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 34, 1043-1054.
- Nisbett, R. E. (2003). *The geography of thought: How Asians and Westerners think differently...and why*. New York: The Free Press.
- Nisbett, R. E., Peng, K., Choi, I., & Norenzayan, A. (2001). Culture and systems of thought: Holistic versus analytic cognition. *Psychological Review*, 108, 291-310.
- Norenzayan, A., & Heine, S. J. (2005). Psychological universals: What are they and how can we know? *Psychological Bulletin*, 131, 763-784.
- Norenzayan, A., Smith, E. E., Kim, B. J., & Nisbett, R. E. (2002). Cultural preferences for formal versus intuitive reasoning. *Cognitive Science*, 26, 653-684.
- Peng, K., & Nisbett, R. E. (1999). Culture, dialectics, and reasoning about contradiction. *American Psychologist*, 54, 741-754.
- Pohl, R. F., Bender, M., & Lachmann, G., (2002). Hindsight bias around the world. *Experimental Psychology*, 49, 270-282.
- Sanna, L. J., Schwarz, N., & Small, E. M. (2002). Accessibility experience and the hindsight bias: I knew it all along versus it could never have happened. *Memory and Cognition*, 30, 1288-1296.
- Sanna, L. J., Schwarz, N., & Stocker, S. L. (2002). When debiasing backfires: Accessible content and accessibility experience in debiasing hindsight. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 28, 497-502.
- Slooman, S. A. (1996). The empirical case for two systems of reasoning. *Psychological Bulletin*, 119, 3-22.
- Stanovich, K. E. (1999). *Who is rational? : Studies of individual differences in reasoning*.

Mahwah, NJ: Lawrence Erlbaum.

Stanovich, K. E. (2004). *The robot's rebellion: finding meaning in the age of Darwin*. Chicago: The University of Chicago Press.

Stanovich, K. E. (2009), Distinguishing the reflective, algorithmic, and autonomous minds: Is it time for a tri-process theory? In J. St. B. T. Evans and K. Frankish (eds.), *In two minds: Dual processes and beyond*. Oxford: Oxford University Press, Pp. 55-88.

Yama, H., Nishioka, M., Horishita, T., Kawasaki, Y., & Taniguchi, J. (2007). A dual process model for cultural differences in thought. *Mind and Society*, 6,143-172.

Footnotes

1. The term consequent is used as just indicating “ q ” in a conditional. It does not mean “outcome” as in the literatures of hindsight bias.

2. Because we needed to avoid excluding ethnic minority people in the UK when we ran Experiment 2, we did not ask the participants to divulge their ethnicity. Approximately 25 percent of the British participants were in minority ethnic groups, although many of them were born and grew up in the UK. We asked French, Japanese, and Korean participants to divulge their ethnicity, and eliminated their data from the analysis. We eliminated all the minority ethnic participants from the analysis in Experiment 1. For the reference of the pattern of British ethnic group, just the means of these groups in the UK of Experiment 1 are shown here. The means of initial estimated probability of ethnic British were 63.5 in the non-outcome condition ($n=8$) and 70.6 in the outcome condition ($n=16$). Those of final estimated probability were 40.4 in the non-outcome condition and 68.4 in the outcome condition. Each SD is in parenthesis. The pattern is almost the same as that of British in Experiment 1.

3. It might be problematic if the majors of some Japanese participant are not psychology, because Koo and Choi (2005) showed the effect of academic training in Korean participants. However, what they demonstrated was that oriental medicine students are more likely to engage in holistic cognition than psychology students. Oriental medicine requires people to think more and more holistically. Therefore, in the case of our Japanese participants, we do not suspect serious differences in training between psychology, sociology, and environmental sciences.

Table 1. Predictions of estimated probability by each of three models.

Models	Non-outcome condition		Outcome condition	
	Initial	Final	Initial	Final
Rule-based without revision	High	High	High	High
Rule-based with explicit revision	High	Low	High	Low
Rule-based with implicit revision	High	Low	High	High
Implicit revision (Dialectic inference)	High	Low	Low	Low

Note. The 'rule-based implicit revision' model is supposed and added as the results of Experiment 1.

Table 2. Initial and final mean estimated probabilities for each condition in Experiment 1(%).

	Non-outcome condition		Outcome condition	
	Initial	Final	Initial	Final
French	76.2 (24.6)	63.5 (28.6)	75.1 (27.7)	73.1 (21.4)
British	66.9 (24.3)	57.8 (22.1)	78.4 (20.0)	73.4 (23.4)
Japanese	86.7 (14.1)	71.7 (17.2)	74.5 (18.3)	69.1 (22.8)
Korean	81.9 (14.9)	70.8 (20.2)	72.2 (23.2)	66.2 (23.4)

Note. Each SD is in the parenthesis.

Table 3. Initial and final mean estimated probabilities for each condition in Experiment 2 (%).

	Non-outcome condition		Outcome condition	
	Initial	Final	Initial	Final
French	63.1 (21.7)	51.6 (20.1)	68.5 (18.3)	61.1 (22.4)
British	68.9 (19.3)	54.1 (21.2)	62.4 (22.4)	69.7 (19.5)
Japanese	67.3 (24.8)	57.9 (23.6)	73.8 (21.5)	72.8 (20.3)
Korean	75.1 (18.4)	61.0 (22.2)	66.4 (19.8)	66.5 (20.7)

Note. Each SD is in the parenthesis.

Table 4. The inferred summary of Experiments 1 and 2.

	Experiment 2 (Good Samaritan)	Experiment 1 (Conditional)
French	Rule-based with implicit revision	Rule-based with explicit revision
British	Rule-based with implicit revision	Rule-based with implicit revision
Japanese	Implicit revision (hindsight bias)	Rule-based with implicit revision
Korean	Implicit revision (hindsight bias)	Implicit revision (hindsight bias)

Note. We infer that hindsight bias was observed when implicit revision is made without adjustment of revised causal models.

Appendix

Scenario of Experiment 1

Please imagine a seminary student whose name is John. He is religious, generous, and helpful. He was taking a sermon course. He was supposed to give a practice sermon as a course requirement. But, unfortunately, he was 10 minutes late for the sermon. The professor was known for being harsh on students for being late. While he was proceeding to the place where he was supposed to give a sermon, he came across a victim who was left lying down by an alley. The following underlined sentences are added in the outcome condition. But it turned out that John did not help the victim. Now if you had been asked the following question before you knew that John had not helped the victim, what might have been your answer?

What is the probability that John will help the victim in this situation?

Scenarios of Experiment 2

Scenario A

Please imagine that students are going to take an exam at a university. The lecturer said, “if a student studies hard, then (s)he will pass the exam.” Mary is a student at the university. She studied hard. But it turned out that Mary did not pass the exam later. Now if you had been asked the following question before you knew that Mary did not pass the exam, what might have been your answer?

What is the probability that Mary will pass the exam in this situation?

Scenario B

Please imagine that you are interested in gardening. People say, “if fertilizer is put on the plants, then they will grow quickly.” John likes growing plants. Fertilizer was put on the plants. But it turned out that the plants did not grow quickly. Now if you had been asked the following question before you knew that the plants did not grow quickly, what might have been your answer?

What is the probability that the plants will grow quickly in this situation?

Note. These are the scenarios used in the outcome condition. The underlined sentences are deleted in the non-outcome condition. The two scenarios of Experiment 1 are those used for the *probability judgment of consequent task*.