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Learning and Transfer: A General Role for Analogical Encoding

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Teaching by examples and cases is widely used to promote learning, but it varies widely in its effectiveness. The authors test an adaptation to case-based learning that facilitates abstracting problem-solving schemas from examples and using them to solve further problems: analogical encoding, or learning by drawing a comparison across examples. In 3 studies, the authors examined schema abstraction and transfer among novices learning negotiation strategies. Experiment 1 showed a benefit for analogical learning relative to no case study. Experiment 2 showed a marked advantage for comparing two cases over studying the 2 cases separately. Experiment 3 showed that increasing the degree of comparison support increased the rate of transfer in a face-to-face dynamic negotiation exercise.

Learning Negotiation Contract Schemas by Analogical Encoding

The use of examples and specific cases in teaching new concepts and problem-solving strategies is a mainstay of educational methodology. Examples are important in all levels of instruction, from elementary to advanced education. For example, in *case-based instruction*, a method widely used in business, law, and medicine, the principles of a domain are taught through discussions of rich concrete examples that embody key points. The idea is that people can readily learn specific examples, which then can serve as models or analogies for future situations (e.g., Dunbar, 1995; Magnani, Nersessian, & Thagard, 1999; Reeves & Weisberg, 1994; Riesbeck & Schank, 1989; Ross, 1987). Because cases and examples are concrete, they are more engaging and more easily understood than abstract, domain-general principles. The understanding gained through these specific cases can then be transferred to novel situations (Kolodner, 1993, 1997; Pirolli & Anderson, 1985; Reed, 1987).

There is considerable evidence that familiar examples can serve as models or analogies to new situations (Dunbar, 1995; Gentner & Gentner, 1983; Holyoak & Thagard, 1995). For example, Ross (1987, 1989) found that giving people examples to illustrate a probability principle facilitated the later use of the probability formula to solve new problems. If people notice a similarity between a new problem and one of their previously learned examples—that is, if the new problem reminds them of a prior example—they can use the prior example to inform the current problem (Pirolli & Anderson, 1985; Ross, 1984).

But in practice, case-based training varies widely in its effectiveness. Prior cases can be highly useful when people bring them to bear on new problems. Unfortunately, people often fail to recall relevant examples that they have been exposed to (e.g., Gick & Holyoak, 1980; Keane, 1988). This is particularly true when the two cases differ in surface features (i.e., salient objects and aspects of the context; Holyoak & Koh, 1987; Simon & Hayes, 1976; Weisberg, DiCamillo, & Phillips, 1978). In short, our ability to take advantage of our prior experiences is highly limited. One explanation for the low degree of appropriate recall is that people often encode cases in a situation-specific manner, focusing mainly on their surface features (Gentner, 1989; Medin & Ross, 1989). This is particularly true of novices, who may have no basis for understanding a situation other than the objects and contextual features. For example, Chi, Feltovitch, and Glaser (1981) asked physics students to sort physics problems into categories. They found that novices in physics grouped the problems on the basis of common concrete features and objects (e.g., those about inclined planes, those about springs, etc.), whereas expert physicists grouped problems on the basis of common underlying principles (e.g., those about conservation of energy). If learners form highly concrete, context-specific representations of the situations they encounter, then it is not surprising that their later remindings to the initial examples occur only when the new example is highly similar in surface details to the earlier one.

The pattern of memory recall just described results in the *inert knowledge* problem—a failure to access prior examples that would be highly useful if retrieved (Lancaster & Kolodner, 1987; Mayer, 1992; Novick & Holyoak, 1991; Perfetto, Bransford, & Franks, 1983; Reed, Ernst, & Banerji, 1974). For example, in one study, people studied mathematical problems that were fully explained; later they were asked to solve new problems and in the process note any earlier problems they were reminded of (Ross, 1984). Over 80% of people's remindings were based on surface similarities to the initial problems. That is, when solving a problem about writing a shopping list, people were very likely to recall a prior problem that was also about a shopping list. Notably, these remindings occurred regardless of whether the two problems exem-

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plified the same probability principle (i.e., their structure was the same). Gentner, Rattermann, and Forbus (1993) found similar results in an investigation of how people remember prose passages (brief stories about, for example, a hunter shooting a hawk). They asked participants to read stories in an initial session and then, a week later, to read new stories and write down any initial stories that they were reminded of while reading the new stories. As in Ross's (1984) study, remindings that bore surface similarities (i.e., another story about a hunter) far outnumbered remindings that were structurally similar (i.e., another story about attacking). Gentner and colleagues took the research a step further and asked the participants to judge the quality of the match (i.e., whether one could profitably be used to draw inferences about the other) between pairs of the same stories. Structurally similar pairs were judged to be of higher quality than the surface-similar pairs, thus showing a very different pattern from their actual remindings. If people are directly comparing two examples, they probably can appreciate structural similarities, but if they are presented with just one example, they are far more likely to recall a prior example on the basis of surface similarities than structural similarities.

The limitations on recall just described are particularly severe for novices. Experts are better than novices at encoding structure in examples and recalling examples on the basis of structural commonalities (Dunbar, 2001). For example, Novick (1988) found that students completing a second set of mathematics problems all recalled some earlier problems with similar surface features to the present problems, but students with high Mathematics SAT scores recalled more structurally similar problems and were also better at rejecting the surface remindings than were students with low scores. A characteristic of expertise may be the ability to transfer concepts learned in one domain to solve problems in a different context. However, most studies suggest that attaining expertise requires substantial experience: By some estimates it takes 50,000 examples (Chase & Simon, 1973), thousands of hours of practice (Ericsson, Krampe, & Tesch-Roemer, 1993), or 10 years of dedicated study (Hayes, 1989; Simonton, 1996) to become an expert. Obviously, accelerating example-based learning would be highly desirable.

In this article, we investigate a technique called *analogical encoding*—in which learners compare two examples and by doing so come to understand the underlying structure common to both (Ferguson, 1994; Ferguson & Forbus, 1998; Loewenstein, Thompson, & Gentner, 1999). Surprisingly, as we will show, comparing two cases can be extremely informative to learners, even when neither is well understood. The analogical encoding method that we describe differs from the standard use of analogy in learning, in which a learner acquires knowledge about a new target situation by invoking an analogy with a situation he or she already understands (e.g., a student may use her knowledge of water flow to understand an electric circuit; Gentner & Gentner, 1983; Vosniadou, 1989). Although this technique can be highly effective for educational purposes (Bransford, Franks, Vye, & Sherwood, 1989; A. L. Brown & Kane, 1988; Bulgren, Deshler, Schumaker, & Lenz, 2000), its applicability is limited to those cases for which the learner understands an appropriate base example or domain. In contrast, in analogical encoding, comparison is not being used to facilitate transfer of a well-learned piece of prior knowledge but rather to highlight and clarify a new concept. Working through the comparison of two cases that share a common underlying principle can be illuminating even if the common principle is only partially understood in either case.

Analogical encoding fosters learning by taking advantage of a basic property of analogical reasoning: Analogies promote attention to commonalities, including common principles or schemas (Gick & Holyoak, 1983). According to Gentner's (1983, 1989) structure-mapping theory, drawing an analogy between two examples leads to a structural alignment—a set of correspondences between the elements of the two analogs in which their shared relational structure is highlighted. For example, comparing an office to a jail highlights their common constraining and regimented and institutional aspects, and minimizes focus on surface details that are not comparable, such as the color of the rug in the office. Thus, drawing a comparison can lead learners to focus on structural commonalities rather than on idiosyncratic surface features (assuming that the learners are provided cases with common underlying structure). Further, although in typical analogical learning, knowledge is being mapped from the well-understood example to the new example, in analogical encoding, the mapping can occur in both directions—whatever is understood about one example can serve to shed light on the other. Our claim is that analogical encoding both captures the value of using concrete cases and focuses learners on precisely those aspects that generalize across cases.

We suggest that learners who compare cases will develop a more general problem-solving schema that primarily captures the common structure of the cases rather than the surface elements. Consequently, in contrast to cases studied individually, cases that are compared should be more easily retrieved when the learner encounters a new case with the same structure. This is because the abstracted schema will have fewer idiosyncratic details and therefore will conflict less with the surface features of the current case. Thus, when solving problems in new contexts, people should be able to recall and apply schemas derived through analogical encoding better than prior individual examples (Catrambone & Holyoak, 1989; Reeves & Weisberg, 1994; Ross & Kennedy, 1990). In short, analogical encoding promotes the abstraction of schemas, which in turn promotes recall and transfer. A further advantage of analogical encoding is that it does not require a prior well-learned situation; it can potentially be beneficial even for people who lack deep knowledge of the domain (Gentner & Medina, 1998; Kurtz, Miao, & Gentner, 2001). Thus, analogical encoding may allow learners to develop knowledge using a bootstrapping process in which cases lead to the abstraction of principles, which are subsequently used to understand new cases and so on.

We have investigated the use of analogical encoding in a series of studies involving negotiation skills (Loewenstein et al., 1999; Thompson, Gentner, & Loewenstein, 2000). Negotiation offers a number of advantages as a domain in which to study learning and transfer. First, it involves a relatively small set of principles that apply over a wide variety of contexts that differ substantially in their surface characteristics—from playground disputes to corporate mergers (Thompson, 2001). Thus, learners must be able to transfer their learning across very different contexts. A further challenge for learners is that lessons learned in the classroom must be applied in real time, often in "hot" situations with the potential for considerable monetary gain or loss (e.g., a job negotiation). Finally, as in many other domains, learners often possess a tenacious but faulty naive mental model of negotiation (Thompson &

Hastie, 1990). For all of these reasons, negotiation poses challenges for learning and transfer. Indeed, instructors at top-rated business schools routinely find that even highly motivated MBA students often fail to make optimal negotiation agreements (e.g., Bazerman, Magliozzi, & Neale, 1985).

Our prior studies provide considerable evidence that analogical encoding facilitates learning and transfer among fairly experienced negotiators. For example, Thompson et al. (2000) taught a useful negotiation skill to a group of advanced, highly motivated MBA students, all of whom had at least 3 years of work experience. Prior to engaging in a simulated negotiation, the students read two analogous negotiation cases that both embodied an optimal strategy for resolving the negotiation. Participants who compared the two cases and wrote out the commonalities were nearly three times as likely to use the negotiation strategies in a subsequent face-to-face negotiation as those who analyzed the same cases one at a time and wrote advice for each protagonist. We have replicated this finding of a two- or three-fold advantage for analogical encoding using a variety of instruction sets and several groups of advanced learners (e.g., accountants, consultants, managers, and executives) and extended the finding to show an advantage of analogical encoding over simply reading statements of the abstract negotiation principles themselves (Gentner, Loewenstein, & Thompson, 2002; Loewenstein et al., 1999; Loewenstein, Thompson, & Gentner, 2003).

The previously discussed findings are evidence for the power of analogical encoding. However, the interpretation of our findings must be hedged a bit, because they have been conducted primarily with fairly expert participants. As we noted earlier, the relation between learning and transfer is modulated by the learner's degree of expertise—novice learners and more expert learners may differentially benefit from the same training (Kalyuga, Chandler, Tuovinen, & Sweller, 2001). We noted previously that analogical encoding may be an ideal way to bootstrap knowledge in beginning learners. This is because comparison processes can reveal common structure and combine partial structures and thus promote transfer, even early in learning when neither example is fully understood. To test that claim, in the present studies we investigated whether analogical encoding would lead to learning gains among students who had little or no formal negotiation experience or management expertise.

We hypothesized that analogical encoding techniques could be used to teach undergraduate students good negotiation strategies. In a typical negotiation situation, there is a set of issues in which two parties have different preferences (e.g., a buyer wants a low price, a seller wants a high price) and to which they assign different levels of importance. One way to resolve such differences is to compromise across the board—that is, parties meet halfway on each issue. This compromise strategy is often suboptimal for both parties, yet it is by far the dominant strategy adopted by novice negotiators (and often even by negotiators with more experience). The strength of this strategy may result in part from its perceived fairness as well as from a naive mental model called the *fixed-pie bias*—the implicit belief that negotiations involve a fixed amount of value (Thompson & Hastie, 1990). However, in many negotiation situations, both parties can do much better by capitalizing on differences in their priorities and beliefs than by compromising on each issue.

One effective strategy is the *trade-off*, in which each party accedes to the others' desires on an issue that is relatively unimportant to be in exchange for making gains on a highly valued issue (Froman & Cohen, 1970). A classic example is Mary Parker Follet's story of two sisters quarreling over a single orange. They compromise and cut it in half. Later the sisters realize that one wanted just the juice and the other wanted just the peel. Thus, their compromise solution was suboptimal because they could have divided the orange in a way that would have given both sisters what they need—namely, by giving all of the juice to one and all of the peel to the other. This trade-off between fruit and peel is a better solution than the compromise solution. In general, whenever two parties differ in how much they value issues, there is an opportunity to make an integrative (i.e., value-creating) trade-off agreement.

A second negotiation strategy is a *contingent contract.* When parties disagree on an important future issue, a contingent contract—a bet or wager based on the result of the future event—can be useful (Lax & Sebenius, 1986). For example, a book author was negotiating with her book publisher about royalty rates. The publisher offered a 12% royalty rate; the author wanted an 18% royalty rate. The publisher believed that book sales would be relatively modest, but the author believed that book sales would be high. Whereas a compromise solution would involve settling for a 15% royalty rate (halfway between the parties' stated demands), a contingent contract agreement would tie royalty rates to sales. For example, the royalty rate would be 12% if book sales were less than or equal to some agreed-on level and would rise linearly as book sales increased. Contingent contracts avoid impasses by allowing parties to make agreements despite their differing expectations about the future (e.g., book sales). By managing risks and incentives, contingent contracts can provide better solutions than a simple compromise.

Overview of Research

In the first study, we gave participants two cases exemplifying either trade-offs or contingent contracts. Then, all participants were challenged to solve a novel negotiation problem that differed in surface features. Our primary question was whether analogical training would help participants learn to propose trade-off or contingent contract solutions. Because we expected this task to be challenging for novices, we devised a training program to take learners through the analogical encoding process and encouraged them to articulate the common principle in full (Collins, Brown, & Newman, 1989). Scaffolding—externally provided problem-solving support attuned to the particular needs of the learner (Vygotsky, 1962)—has been shown to help in initial learning, not only for young children (A. L. Brown & Kane, 1988) but also for older learners (Barron et al., 1998; Collins, 1991). More specifically, guiding learners through a comparison so that they articulate key correspondences can improve their mapping and subsequent performance (Kurtz et al., 2001; Loewenstein & Gentner, 2001; Loewenstein et al., 1999). In addition to testing whether novices can learn to use negotiation skills, this study also tested whether a subtle hint to retrieve the cases would facilitate transfer (Gick & Holyoak, 1980). In the second study, we removed the scaffolding and tested whether novices could benefit from a simple instruction to compare. The benefits of analogical encoding are hypothesized to result from the abstraction of an articulated schema (Gick & Holyoak, 1983). In our studies, we analyzed the participants' written statements after the initial learning to test (a) whether

people who are given comparison training produce schemas capturing the key relations better than those who study the cases separately and (b) whether the goodness of schema participant predicts the likelihood of transfer. By including two different kinds of negotiation, we can also test a further prediction of this position, namely that the benefits should not be attributable to some general facilitation of integrative agreements but should reflect schema-consistent learning and transfer. In the third study, we tested transfer in a face-to-face negotiation situation (as opposed to the paper-and-pencil task used in the first two studies). In addition, we tested whether varying the degree of comparison guidance influenced the degree of transfer.

Experiment 1

In Experiment 1, we tested whether guided analogical learning facilitates learning and transfer for novices. Participants were presented with written materials that scaffolded their comparison of two (roughly 200-word) negotiation cases. One group of participants read two cases that each described how protagonists fashioned a trade-off based on their differing priorities, and another group read two cases exemplifying how protagonists fashioned a contingent contract in the face of differing beliefs about a future event. Following this training, participants read a different negotiation case and were asked to write a solution. The test problem was designed to have different surface features than the study examples. The test problem was structured such that three solutions could be formed: a (suboptimal) compromise solution (akin to cutting the orange in half), a trade-off solution, or a contingent-contract solution. In addition, we included a baseline group of participants who received only the written negotiation test problem (with no prior training cases). The chief experimental predictions were as follows: (a) that the analogy training groups would propose either trade-off or contingent-contract agreements, according to their training, and (b) that both groups would propose fewer (suboptimal) compromise solutions than the baseline group.

Method

Participants. A total of 48 undergraduate students participated to fulfill a course requirement. One third were assigned to the trade-off guided-analogy condition, one third to the contingent-contract guided-analogy condition, and one third to a baseline (i.e., no-training) condition.

Materials and procedure. Trade-off guided-analogy and contingent-contract guided-analogy participants were given a packet containing analogy training worksheets. All participants then completed written negotiation test materials. Participants were tested in individual booths. They were given as much time as they needed, which was roughly 20 min for the two analogy training groups and 15 min for the baseline group.

Guided-analogy training. The guided-analogy training worksheets consisted of four brief parts, designed to guide participants through a comparison between two examples (Loewenstein et al., 1999; see the Appendix). First, participants were given a definition of the key principle (either the trade-off or contingent-contract principle). Second, participants read an example that demonstrated the principle. The trade-off example described a case of two sisters quarreling over an orange, and the contingent-contract example described a buyer and seller arranging the shipment of goods (see the Appendix for an example). Both examples described compromise solutions rejected in favor of a solution using the principle and had accompanying diagrams. Third, participants read a second example of the same principle but one taken from a different domain and written in paragraph form. For the trade-off condition, this was a story about two divisions of a company, each with its own interests, planning a retreat. For the contingent-contract condition, the second case described two students deciding whether to place a deposit for a hotel reservation for spring break. Finally, participants were asked to complete a diagram for the second example similar to that accompanying the first example. After completing these tasks, participants were asked to read and respond to a novel negotiation case (the test case), which served as the transfer task for the analogy training.

Test case. All participants read a one-page statement by a (fictitious) student concerning his negotiation for an apartment lease. Next, participants read a two-page transcript of a negotiation between the student and a landlord (pretested to ensure that it was engaging and clear). The transcript ended once three issues had been raised (rent, laundry fee, and length of lease) but before the protagonists had resolved their negotiation. The landlord wanted, in order of importance, a high ($650) monthly rent, a long (2-year) lease, and a high ($20) monthly laundry fee. The student wanted, in order of importance, a low ($550) monthly rent, a low ($10) monthly laundry fee, and a short (1-year) lease. One compromise solution (analogous to the sisters' initial solution with the orange) is $600 monthly rent, $15 monthly laundry fee, and a 1.5-year lease. The value created by a trade-off or a contingent contract is generated through the laundry-fee and lease-length issues, for which the protagonists have different priorities and time preferences. An example of a trade-off solution is $600 monthly rent, $10 monthly laundry fee (student's priority), and a 2-year lease (landlord's priority). An example of a contingent-contract solution is $600 monthly rent, $20 monthly laundry fee the first year, and free laundry the second year, if the student stays. Both a trade-off and a contingent-contract solution yield a more profitable agreement for both parties than a compromise solution.

Comprehension questions. After reading the negotiation transcript, participants were asked several questions to ensure that they had understood the transcript (following Thompson & Hastie, 1990). First, they were asked basic questions about the topics discussed and identifying the main characters, for example, "What were the issues that Stephen and Brian negotiated about?" Next, they were asked to rank order the negotiated issues in terms of their priority for each party and whether each issue was important to one or both parties. Finally, participants were asked if the negotiation hinged on the outcome of any future event. These questions assessed whether participants grasped the basic knowledge they would need to propose trade-off and contingent-contract solutions (i.e., about priorities and expectations about the future, respectively).

Constructing solutions. Our primary measure of transfer was the solution that participants wrote. Participants were asked to propose what they thought would be the best solution to the test case and to explain why:

> Both the student and the landlord want to work something out. But as you can see, it's not certain what the terms of the lease should be. Please specify a set of terms that takes both parties' interests into account. You should decide what is best for the two of them based upon the information in the transcript—not based upon what might be common or true in your personal life. Your answer should be distinctive and unambiguous: clearly state what you think should happen.

Given the structure of the case, participants' responses could be one of three kinds: trade-offs, contingent contracts, or compromises.

After proposing one solution, participants were asked whether they had been reminded of any of the study cases while reading the test case. Specifically, they were asked "Were you reminded of any of the prior negotiations while reading this transcript? Which one?" and "Were any of these prior stories helpful? Which one? Why?" In contrast to prior research in which participants who failed to solve a problem were explicitly told that they might find the prior story helpful (e.g., Gick & Holyoak, 1980), participants were not explicitly told that the prior cases would be helpful. Finally, participants were asked to propose a second solution to the negotiation. This was done so that we could code any other solutions participants devised as well as to give them an opportunity to propose

another solution based on any remindings they might have had in response to the preceding questions. Thus, each participant had the opportunity to propose two solutions to the negotiation.

Baseline. The baseline participants received no training but were given the same test case and questions following the test case as in the analogy conditions.

Scoring. Two coders, blind to the condition of the participants, scored the proposed agreements to the lease negotiation as to whether they embodied trade-offs, contingent contracts, or compromises (each agreement was scored as one and only one of these three kinds; see Table 1). There was 93% agreement on the coding of the stories; disagreements were resolved through discussion. As each participant could write two agreements (i.e., the sum of the proportions of participants proposing each kind of solution can be greater than one), the key dependent measures were the number of participants who wrote each kind of agreement. Because this dependent measure is categorical, we used nonparametric analyses.

Results

Negotiation solutions. As predicted, participants given guided-analogy training were able to transfer the principle in the study cases to the test case—either trade-off and contingent-contract solutions—as shown in Table 2. Roughly half of the guided-analogy participants (15 out of 32, or 47%) proposed solutions to the test negotiation using the principle embedded in their study cases. In contrast, only 6% of the baseline participants (not given analogies) proposed contingent-contract or trade-off solutions, $\chi^2(1, N = 48) = 7.92$, $p < .01$. The analogy-training participants also proposed more solutions using the principle they were taught than using the principle they were not taught, $\chi^2(1, N = 64) = 9.06$, $p < .01$, with 13% of analogy-training participants doing so. As participants could generate up to two solutions, we also scored the number of compromise solutions generated. About 72% of the guided-analogy participants proposed compromise solutions, as compared with 100% of the baseline participants, a reliable association, $\chi^2(1, N = 48) = 22.08$, $p < .01$. Thus, guided-analogy training reduced, but did not eliminate, the tendency to propose compromise solutions. Overall, (a) analogical learning led to performance advantages on the test negotiation relative to no training, and (b) this advantage was specific to learning and transferring a particular principle.

Reported remindings. Most of the analogy participants responded to the reminding questions by describing how they generated their first solution, primarily by stating they were reminded of the training cases (65% said they had such remindings). This is consistent with the pattern of proposing trade-off and contingent-contract agreements: 84% of these agreements were generated prior to the reminding questions. Nearly all of the solutions written after the remindings questions were either (a) minor variants of people's first solutions (50% of the postremindings solutions) or (b) compromise solutions written after trade-off or contingent-contract solutions (33%). These were typically stated to be backup plans, worse alternatives, or the only other solution participants could devise. Only 3 people generated integrative agreements after the reminding questions after first proposing compromise solutions. They all stated that they were reminded of the prior examples, suggesting that the reminding questions might have served as a subtle hint to use the solution from the training cases. The baseline-group participants were also asked for their remindings; 31% said they had been reminded of a prior negotiation they had engaged in or heard about such as their own apartment lease or job negotiations.

Principle-specific results. Among the contingent-contract analogy participants, 44% proposed a contingent-contract solution. However, virtually no one in the other two conditions did (only 1 of the 16 trade-off analogy participants and none of the baseline

Table 1
Trade-Off, Contingent-Contract, and Compromise Agreements From Participants in Experiment 1

Agreement type	Example
Trade-offs	"The length of the lease was more important to Brian, so Stephen should agree to the 2 years, but laundry was more important to Stephen, so Brian should give him the $10 month fee."
	"The length of time for the lease is more important to Brian, so Stephen gives in. The laundry is more important to Stephen, so Brian gives in."
	"The laundry and length of stay are trade-offs. It is very important to the landlord that the lease be at least 2 years, but the laundry is not that important. To the student, access to a washer and dryer is more important than the length of the lease. Therefore, the landlord should get the 2-year lease and let the student do his laundry at the lower price."
Contingent contracts	"The rent should be set at $600 if Stephen decides to stay for 2 years. If not, then the rent should be at $650. . . . If Stephen stays for 1 year, then he should pay extra, as he is disadvantaging Brian."
	"Stephen will have to pay $650 per month because he won't be sure whether he will leave in a year or not . . . . The second year (if Stephen decides to stay), the price of the apartment should go down to $550 per month."
	"The student will sign a 1-year lease and pay $625 per month rent and $20 per month laundry. If he decides to stay another year, they will have an agreement for $575 per month rent and $10 per month laundry for the second year."
Compromises	"Meet halfway on everything."
	"Brian wanted $650 per month and Stephen wanted $550 per month. $600 is between the two. . . . For laundry, $15 for the month is between the $10 that Stephen wanted to pay and the $20 that Brian wanted to charge."
	"The average price of what they want."

Table 2
Proportions of Participants in Experiment 1 Writing Trade-Off, Contingent-Contract, and Compromise Solutions

Training	Trade-off	Contingent contract	Compromise
Baseline	.06 (1/16)	.00 (0/16)	1.00 (16/16)
Trade-off analogies	.50 (8/16)	.06 (1/16)	.69 (11/16)
Contingent-contract analogies	.19 (3/16)	.44 (7/16)	.75 (12/16)

Note. Raw numbers are in parentheses. Proportions total to more than 1 because participants could each propose up to two solutions.

participants; both contrasts are reliable by Fisher's exact tests, $p < .05$). Likewise, 50% of the trade-off participants proposed a trade-off solution. Only 19% of the contingent-contract participants proposed a trade-off solution, marginally reliable by a Fisher's exact test ($p = .07$). Likewise, only 1 of the baseline participants proposed a trade-off solution, reliable by a Fisher's exact test ($p < .01$). This is evidence that analogy participants transferred the specific strategy they were taught—as opposed to simply gaining a general familiarity with negotiation principles—and used the strategy to solve the test problem.

It is important to note that the baseline participants were not inattentive. All participants answered the comprehension questions correctly (85% correct) and were largely accurate about the priorities of the parties (70% correct) and about the fact that the negotiation depended on future outcomes (89% correct). This suggests that the guided-analogy training participants were simply better able to use this information to solve the negotiation problem.

Discussion

Analogy training enabled participants to propose sophisticated solutions to negotiation problems. This constitutes a considerable analogical learning effect and stands in contrast to the near absence of integrative agreements found in the baseline group here as well as in prior studies (e.g., Bazerman et al., 1985; Loewenstein et al., 1999). Moreover, the guided-analogy training led to principle-specific learning. When participants took up the opportunity to propose a second solution, they rarely proposed a second advanced solution. For example, after proposing a trade-off, they did not propose a contingent contract, even though both were good solutions. If they proposed a second solution, it was almost always the default compromise solution—the same one proposed by the baseline group. (Indeed, 75% of the participants proposed a compromise solution, generally as their second proposal.) In contrast, all of the baseline participants wrote compromise solutions, almost always as their only proposal.

The findings of Experiment 1 are consistent with our claim that actively comparing examples allows learners to grasp their common structure and to transfer that learning to skill in a subsequent novel situation. However, the intervention here included more than just drawing a comparison; it also included a definition and a diagram. Additionally, the materials were explicit about providing training, leaving open the possibility that at least part of the guided-analogy training advantage resulted from a demand characteristic. Further, the comparison groups differed from each other and from the baseline group not only in whether they carried out comparisons but also in which materials they read. Thus, the apparent benefits of comparison could have been due simply to having learned cases embodying the principle. We cannot rule out the possibility that the transfer resulted simply from learning the individual cases, not from comparing them. The second experiment addresses these questions. In addition, this study tests an important prediction of our analogical encoding claim: namely, that gains due to analogical encoding result from better relational schemas.

Experiment 2

Experiment 2 focused on our claim that analogical encoding using case comparison is a key driver of learning and transfer. All participants read either two examples of trade-offs or two examples of contingent contracts. Half of the participants were encouraged to compare the examples, and half were encouraged to study them one at a time. If the high rate of transfer in Experiment 1 was largely due to task demands, or to the information in the individual cases, then both the comparison groups and the separate-case groups should show increased use of the solutions embodied in their study examples (i.e., trade-offs or contingent contracts). However, if, as we hypothesize, drawing comparisons is a particularly powerful means of learning problem-solving schemas, then participants who compare cases should show far more learning and transfer than those who analyze the cases separately.

In addition, we analyzed participants' open-ended statements regarding the training examples as a measure of their understanding of the principle after completing the study materials. We predicted that comparison would lead to better understanding of the solution strategy underlying the two exemplars (Gick & Holyoak, 1983) and, further, that better understanding of the schema would be associated with greater transfer. Accordingly, we predicted (a) that participants who draw comparisons would articulate the solution principle more clearly in their descriptions than would those who study the cases separately and (b) that participants who show better understanding of the principle will show more transfer of the principle to the test case. A further benefit of examining the written statements is that we can check whether participants who were not told to compare the examples will do so spontaneously. One might imagine that studying two analogous examples one after the other might lead participants to notice their likeness. However, if novices do indeed primarily focus on surface features of the examples and represent the examples in contextually specific form, then we should expect to see little spontaneous comparison of the examples—which are designed to be similar in higher order relational structure but not in surface features.

In sum, the analogical-encoding account predicts that drawing a comparison between the study cases will lead to better learning, because it will lead participants to focus on the common principle.

This will lead to (a) better (more principle-focused) descriptions of the study materials and to (b) a higher rate of transfer of the principle to the test case. In contrast, the separate-case groups are predicted to focus relatively more on concrete, specific details of the study cases, with the principle encoded in highly concrete terms (if at all). Thus (a) their descriptions of the study cases should not focus on the negotiation principles, and (b) they should fail to transfer the principle to the test case.

Method

Participants. A total of 128 undergraduate students participated to fulfill a course requirement. Half of the participants were randomly assigned to the comparison condition, and half were assigned to the separate-cases condition. Within each condition, half read trade-off examples, and half read contingent-contract examples. Thus, the study had a between-subjects 2 × 2 factorial design.

Materials and procedure. Participants were given a packet with a brief case training section followed by the lease-negotiation materials. The training section included two cases of roughly 225 words. These were the examples used in Experiment 1, with the change that both were presented in narrative form. In the comparison conditions, participants read the two cases on a single page, then were asked, "What is going on in these negotiations? Think about the similarities between these two cases. What are the key parallels in the two negotiations? Please describe the solution and say how successful you think it is." In the separate-cases conditions, participants first read one case, followed by the question "What is going on in this negotiation? Please describe the solution and say how successful you think it is." Then, on the next page, participants read the second case and answered the same question. After receiving either comparison or separate-cases training, participants were given the test negotiation materials from Experiment 1.

Scoring. Two judges rated the solutions that participants wrote to the test negotiation, as in Experiment 1. The judges also scored participants' statements about the study cases for understanding of the principle. The statements about the cases were rated on a 3-point scale, with 0 = *not containing any elements of the schema (either contingent contract or trade-off according to which cases were presented*), 1 = *containing some elements of the schema*, and 2 = *containing the complete schema.* The judges also coded whether participants linked the two cases in any way (e.g., writing "as before," "again," or "both cases . . . ") as a check for whether comparison-condition participants compared the two examples, and separate-cases-condition participants did not. The judges' agreement on the scoring of the solutions, linking, and statements of the principle was .90, and disagreements were resolved through discussion.

Results

Negotiation solutions. Drawing comparisons led to greater understanding of the schema and greater transfer than did reading the cases separately. Participants in the comparison condition were over twice as likely (48% of participants) to transfer the principle to the test case as participants in the separate-cases condition (19%), $\chi^2(1, N = 128) = 11.85$, $p < .01$, as shown in Table 3.

Analogical encoding was effective for both types of negotiation principles. For participants receiving contingent-contract examples, comparison-condition participants (38%) were more likely to propose contingent-contract solutions than participants in the separate-cases condition (16%), $\chi^2(1, N = 64) = 3.92$, $p < .05$. For participants receiving trade-off examples, comparison-condition participants (59%) were more likely to propose trade-off solutions than participants in the separate-cases condition (22%), $\chi^2(1, N = 64) = 8.26$, $p < .01$. The benefit of comparison was also manifested in reduced rates of proposing compromise solutions. Participants in the separate-cases condition (83%) were more likely to write compromise solutions than participants in the comparison condition (61%), $\chi^2(1, N = 128) = 7.58$, $p < .01$.

As in Experiment 1, participants rarely proposed solutions using the principle for which they were not given examples: Only 20% of participants in the comparison condition and 13% of participants in the separate-cases condition wrote agreements using the nontrained principle. The association between comparison and the use of the untrained principle was not reliable, $\chi^2(1, N = 128) = 1.42$, $p > .10$. In summary, participants used a negotiation principle over baseline rates if and only if they made comparisons among examples embodying that principle.

Reported remindings. Overall, most of the participants (68%) indicated that they did not think of prior cases when solving the test case, and there was no difference in the rate of stated remindings due to drawing comparisons during training (34% of the comparison groups and 30% of the separate-cases groups listed a reminding to at least one of the prior cases). However, prompting participants about their remindings may have increased transfer, particularly for the contingent-contract principle. Among those receiving contingent-contract cases, most of those who proposed a contingent-contract solution (65%) did so after the reminding questions. In contrast, among those receiving trade-off cases, most of those who proposed a trade-off solution (69%) did so before the reminding questions. The association between solution type and time of proposal was reliable, $\chi^2(1, N = 43) = 4.80$, $p < .05$. This

Table 3
Proportions of Participants in Experiment 2 Writing Trade-Off, Contingent-Contract, and Compromise Solutions and Proportions of Individuals in Each Schema Quality Rating Category

				Individuals' rated schema quality		
Training	Trade-off	Contingent contract	Compromise	0	1	2
Compare trade-offs	.59 (19/32)	.16 (5/32)	.50 (16/32)	.31	.34	.34
Compare contingent contracts	.25 (8/32)	.38 (12/32)	.72 (23/32)	.22	.28	.50
Separate trade-offs	.22 (7/32)	.06 (2/32)	.84 (27/32)	.53	.31	.16
Separate contingent contracts	.19 (6/32)	.16 (5/32)	.81 (26/32)	.50	.41	.09

Note. Raw numbers are in parentheses. Proportions of proposed solutions total to more than 1 because participants could each propose up to two solutions.

difference is consistent with other evidence suggesting that the contingent-contract principle is more difficult for novices than the trade-off principle.

Schema quality. We analyzed participants' statements about the training cases to assess their understanding of the agreement structures (Table 3). According to the blind judges' ratings, participants who compared cases (42%) stated the key principle in full more often than those who read cases but did not compare them (13%), $\chi^2(2, N = 128) = 15.64$, $p < 01$. This comparison advantage was significant for those learning contingent contracts, $\chi^2(2, N = 64) = 13.14$, $p < .01$, but not for those learning trade-offs, $\chi^2(2, N = 64) = 4.11$, $p = .13$.

Overall, better schemas were associated with higher transfer. Only 20% of the participants who were given a 0 for their schema rating—indicating that no elements of the schema were present—transferred the agreement structure. In contrast, participants given a 1 or a 2 for their schema rating (where 1 indicates that some elements of the schema were present and 2 indicates that the complete schema was present) were twice as likely to transfer (40% and 46%, respectively). The association between schema rating and transfer proportion was reliable, $\chi^2(2, N = 128) = 7.13$, $p < .05$.

Linking. Participant's responses were scored as to whether, when discussing the second study case, they made any reference to the first study case (e.g., writing "both cases," "again," or "as before . . ."). Confirming the distinction between conditions, comparison-condition participants (98%) were more likely to link the two study examples than were separate-cases-condition participants (16%), $\chi^2(1, N = 128) = 89.55$, $p < .01$. In addition to confirming that our instructions were effective, this fact brings home the point that learners tend not to spontaneously compare cases that lack surface similarity—even when the two cases are presented in immediate succession.

Discussion

Experiment 2 found support for the specific claim that making comparisons promotes schema abstraction and transfer. Participants who compared two cases generally wrote elements of the schemas contained in the cases, demonstrating immediate learning of the negotiation principle. Nearly half of them used the schema from the cases to generate a solution to the test negotiation, demonstrating that the learning could transfer to a new situation with quite different surface features—a typically challenging transfer problem. Finally, learning and transfer were related, with better schema abstraction associated with greater use of the schema to solve a novel problem.

In contrast, participants in the separate-cases conditions showed little evidence of correct schema abstraction. Moreover, even though the cases were presented successively, less than 20% spontaneously linked the two cases. This suggests that their encoding of the cases was specific to the context of the cases. Thus, it is not surprising that they showed little transfer to the test negotiation. Indeed, they did not perform appreciably better than did the baseline condition from Experiment 1.

In sum, the comparison group showed a two-fold transfer advantage over the separate-cases group. This difference can be attributed to the effects of analogical encoding—the use of comparison to inform the understanding of two input cases. All participants were given the same two analogous cases. Thus, reading and describing two analogous stories about successful negotiation is not sufficient to foster learning and transfer. Rather, the critical step appears to be drawing a comparison between examples to extract their common structure. The overall pattern of findings is consistent with our claim that analogical encoding leads to better learning, which in turn leads to superior transfer.

Experiment 3

Thus far, we have shown that analogical encoding can improve novices' ability to transfer principles learned from examples to hypothetical negotiation problems. An obvious question concerns whether the analogical learning benefit generalizes to actual negotiation behavior. In prior research we have found that advanced learners—management students possessing some professional negotiation experience—benefited from analogical encoding in actual negotiations. In this experiment, we asked whether novice negotiators would transfer principles in an actual face-to-face negotiation. We know from Experiments 1 and 2 that analogical encoding helps novice negotiators grasp problem-solving schemas and apply them to a hypothetical written test case for which they are a third party. It is a much bigger challenge to recognize an opportunity to apply principles in an actual negotiation in which they are a protagonist.

A further goal was to contrast guided-analogy training (as used in Experiment 1) with a simple instruction to compare (as used in Experiment 2). We predicted that guided training would result in greater transfer than open-ended training. For example, Kurtz et al. (2001) asked college students to compare two diagrams depicting heat-flow situations. They divided participants into four groups whose instructions were designed to encourage different degrees of effort or cognitive activity in the comparison process, from none (describing each diagram separately) to low (rating their similarity) to moderate (describing their commonalities) to high (stating their correspondences and describing their commonalities). Participants were asked to list differences between the two situations, and the causal relevance of the differences was rated. The likelihood of the listed differences being related to the common causal principle increased with the strength of the requested comparison process. Thus, we expect that guiding learners' comparisons should enable a greater proportion of participants to focus on the important structural commonalities that define the negotiation agreements.

Pilot Investigation

Prior research indicated face-to-face negotiation tasks, such as the one we use in Experiment 3, are extremely challenging (Thompson & Hrebec, 1996). We conducted an initial pilot study with undergraduate negotiators and found that indeed face-to-face negotiations proved difficult to resolve in an effective fashion. Despite finding levels of learning consistent with those in Experiments 1 and 2, participants rarely used the negotiation principles to form their negotiated agreements. Specifically, we engaged 120 participants in two simulated negotiation exercises, one before and one after training. First, they were given role information (e.g., 1 person played the role of a job candidate and another played a recruiter) for a three-issue negotiation that allowed the opportunity to form a contingent contract (e.g., tying a bonus to eventual start date). They then negotiated and formed agreements. Students then

received separate-cases instructions, comparison instructions, or guided-analogy instructions for contingent contracts. Finally, students engaged in a second 3-issue negotiation that also allowed an opportunity to form a contingent contract. Those receiving separate-cases instruction showed little linking of cases, little grasp of the principle, and no evidence of transfer—that is, no increase in tendency to form contingent contracts from their first to their second negotiations. The same 10% formed contingencies in both rounds. Those receiving comparison instruction evidenced schema abstraction, as in Experiment 2. However, this resulted in only a minimal transfer benefit. The rate of forming contingent contracts increased from 5% initially to 15% after instruction. Finally, those receiving the guided-analogy training had a slightly larger increase in using contingencies: 5% to 25%. Thus, this pilot study showed that (a) the face-to-face negotiation task was challenging for novices, and (b) as expected, transfer increased with more intensive comparison activity.

In the present study, we used a single-issue face-to-face negotiation task between an employer and employee as the transfer task. This negotiation task was adapted from the standard paradigm used in conflict management research (Bazerman, Curhan, Moore, & Valley, 2000). In our pilot investigation, college undergraduates regarded the situation as both relevant and valuable. In the scenario, participants were assigned roles and told to negotiate over salary. There was a conflict concerning the start date that did not need to be resolved to reach a decision on salary but could be used to create value by forming a contingent contact. We examined separate-cases, comparison, and guided-analogy training conditions as well as a baseline (i.e., no-training) group that simply engaged in the face-to-face negotiation. We also assessed the quality of participants' descriptions of the study materials, as before. In addition, we asked participants to rate the similarity of the two cases at the end of the session.

We predicted that the two analogy groups would learn the principle better than the separate-cases and baseline groups, as reflected in their schema quality, and that this would lead to superior transfer among the analogy groups. We also predicted that guided comparison would be even more effective than simple comparison in promoting learning and transfer. Thus, we predicted that the guided-analogy-condition participants would form more contingent contracts than would participants in the comparison condition, who in turn would form more than those in the separate-cases and baseline conditions.

Method

Participants. A total of 158 undergraduate students participated to fulfill a course requirement, randomly assigned to one of four groups. There were 40 students in each of the guided-analogy, comparison, and separate-cases conditions and 38 students in the baseline condition. Thus, there were 20 negotiating pairs for each condition except the baseline condition, for which there were 19 pairs.

Materials and procedure. The training materials were the same as used in Experiments 1 and 2. The procedure for participants in the separate-cases and comparison conditions was as in Experiment 2; the separate-cases participants analyzed each case separately on successive pages, and the comparison participants wrote the commonalities between the two cases. Participants in the guided-analogy condition completed a guiding training packet for contingent contracts in the same manner as in Experiment 1. The baseline participants were given no training.

All participants were then given role materials for their face-to-face negotiation. Participants played the role of either a job candidate (depicted as a recent university graduate) or a job recruiter. The candidate wanted a high salary; the recruiter wanted a low salary. In addition, it was common knowledge that candidates were expected to pass an important qualifying exam prior to employment. This was the basis for making a contingent contract, and we attempted to make this information salient to participants. To this end, written in bold type in both the candidate's and recruiter's role materials were their expectations regarding the exam: The candidate expected to pass on the first try, but the recruiter expected the candidate to need to retake the test. A contingent contract could be formed tying starting salary to the eventual start date (i.e., pending the passing of the exam). Participants were given roughly 10 min to complete the negotiation (judged to be sufficient on the basis of results from pilot testing).

Participants then completed a postnegotiation questionnaire. First, and of greatest importance, they indicated their proposed resolution of the negotiation by writing their version of the agreement they had reached. They were also asked, "What do you feel the best agreement could have been, taking both your interests and the other party's interests equally into consideration?" (Participants were also given a forced-choice task among three potential agreements to their negotiation, but as a typographical error rendered one of the choices uninterpretable, these data were not analyzed.) Finally, all participants except those in the baseline condition answered two similarity questions: "How similar were the underlying situations in the training cases?" and "How similar were the training cases and the negotiation?" Their responses were made on a 7-point scale, ranging from 1 (*not similar*) to 7 (*highly similar*).

Scoring. Separate-cases and comparison-group participants' responses to the training materials were scored for schema quality and linking between the two cases as in Experiment 2. The negotiation agreements were scored dyadically. A negotiating pair was scored as generating a contingent contract if both parties wrote a contingency in their contract statements. This criterion constitutes a conservative test of transfer, omitting four cases in which only 1 partner wrote a contingent contract—two in the baseline condition and one each in the separate-cases and guided-analogy conditions. However, the results were unchanged if a more liberal measure is used (where transfer was counted if either partner wrote a contingent contract). Desired agreement statements were also scored as to whether they advocated forming contingencies. The overall agreement across two judges was 86%. A third judge's ratings were used to settle disagreements between the first two.

Results

Face-to-face negotiations. As predicted, participants in the guided-analogy condition (90%) formed more contingencies than those in the comparison condition (70%), who in turn formed more than those in the separate-cases condition (55%) and baseline condition (37%; see Table 4). As predicted, the two groups that drew comparisons between study cases formed reliably more con-

Table 4
Proportions of Negotiating Pairs in Experiment 3 Forming Contingent-Contract Agreements in Their Face-To-Face Negotiations and Proportions of Individuals in Each Schema Quality Rating Category

		Rating		
Training	Dyad	0	1	2
Guided analogy	.90 (18/20)			
Comparison	.70 (14/20)	.25	.40	.35
Separate cases	.55 (11/20)	.40	.53	.08
Baseline	.37 (7/19)			

Note. Raw numbers are in parentheses.

tingency contracts than the groups that did not, $\chi^2(1, N = 79) = 9.74$, $p < .01$ (and reliably more than just the separate-cases group). Further, guidance through the comparison process was beneficial; the overall association between training and forming contingencies was reliable, $\chi^2(3, N = 79) = 12.84$, $p < .01$, as was the linear trend across levels of training (Cochran-Armitage Trend Test, $p < .01$).

After reporting the deals they actually negotiated, participants were independently asked to suggest an "ideal" settlement. This allowed us to examine whether some participants might have believed that a trade-off or contingent contract would be ideal but failed to arrive at such a contract because their partner rejected it. People who compared examples were more likely to regard a contingency as ideal than people who did not compare examples. The guided-analogies (73%) and comparison (68%) groups suggested contingencies as their ideal contract more often than did the separate-cases (48%) and baseline (47%) groups, $\chi^2(1, N = 158) = 8.30$, $p < .01$.

Schema quality. As in Experiment 2, we scored the comparison and separate-cases participants' open-ended statements about the study cases for descriptions of the contingent-contract schema. Replicating the previous study, participants in the comparison condition showed greater schema abstraction than those in the separate-cases condition. Roughly one third of the comparison participants (35%) fully articulated the schema, whereas only 8% of the separate-cases-condition participants did so. Participants in the comparison condition were significantly more likely to score a 2 and less likely to score a 0 than were participants in the separate-cases condition, $\chi^2(2, N = 40) = 9.18$, $p < .05$.

To assess whether schema quality predicted the likelihood of successfully transferring the principle to the face-to-face negotiation, we computed a dyadic score for schema quality by summing together the schema rating for each pair of negotiating partners. (Combining individual data to form a dyadic score is commonly done in negotiation and other small-group research; for discussion, see Loewenstein et al., 1999). A dyad could thus be given a schema rating between 0 and 4. There was a trend for an association between the total schema quality across a dyad and the likelihood that the dyad formed a contingent contract. Fifty percent of the dyads that articulated one or fewer elements of the schema (i.e., the dyadic schema rating was at most 1) transferred the principle to their negotiations, whereas 71% of the dyads that displayed a greater understanding of the schema (i.e., the dyadic schema rating was at least 2) did so, a suggestive trend, but not a reliable association, $\chi^2(1, N = 40) = 1.78$, $p = .18$.

Linking cases. As expected, nearly all (90%) of the comparison participants explicitly linked the two cases. In contrast, only about half (45%) of the separate-cases participants linked the cases, $\chi^2(1, N = 40) = 18.46$, $p < .01$.

Similarity ratings. The similarity ratings between the training cases and the test case suggest that the guided-analogy-condition participants may have perceived greater similarity among these materials than the comparison and separate-cases participants. The rated similarity of the training examples to the negotiation was reliably associated to training: The participants in the guided-analogy condition ($M = 5.1$, $SD = 1.4$) rated the negotiation as more similar to the training cases than did participants in the comparison ($M = 4.3$, $SD = 1.6$) and separate-cases ($M = 4.0$, $SD = 1.5$) conditions, $F(2, 115) = 5.08$, $p < .01$, $MSE = 2.34$. The ratings in the guided-analogy condition were higher than those in the separate-cases condition ($p < .01$) and marginally higher than those in the comparison condition by a post hoc test for mean differences ($p < .10$). Surprisingly, comparison experience did not result in increased subjective similarity between the two training cases. Guided-analogy-($M = 5.7$, $SD = 0.9$), comparison ($M = 5.6$, $SD = 1.4$), and separate-cases-($M = 5.4$, $SD = 1.2$) condition participants all perceived the training examples to be fairly similar to each other.

Discussion

An opportunity to compare examples enabled learners to grasp the contingent-contract principle and transfer it to a face-to-face negotiation. In accord with the analogical encoding hypotheses, novices learned and transferred better when they were instructed to compare the study cases. This benefit was greatest for the guided-analogy group, in which participants were guided through the comparison and received a supporting definition and diagrams; 90% of this group transferred the principle to the test negotiation. However, even without special guidance, the simple instruction to compare led to greater transfer: 70% of the comparison participants transferred the solution to the test case as compared with 55% among those who processed the cases separately and 37% among those receiving no cases.

Consistent with prior research, drawing comparisons led to higher schema quality than separate case analysis. There was a nonsignificant trend suggesting that negotiators were more likely to form contingent contracts when both members showed good understanding of the contingent principle, as assessed by their schema ratings. This is consistent with our prior finding that pairwise measures of schema quality are linked to likelihood of transfer (Loewenstein et al., 1999).

We found two further pieces of evidence that drawing comparisons led to different understandings of the case materials. First, drawing comparisons not only led to increased transfer but it also led participants to judge that contingent-contract agreements were the best agreement to form. Second, guiding participants through a comparison led them to see that their negotiation case was highly similar to the study materials. Both of these findings are consistent with the claim that drawing comparisons helps participants acquire a coherent and portable relational structure.

General Discussion

Three studies tested the claim that analogical encoding—comparing two instances of a to-be-learned principle—is a powerful means of promoting rapid learning, even for novices. Our participants were clearly novice negotiators. When given no training, 100% of our participants proposed compromise solutions to a written negotiation problem—solutions that are regarded to be suboptimal (Lax & Sebenius, 1986; Thompson, 2001). Additionally, our pilot study (reported prior to Experiment 3) revealed that few untrained participants formed agreements other than compromises in their actual face-to-face negotiations.

The present studies provide five lines of evidence for our claim that analogical encoding fosters the extraction of the common relational schema inherent in the cases and that this in turn promotes the ability to transfer the knowledge to new cases. First, learners who compared two cases developed better schemas—that is, schemas containing more elements of the key principle—than

those who studied the cases separately (Experiments 2 and 3). Second, learners who compared cases were better able to transfer the principle to a new situation than those who studied cases separately (Experiments 1–3), even when the new situation involved a challenging face-to-face negotiation (Experiment 3). Third, comparison groups performed reliably better than baseline groups, but separate-cases groups did not (Experiments 1–3). Fourth, the gains are specific to the principle taught, as predicted by the claim that comparison promotes extraction of the schema common to the two study cases. Comparison participants do not show increased ability to apply the noninstantiated principle (Experiments 1 and 2). Also consistent with this claim, the better the schema, the better the transfer to new cases (Experiment 2). Finally, the degree of schema abstraction and of resultant transfer is positively related to the degree of effort or intensity in the comparison process (Experiment 3), consistent with the findings of Kurtz et al. (2001).

Related Research

Although the great majority of studies of analogical training has focused on standard analogical learning (in which the learner applies knowledge from a well-understood situation to a new or poorly understood situation), there is some prior research and theory that relates to analogical encoding and case comparison (Bereiter, 1985; Cummins, 1992; Duit, Roth, Komorek, & Wilbers, 2001). Several studies have shown that inducing people to explicitly compare two exemplars fosters transfer to new situations (Catrambone & Holyoak, 1989; Gick & Holyoak, 1980, 1983; Kurtz et al., 2001; Reeves & Weisberg, 1990). However, with a few exceptions (Catrambone & Holyoak, 1989; Ross & Kennedy, 1990), these studies have contrasted groups that compare two examples with groups that receive only one study example, so that the number of study cases is not equated (e.g., Gick & Holyoak, 1983; Holyoak & Koh, 1987). A second limitation of prior research on analogical encoding is that the research has involved somewhat artificial tasks (e.g., paper-and-pencil hypothetical situations). Yet, one of the main issues faced by educators concerned about the "inert knowledge" problem is the lack of transfer of classroom knowledge to dynamic real-time situations. Our prior studies have helped to bridge this gap by demonstrating that analogical encoding can promote transfer in both written tasks and real-time simulated negotiations (Loewenstein et al., 1999; Thompson et al., 2000). Third, most prior studies have used a limited participant population—college undergraduates—and minimal levels of expertise. In our project, we have examined the effects of analogical encoding across a wide range of participants and skill levels.

Principles of Negotiation

We examined two different negotiation principles—trade-offs and contingent contracts. The results suggest that contingent contracts might be more challenging to learn and use than trade-offs. Across Experiments 1 and 2, 30% of the participants proposed trade-offs, but only 18% proposed contingent contracts across all training conditions. Also, in Experiment 2, the majority of participants who generated trade-off agreements did so prior to the reminding question, whereas the majority of participants who generated contingent-contract agreements proposed them only after the reminding question. These findings suggest that the contingent-contract principle is more difficult to grasp than the trade-off principle, perhaps because it has fewer antecedents in the participants' experience. This differential comprehensibility explanation receives indirect support from the results of Experiment 1. In Experiment 1, when a step-by-step guided instruction set was used instead of the open-ended instruction, the difference in performance between the contingent-contract principle and the trade-off principle largely disappeared.

Analogical Encoding Is Widely Applicable

The present studies demonstrate that analogical encoding can help novices to learn and transfer negotiation strategies. Broader evidence in support of analogical encoding facilitating schema abstraction and transfer comes from a wide range of tasks and age groups (Gentner, Holyoak, & Kokinov, 2001; Gentner & Medina, 1998). For example, Loewenstein and Gentner (2001) found that drawing comparisons focused children on spatial relations and thereby facilitated their spatial mapping performance. Specifically, 3-year-old children who were asked to point out similarities across two similar dollhouses performed significantly better on a spatial mapping task to a third dollhouse than children who interacted with the two initial dollhouses separately. We suggest that comparing the two initial dollhouses led the children to encode a more delineated representation of the common spatial relations. Comparison also appears to aid children's word learning. Gentner and Namy (1999) and Namy and Gentner (2002) found that when preschool children were induced to compare two exemplars of a new word, they were more likely to extend the word on the basis of important functional relations (such as edibility) rather than on the basis of surface perceptual similarities (such as shape).

Comparison effects appear to be durable over time. Chen and Klahr (1999) taught elementary school students the control of variables strategy used in experimental design by juxtaposing many contrasting variations in highly similar physical situations (e.g., dropping an object from different heights). Once the within-situation contrasts were well established, the experiments shifted to a new domain (e.g., the period of a pendulum) and again provided the learners with large numbers of closely comparable experiences. This kind of training encourages within-domain comparison and abstraction and allows for cross-domain comparisons to occur. With this training, students were able to learn the control of variables strategy and to retain it when tested 7 months later. Studies with adults also suggest that abstract concepts learned by comparing examples are used effectively long after the initial study (Fong & Nisbett, 1991). These kinds of findings lead us to speculate that analogical encoding across many examples may provide a means by which experiential learning yields broad conceptual change (Gentner & Loewenstein, 2002; Gentner & Medina, 1998).

Prescriptions for Education

Two findings emerge from our studies, one encouraging and one cautionary. On the positive side, our results show that analogical encoding is an effective means of promoting learning from cases. On the negative side, our results show that learners cannot be counted on to spontaneously draw appropriate comparisons, even when the two cases are presented in close juxtaposition. Given that

in typical learning situations, cases are encountered in different contexts and at different times, we suspect that still less spontaneous comparison occurs in natural situations. Under these conditions, students' learning is likely to remain grounded in the existing concrete situation (e.g., Nunes, Schliemann, & Carraher, 1993; cf. J. S. Brown, Collins, & Duguid, 1989). If this is correct, there is an opportunity to accelerate students' learning by encouraging explicit comparisons.

We are not suggesting that comparison of cases is a panacea. Even if learners do compare examples, they may imperfectly abstract the schema or fail in their attempt to apply the schema to a new situation (Reeves & Weisberg, 1994; Ross & Kilbane, 1997). Rather, what we suggest is that pedagogical methods that assume that learners will abstract principles from single examples or that they will spontaneously draw comparisons across examples are likely to fall well short of the potential gains. We suggest that one aim for instruction should be not simply to provide cases but to facilitate active case comparison. This may be done directly (by juxtaposing two cases and asking for their commonalities as we have done). It can also be done indirectly—for example, by asking questions (Catrambone & Holyoak, 1989), by asking participants to list correspondences (Kurtz et al., 2001), by inducing participants to discuss closely related explanations (Schwartz, 1995), or by designing a software interface to induce users to contrast cases (Kolodner, 1997).

Conclusion

In sum, analogical encoding leads to better learning by fostering representation in terms of a more general and complete relational schema. Such a schema is more likely to be retrieved when an analogous situation is encountered than are the concrete representations formed when learners study examples separately. In this sense, analogical encoding promotes acquiring portable knowledge. Further, the present studies show that analogical encoding can be effective even early in learning, when learners may lack knowledge of an appropriate base domain; thus, it can act to bootstrap knowledge.

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(*Appendix follows*)

Appendix

Instructions for the Contingent-Contract Guided-Analogy Condition in Experiments 1 and 3

In a moment, you will be reading examples of a negotiation type. Please pay close attention, as you will be asked questions about it afterwards.

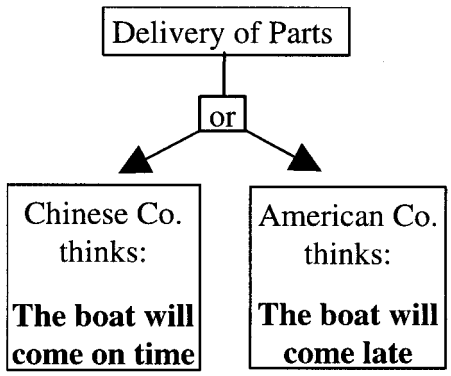
• A safeguard is a type of negotiated agreement in which the future is uncertain, but people are willing to proceed based on what they think will occur. It gives each party a "no risk" guarantee in a risky situation.

• An example of a safeguard comes from a story about an American company which has ordered parts from a Chinese company.

• Normally, the Chinese company sends parts by boat.

• The American company was worried that the parts wouldn't come in time for them to meet a construction deadline, so they asked the Chinese company to ship the parts by airmail, rather than sending them by boat.

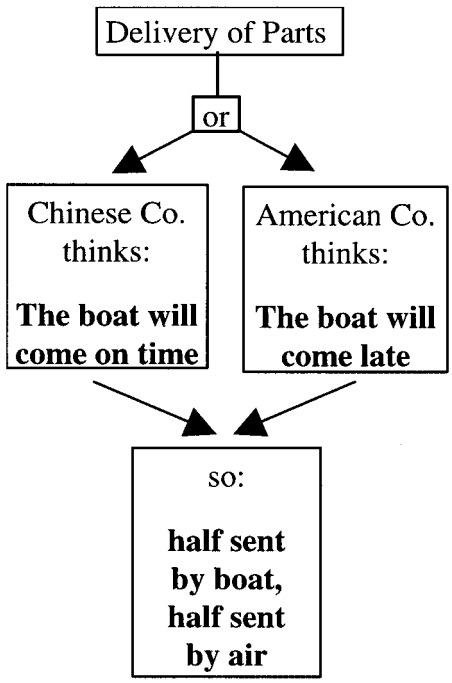
• The Chinese company refused, not wanting to pay the extra expense of airmail.



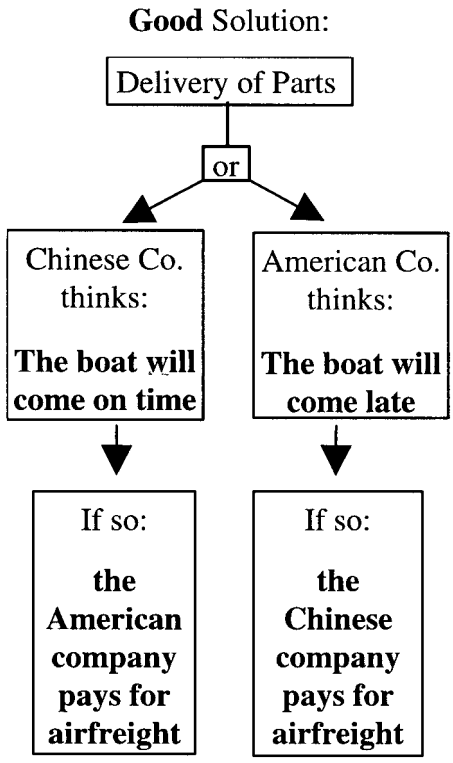
• The two companies considered sending half the parts by boat, and half by airmail.

• They realized, however, that this was a poor solution because it satisfied neither company's needs—the Chinese company would have to pay more to send the parts, and the American company wouldn't have everything it needed.

Bad Solution:



• Instead, the two companies decided to make a safeguard:
• The Chinese company will ship the parts by airmail. Both companies will watch the boat to see when it arrives in the states.
• If the boat arrives early, the American company will pay for the added cost of airmail.
• If the boat arrives late, then the Chinese company will pay for the added cost of airmail.



(*Appendix continues*)

Another example of a safeguard is:

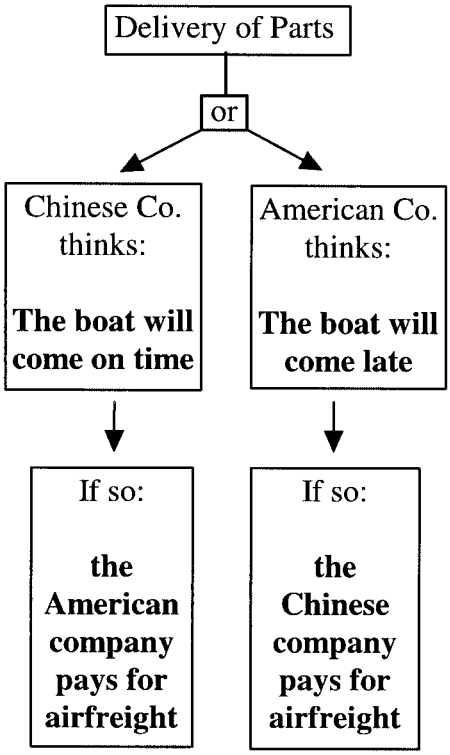
Mark and Paul are arguing about where to stay on their spring break trip to Cancun. They are going at the peak travel time to Cancun, so they know that figuring out where to stay in advance is important. Mark's parents own a condo there where they could stay, but they could also reserve a hotel room.

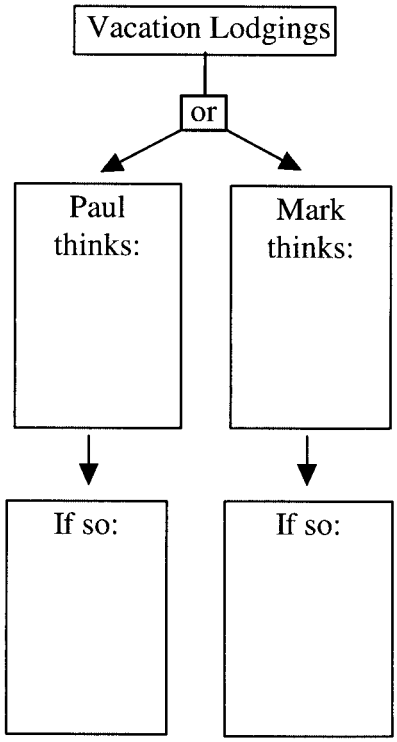
The condo would be an ideal place to stay, but Mark's parents might be staying at the condo at the same time. Neither wants to spend his vacation sleeping on the floor if Mark's parents do end up coming. Mark says in all likelihood his parents won't come. Paul wants to make a reservation at a hotel just in case.

They argue about reserving a room at a nice hotel, because it would cost $200, and Mark doesn't think they're going to need the room. They consider putting a little money on a deposit at a cheap hotel, but they decide that this isn't a good solution because they wouldn't want to spend their spring break at some fleabag.

They decide to put down the money on the nice hotel, and leave it open as to who will pay for it: if they don't need the room, Paul will pay because he wanted to reserve it in the first place, but if they do need the room, Mark will pay the deposit because he didn't think it would be necessary.

Below are two diagrams. The first diagram is of the negotiation that you read about first. The issues which formed the safeguard are entered according to how each thinks the events will unfold, and how they have agreed to handle each outcome. Please fill in the corresponding boxes in the second diagram such that it describes the negotiation that you just read about.





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