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A Look into the Mind of the Negotiator: Mental Models in Negotiation

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Negotiation can be conceptualized as a problem-solving enterprise in which mental models guide behavior. We examined the association between negotiation outcomes and mental models, as measured by negotiators' associative networks. Four hypotheses were supported. First, negotiators who reached optimal settlements had mental models that reflected greater understanding of the negotiation's payoff structure, and of the processes of trading and exchanging information, compared to negotiators who did not reach optimal settlements. Second, negotiators who reached optimal settlements exhibited greater within-dyad mental model similarity. Third, experience-based training was more likely than instruction-based training to produce mental models similar to the mental models of negotiators who actually reached optimal settlements. Finally, negotiators who received 10 weeks of experience-based training had mental models that were similar to novice negotiators who reached optimal settlements, except that the mental models of the experienced negotiators were more abstract.

KEYWORDS experience, integrative, mental models, negotiation, problem-solving, training

THERE IS overwhelming evidence that people are ineffective negotiators (see Bazerman, Curhan, Moore, & Valley, 2000; Neale & Bazerman, 1991; Thompson, 1990, for reviews). Negotiators often fail to discover mutually beneficial settlements and thus reach suboptimal settlements, leaving 'money on the table' unclaimed. Not surprisingly, research on negotiation has attempted to discover why negotiators fail to reach optimal settlements. The decision-analytic perspective suggests that people approach negotiation as a decision task in which they must choose from among different negotiation strategies or courses of action (Neale & Bazerman, 1991; Pruitt & Carnevale, 1993; Raiffa, 1982; Thompson, 1990). From this perspective, suboptimal settlements result from judgment heuristics and biases that lead to ineffective decision making.

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We propose that negotiation is better viewed as a problem-solving enterprise in which negotiators' mental models of the causal relationships within the negotiation situation guide their behavior. Negotiators' mental models lie along a continuum ranging from purely fixed-pie to purely integrative mental models. Fixed-pie mental models represent negotiation as a resource-claiming task in which gains for one party necessitate losses for the other party. Integrative mental models represent negotiation as a resource-creating task in which negotiators may 'create value' by working with one another to exchange information and maximize joint gains. If negotiators' mental models influence their behavior, then different negotiation outcomes should be associated with different mental models. In particular, the mental models of negotiators who reach optimal settlements should have more integrative features than the mental models of negotiators who do not reach optimal settlements.

In this article, we present an initial investigation of the association between negotiators' outcomes and their mental models of the negotiation situation. We also investigate the effectiveness of two kinds of training—didactic and experiential—in producing mental models with integrative features. Finally, we investigate the mental models of experienced negotiators, comparing them to the mental models of novice negotiators who reach optimal settlements.

Mental models in problem solving

Mental models are cognitive representations of the causal relationships within a system that allow people to understand, predict, and solve problems within that system (Gentner & Stevens, 1983; Holyoak, 1984; Johnson-Laird, 1983; Rouse & Morris, 1986). Mental models are based on people's experiences and expectations. They can guide behavior in different situations, organize thoughts about a problem, and influence the interpretation of information. Mental models differ from schemas in that they specify causal relationships. Mental models are also dynamic, rather than static mental representations (Gentner & Whitley, 1997). Individuals can mentally manipulate or 'run' mental models to see the consequence of particular problem-solving strategies (Gentner & Stevens, 1983; Montgomery, 1988).

Mental models have been a focus of research on the representation and use of causal knowledge in many domains including naive physics (Forbus & Gentner, 1986; McClosky, 1983), astronomical knowledge (Vosniadou & Brewer, 1992), spatial representations (Forbus, 1983; Glenberg & McDaniel, 1992; McNarma, 1986), problem solving by analogy (Bassok, 1990; Gentner, Rattermann, & Forbus, 1993; Holyoak, 1984; Holyoak & Koh, 1987; Keane, 1988), physical mechanisms (Hegarty & Just, 1993; Kempton, 1986; Kieras & Bovair, 1984), the understanding of man–machine systems (Chee, 1993), judgments of probability (Johnson-Laird, Legrenzi, Girotto, Legrenzi, & Caverni, 1999; Kahneman & Tversky, 1982), and propositional reasoning (Johnson-Laird, Byrne, & Schaeken, 1992). Although the mental model concept has its share of critics (e.g. Norman, 1983; Rips, 1986) there is nevertheless convergent evidence that mental models are associated with differential success in reasoning and problem solving across varied domains.

The accuracy of mental models is often associated with the quality of solutions to problems. Kempton (1986), for example, examined people's mental models of the operation of a thermostat. According to the (erroneous) valve model, thermostats work much like the accelerator in one's car—just as greater depression of the accelerator causes the car's speed to increase at a faster rate, turning the thermostat to a higher setting causes a room's temperature to increase at a faster rate. The threshold model is more accurate. A room heats at a constant rate, and the thermostat simply determines how long the heat is on. The greater the discrepancy between the current room temperature and the thermostat setting, the longer the heat will be on. Kempton reasoned that different mental models of thermostat operation might be associated with different strategies that people use to set the thermostats in their homes. Indeed, people with valve models tend to continuously adjust their thermostats in an apparent effort to 'home in' on a comfortable room temperature. People with threshold models, in contrast, tend to set their thermostats to only one or two settings per day (a nighttime setting and a daytime setting). These findings indicate that incorrect mental models may lead to inefficient problem solving and undesirable outcomes. People with valve models of thermostats, for example, may spend more time and effort adjusting their thermostats, resulting in more discomfort (because this fiddling tends to leave them too warm or too cold) and higher utility bills.

Mental models of social situations

Of particular relevance for this article is research on mental models of social interactions. For example, people are thought to have mental models of social cliques that influence their perceptions of and memory for social information (Hinz, 1995; von Hecker, 1997; von Hecker, Crockett, Hummert, & Kemper, 1996). Similarly, managers have mental models of competition (Johnson, Daniels, & Asch, 1998), entrepreneurs have mental models of industries (Hill & Levenhagen, 1995), teachers have mental models of student learning (Strauss, Ravid, Magen, & Berliner, 1998), and spouses have mental models of marriage (Quinn, 1987). In each case, these mental models seem to guide social behavior and perceptions of social situations.

Research on team mental models has focused on the role of shared mental models in problem solving (Cannon-Bowers, Salas, & Converse, 1993; Orasanu, 1994). After reviewing the literature, Klimoski and Mohammed (1994) suggested that groups have shared mental models that can guide and coordinate group decision making. For example, in one study of flight simulations, pairs performed better when they had similar mental models (Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000; see also Marks, Zaccaro, & Mathieu, 2000).

Our study

We studied mental models in negotiation. Our starting point was the assumption that negotiation can be meaningfully analyzed as a problem-solving activity in which behavior is influenced by negotiators' mental models. Different negotiation outcomes should thus be associated with different mental models of the negotiation situation.

As noted earlier, negotiators' mental models lie along a continuum that ranges from purely fixed-pie to purely integrative (Neale & Bazerman, 1991; Thompson, 1991; Thompson & Hastie, 1990a). Purely integrative mental models reflect a belief that negotiation situations offer opportunities for joint gain through resource 'creation'. This often requires trading issues for which the negotiators have different preferences so that each negotiator obtains more of what is more important to him or her. Integrative mental models accurately reflect the underlying structure of the negotiation situation, and emphasize the key integrative processes of exchanging information to discover potential trade-offs (Thompson, 1991; Thompson & Hastie, 1990a).

Purely fixed-pie mental models, in contrast, reflect a belief that negotiations do not offer opportunities for joint gains, and that gains for one party necessitate losses for the other party. Fixed-pie mental models focus more on the resource-claiming aspect of negotiation, and less on resource creation. Fixed-pie mental models tend to be inaccurate, because most negotiations have opportunities for resource creation (Raiffa, 1982; Walton & McKersie, 1965). Negotiators with purely fixed-pie mental models are usually reluctant to share information about their preferences, and make more demands and concessions.

Hypotheses

Based on this analysis of mental models in negotiation, we developed four hypotheses regarding negotiators' mental models. The first involved structural differences between the mental models of negotiators who reach optimal settlements and those who do not.

> *Hypothesis 1.* The mental models of negotiators who reach optimal settlements ('solvers') are more likely to have integrative features than the mental models of negotiators who do not reach optimal settlements ('non-solvers').

In particular, we predicted that the mental models of negotiators who reach optimal settlements (thereby 'solving' the negotiation problem) would be more likely to show: (1) understanding of the payoff structure of the negotiation situation; (2) greater understanding of trading issues for which negotiators have different preferences; and (3) greater emphasis on information exchange. Some support for the first part of this hypothesis can be found in prior studies showing that negotiators who reach optimal settlements have more accurate perceptions of the payoff structure of the negotiation situation (Carnevale & Isen, 1986; Thompson & Hastie, 1990a, 1990b). We know of no previous research on the association between negotiation outcomes and perceptions of the processes of exchanging information and trading.

Our second hypothesis was based on studies suggesting that optimal settlements in mixed-motive negotiations require collaboration between negotiators (Deutsch, 1973; Pruitt & Rubin, 1986; Walton & McKersie, 1965), and that shared mental models facilitate collaboration (Bettenhausen & Murnighan, 1985; Wegner, Erber, & Raymond, 1991). There are many ways of reaching suboptimal settlements, few of which require collaboration. In contrast, there are relatively few ways of reaching optimal settlements, most of which require collaboration. Shared mental models should thus play a larger role in attaining optimal settlements than in attaining suboptimal settlements.

> *Hypothesis 2.* The within-dyad similarity of negotiators' mental models is greater in dyads that reach optimal settlements than in those that reach suboptimal settlements.

Our third hypothesis concerned the relative effectiveness of different types of training as a means of helping people to understand integrative processes. We investigated two types of training. Didactic training involves instructing, lecturing, or simply explaining concepts. Experiential training, in contrast, involves 'hands on' learning through experience. Although didactic training can be more effective than no training at all (Neale & Northcraft, 1986), experiential training is generally considered to be more successful than didactic training when it comes to understanding integrative processes (Bereiter & Scardamalia, 1989; Brown, Collins, & Duguid, 1991).

> *Hypothesis 3.* Compared to didactic training, experiential training produces better understanding of integrative processes, that is, of exchanging information and trading issues of differential importance.

We did not have any hypothesis about whether experiential or didactic training is more effective at producing accurate perceptions of the payoff structure of a negotiation. Information about payoff structures can be more easily conveyed than information about integrative processes, which concern behavioral implications of the payoff structure of a negotiation (Bereiter & Scardamalia, 1989; Brown, et al., 1991). That is, learning the payoff structure of a negotiation is easier than learning what to *do* with that knowledge.

Our final hypothesis concerned the mental models of experienced negotiators. Studies of experts in other domains suggest that they understand problems within their area of expertise in terms of abstract causal relations, whereas novices think about such problems in terms of surface-level features (Chase & Simon, 1973; Chi, Feltovich, & Glaser, 1981; Chi, Glaser, & Farr, 1988; Smith-Jentsch, Campbell, Milanovich, & Reynolds, 2001; Wyman & Randel, 1998). For example, when they were asked to categorize various physics problems, PhD physics students organized those problems according to their abstract, underlying structures, such as whether they involved conservation of energy or Newton's second law. In contrast, novices categorized the problems according to their surface features, such as whether they involved rotation or inclined planes (Chi et al., 1981).

> *Hypothesis 4.* The mental models of experienced negotiators, like those of solvers, are more likely to

have integrative features than the mental models of non-solvers, and to be more abstract than the mental models of solvers.

Mental model measurement

There is no standard way to measure mental models (Gentner & Stevens, 1983; Klimoski & Mohammed, 1994; Mohammed & Dumville, 2001; Rouse & Morris, 1986). Researchers have used many methods, including direct measurement of beliefs about rules and norms (Bettenhausen & Murnighan, 1985), card-sorting (Smith-Jentsch et al., 2001), multidimensional scaling, multiple regression (Marks et al., 2000), and verbal protocols (Martin & Klimoski, 1990). Each of these methods has strengths and weaknesses (see Mohammed & Dumville, 2001, for a review). Some methods, for example, require reporting directly on one's own psychological processes (Gentner & Whitley, 1997; Kempton, 1986; Quinn, 1987), a task for which people may be ill-suited (Ericson & Simon, 1980; Nisbett & Wilson, 1977).

Our method involved the Pathfinder algorithm. This method uses judgments of concept relatedness to compute graphical representations of people's associative networks, which represent mental models. Each concept is represented as a node in a graph. Terms judged to be closely related are connected in the graph, whereas those that are less closely related are not connected. We chose the Pathfinder because it has been successfully used in previous research to relate cognitive structures to problem-solving behavior (Cooke, Neville, & Rowe, 1996; Dorsey, Campbell, Foster, & Miles, 1999; Stout, Cannon-Bowers, Salas, & Milanovich, 1999; Wyman & Randel, 1998; see Schvaneveldt, 1990, for a review). The Pathfinder method is also indirect and non-obtrusive—people are asked only to judge the relatedness of pairs of different concepts. Other methods, such as the measurement of response times or eye movements, are even more indirect, but they tend to provide less information about higher-level conceptual relations.

Method

Participants

University undergraduates enrolled in psychology courses ($N = 201$) participated in exchange for course credit or for payment of US$10. There were approximately equal numbers of males and females in our sample, although we did not measure gender. Participants were randomly assigned to the standard negotiation, experiential training, and didactic training conditions. Experienced negotiators were selected from an advanced undergraduate course on negotiation. In the standard negotiation and experiential learning conditions, precautions were taken to ensure that dyad members were previously unacquainted.

Procedure

Standard negotiation Participants (n = 110) arrived in the lab in groups of 4 to 10 people and were randomly assigned to dyads (n = 55). They were told they would engage in a negotiation in which they would play the roles of commodity brokers negotiating the purchase of five commodities (rice, copper, wheat, crude oil, and platinum) from a hypothetical supplier. We used this particular negotiation because we expected participants to be unfamiliar with commodity negotiation and therefore unlikely to have pre-existing mental models about such negotiations. Each of the five commodities had nine possible 'quality levels'. Each quality level was associated with a specific point value for each negotiator. Participants were asked to negotiate a quality level for each commodity. Participants were randomly assigned to the role of Broker Jones or Broker Smith, then given a private, written payoff schedule that specified their hypothetical earnings for each quality level of each commodity (see Table 1). Participants were told to negotiate quality levels that would maximize their overall (hypothetical) earnings. They could win one of several cash prizes—one $100 prize and ten $10 prizes—based on their negotiation performance, as measured by their hypothetical earnings. Participants in the standard condition were not given any training, and were not provided with

Table 1. Payoff schedules for Broker Jones and Broker Smith

	Commodity and profit				
Quality level	Rice profit	Copper profit	Wheat profit	Crude oil profit	Platinum profit
Broker: Jones					
1	$1800.00	$675.00	$900.00	$2025.00	$1350.00
2	$1600.00	$600.00	$800.00	$1800.00	$1200.00
3	$1400.00	$525.00	$700.00	$1575.00	$1050.00
4	$1200.00	$450.00	$600.00	$1350.00	$900.00
5	$1000.00	$375.00	$500.00	$1125.00	$750.00
6	$800.00	$300.00	$400.00	$900.00	$600.00
7	$600.00	$225.00	$300.00	$675.00	$450.00
8	$400.00	$150.00	$200.00	$450.00	$300.00
9	$200.00	$75.00	$100.00	$225.00	$150.00
Broker: Smith					
1	$100.00	$675.00	$200.00	$225.00	$150.00
2	$200.00	$600.00	$400.00	$450.00	$300.00
3	$300.00	$525.00	$600.00	$675.00	$450.00
4	$400.00	$450.00	$800.00	$900.00	$600.00
5	$500.00	$375.00	$1000.00	$1125.00	$750.00
6	$600.00	$300.00	$1200.00	$1350.00	$900.00
7	$700.00	$225.00	$1400.00	$1575.00	$1050.00
8	$800.00	$150.00	$1600.00	$1800.00	$1200.00
9	$900.00	$75.00	$1800.00	$2025.00	$1350.00

any introduction to the task, other than their role assignments and payoff schedules.

Notice that Broker Jones valued rice (worth up to $1,800.00) more than wheat (worth up to $900.00), whereas Broker Smith valued wheat (worth up to $1,800.00) more than rice (worth up to $900.00). They could therefore trade off these two issues to allow each negotiator to earn more of what was more important to him or her. For example, each person earned $1,900 if they agreed to level 1 for rice and level 9 for wheat. If they 'split the difference', agreeing to level 5 for both commodities, then each earned only $1,500. Notice too that both negotiators preferred the same quality level for copper, a compatible issue. In contrast, the negotiators had perfectly conflicting preferences for crude oil and platinum—a gain for one participant necessitated an equal loss for the other participant.

Participants were allowed to negotiate for up to 20 minutes. Communication was unrestricted, except that participants could not physically exchange their payoff schedules. Following the negotiation, participants completed the dependent measures (described shortly) and were debriefed. Prizes were awarded after data collection was finished.

Didactic training We designed the two training manipulations to provide similar information about key negotiation principles, but to deliver that information through different means. Participants in the didactic training condition ($n = 23$) were told that their task was to analyze a negotiation between two commodities brokers. They were provided with the same instructions and payoff information received by participants in the standard negotiation condition. They were then given a written analysis of the negotiation situation that described how rice and wheat could be traded and noted that the negotiators had identical preferences for copper. The analysis also suggested that crude oil and platinum should be evenly split (level 5). The analysis thus reviewed the negotiation situation, the payoff structure of the negotiation, and the processes (exchanging information and trading) by which negotiators could take advantage of the payoff structure to increase their earnings. The document suggested a settlement identical to the one we used to identify negotiators who reached optimal settlements (solvers). We measured participants' mental models immediately after they read the analysis.

Experiential training Participants assigned to the experiential training condition (n = 46; 23 dyads) were also given the same instructions and payoff information received by parties in the standard negotiation condition, minus the cash prize incentive. After they negotiated for five minutes, the experimenter unexpectedly interrupted them, explaining that their negotiation was being analyzed by a neutral third party who had suggested a settlement. The experimenter then gave participants the same written analysis that was given to participants in the didactic training condition. Negotiators were given 15 minutes to discuss this analysis with their partner. We measured their mental models immediately after that discussion.

Experienced negotiators Participants in this condition were students in an undergraduate, upper division course on negotiation (n = 22; 11 dyads) who had received 10 weeks of training on integrative negotiation. They completed the same negotiation, with the same instructions, payoff information, and incentives as participants in the standard negotiation condition. Their training consisted of lectures and classroom exercises that illustrated how to discover integrative opportunities in negotiations. These students had previously completed negotiation exercises that had required integrative processes similar to those required to solve the standard negotiation condition, but the students were not familiar with the commodity negotiation task. We measured the mental models of these participants immediately after they completed the negotiation.

Dependent measures

Judgment accuracy We used previously developed methods (Thompson, 1992; Thompson & Hastie, 1990a) to measure the accuracy of the standard negotiation participants' estimates of their partners' preferences. Participants were given a blank payoff sheet and asked what they believed their partners' payoffs were during the negotiation. We then created a variable that was coded '1' if participants recognized their partner's preferences for rice and wheat were, in fact, opposite to their own, '.5' if they believed their partner was indifferent between the two issues, and '0' if they thought their partner shared their own preferences. Higher values on this score thus indicated a more accurate perception of the negotiation's payoff structure.

Mental models Participants judged the relatedness of all 105 possible pairs of 15 terms on scales anchored at *very unrelated* (1) and *very related* (9). Some terms pertained to the basic elements of the negotiation situation (*Broker Jones, Broker Smith, copper, crude oil, rice, platinum,* and *wheat*); others pertained to the competitive dimension of negotiation (*compromise, even split,* and *give away*); and still others to the collaborative dimension of negotiation (*both gain, exchange information, same interest, surprise,* and *trade off*). Pairs of terms were randomly ordered for each participant, who was asked to judge relatedness in terms of the negotiation situation, not everyday life. Pretesting indicated that these were the terms undergraduates would use to describe this particular negotiation.

We used the Pathfinder network generation algorithm to compute graphical representations of participants' associative networks, based on their relatedness judgments (Schvaneveldt, 1990). The Pathfinder algorithm computes a graph in which each term is a node. Terms judged to be closely related are connected to each other, whereas terms that are less related are not connected. Pathfinder uses the relatedness judgments to compute the distances, or weights, of all possible paths between nodes. The weight of a path P, $w(P)$, consisting of k links with weights $w_1, w_2, \ldots, w_k$, is:

$$w(P) = \left(\sum_{i=1}^{k} w_i^r \right)^{1/r}$$

where $r > 1$, $w_i \geq 0$ for all i. The Minkowski r distance function is determined by r. When $r = 1$, the function corresponds to simple addition. When $r = \infty$, the function is the maximum function, which is order-preserving and therefore appropriate for ordinal data (Schvaneveldt, Dearholt, & Durso, 1988). Pathfinder computes the shortest path between nodes by eliminating paths that violate the triangle inequality.[1]

Results

Because negotiators were highly interdependent, we used the dyad as the unit of analysis where possible. We averaged the scores of both negotiators to create a dyad measure, unless otherwise specified.

Standard negotiation outcomes and judgment accuracy

As in prior work (Thompson, 1992; Thompson & Hastie, 1990a), the distribution of negotiators' outcomes was bimodal, as can be seen in Figure 1. One-quarter of the dyads reached fully optimal settlements, achieving joint outcomes of \$8,900, with an average individual profit of \$4,450. The second most common outcome, one reached by 18% of the dyads, was to 'split down the middle' on rice and wheat, obtaining joint outcomes of \$8,000.

Because we conceptualized negotiation as a problem that negotiators either solve or do not solve, we categorized negotiators into two groups. 'Solvers' (n = 26; 13 dyads) were those who reached an optimal settlement, trading

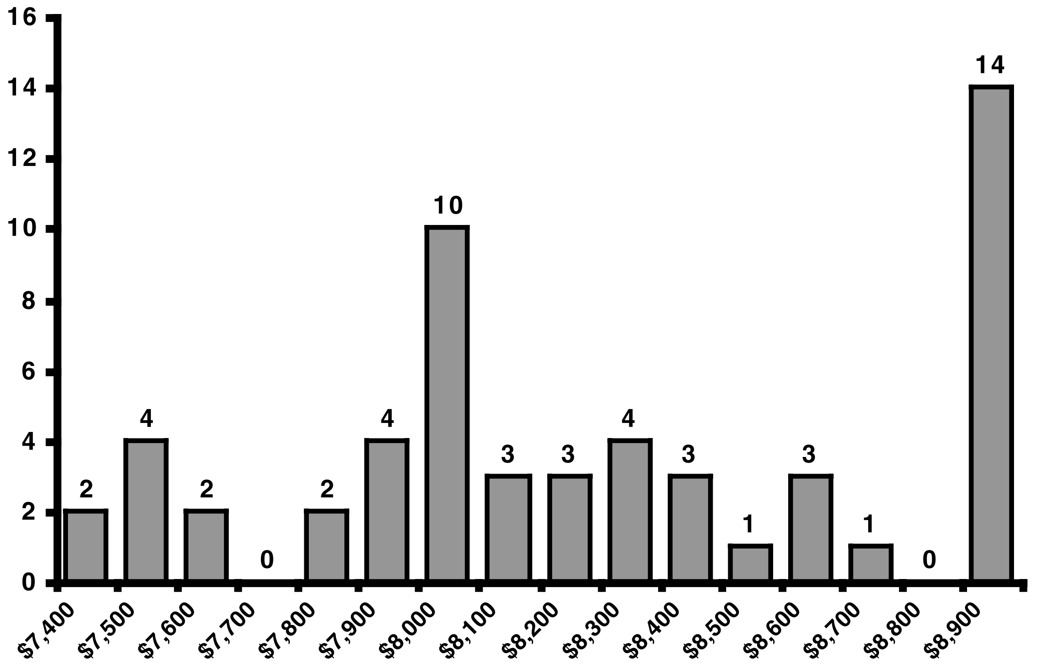

Figure 1. Distribution of dyadic payoffs in the standard negotiation condition. Joint profit labels define the lower end of the category; e.g. joint profit in the category labeled \$7,400 are as high as \$7,499. The maximum joint profit was \$8,900.

rice and wheat and maximizing payoffs on copper (the issue for which both negotiators wanted the same quality level). 'Non-solvers' (n = 84; 42 dyads) were those who did not reach an optimal settlement. Non-solvers' joint profit (M = \$8,000) was substantially less than solvers' joint profit (by definition); the two outcome distributions did not overlap. As in previous research (Thompson, 1992; Thompson & Hastie, 1990a), solvers also had greater judgment accuracy (M = .64) than did non-solvers (M = .21) ($t(53) = 3.92$, $p < .001$).

Hypothesis 1

We tested whether differences in performance were associated with differences in mental models, as measured by the graphical representations of negotiators' associative networks. We first investigated qualitative differences in the two groups' mental models by computing the average relatedness judgment for each of the 105 pairs of terms for solvers and for non-solvers. We then computed one "average" mental model for solvers and one for non-solvers, using the Pathfinder algorithm with $r = \infty$ (see Figures 2 and 3, respectively).

Although similar in many respects, the mental models of non-solvers and solvers differed in ways consistent with hypothesis 1. There were four central nodes in the solvers' graph: 27% of the links were connected to *compromise*, 23% to *both gain*, 19% to *trade off*, and 19% to *exchange information*. The non-solvers' graph had three central nodes: 37% of the links were connected to *compromise*, 25% to *both gain*, and 21% to *trade off*. Importantly, *exchange information* was less central in the non-solvers' graph (connected to only 13% of non-solvers' links). Solvers also appeared to have insight into the structure of the task—*Broker Jones* was linked to *rice* and *Broker Smith* was linked to *wheat*. Solvers also seemed to

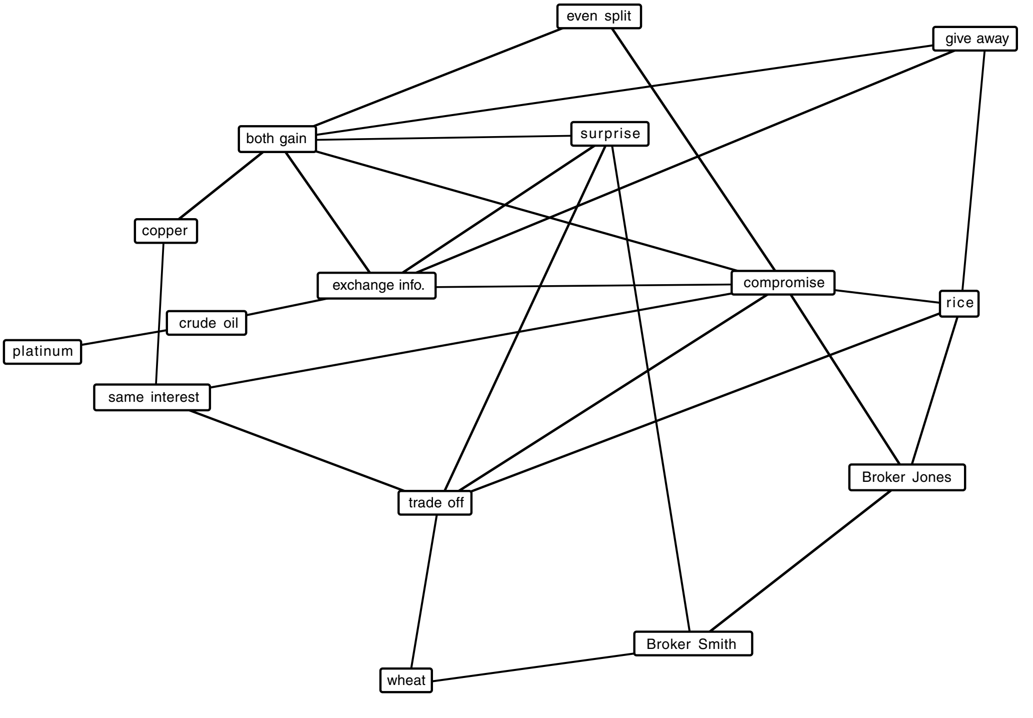

Figure 2. Solvers' average mental model.

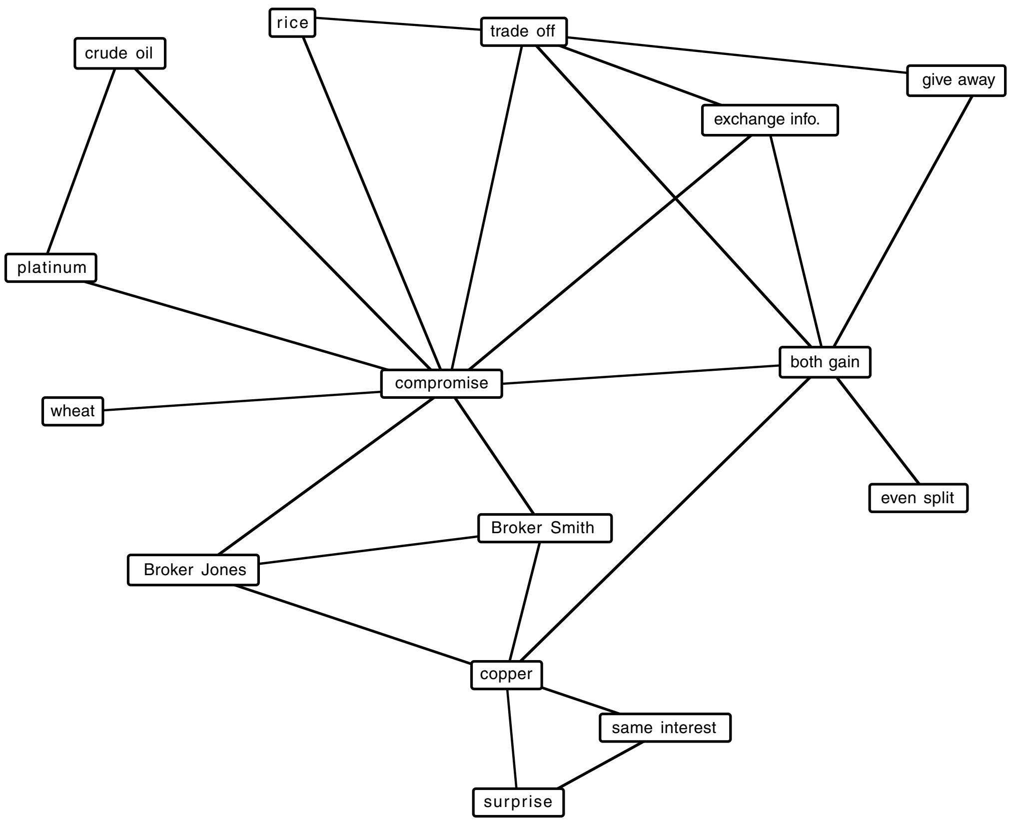

Figure 3. Non-solvers' average mental model.

understand that these issues should be traded—both *rice* and *wheat* were connected to *trade off*. Non-solvers, in contrast, connected both brokers and every issue (except *copper*) to *compromise*. Consistent with Hypothesis 1, then, the aggregate mental model for solvers had more integrative features—a greater emphasis on information exchange, insight into the structure of the task, and insight that rice and wheat could be traded—than did the aggregate mental model for non-solvers.

We next conducted a more rigorous comparison of the non-solvers' and solvers' graphs. We created a graph for each participant, coding three 'insight scores' derived from hypothesis 1 and based on the presence of certain links. First, we created a preference insight score. This score was '1' if *Broker Jones* was connected to *rice* and *Broker Smith* was connected to *wheat*; '.5' if only one of these links was present; and '0' otherwise. Higher values indicated a more accurate representation of the structure of the negotiation. Second, we coded a trade-off insight score '1' if *rice* and *wheat* were both connected to *trade-off*, '.5' if only one link was present, and '0' otherwise. Higher values indicate greater recognition that these issues could be traded. Both insight scores ranged from 0 to 1. Finally, we computed the percentage of links in each graph connected to *exchange information*, assuming that this measure reflected the extent to which an individual's mental model emphasized exchanging information. For the purposes of data analysis, we averaged the scores of both participants within each dyad.

As expected, solvers had greater preference insight, greater trade-off insight, and a greater percentage of links connected to *exchange information* than did non-solvers (see Table 2). We examined participants' preference and trade-off insight scores with an analysis of covariance (ANCOVA), controlling for the number of links in a graph (solvers' graphs contained more links [M = 38.50] than did the graphs of non-solvers [M = 29.33] (t[53] = 3.10, $p < .01$)). As expected, solvers' preference insight scores (F(1, 52) = 15.68, $p < .001$), and trade-off insight scores (F[1, 52] = 7.31, $p < .01$) were significantly higher than those of non-solvers. And a greater percentage of the links in the solvers' mental models was connected to *exchange information* than in the non-solvers' mental models (F[53] = 6.43, $p < .025$). These findings support our first hypothesis. Solvers' mental models reflected greater insight into the underlying structure of the task, and into the integrative processes of trading and exchanging information, than did the mental models of non-solvers.

Hypothesis 2

We predicted that the similarity within dyads of solvers' mental models would be greater than the similarity within dyads of non-solvers' mental models. We tested this prediction using two measures of network similarity (Schvaneveldt, 1990; Schvaneveldt, et al., 1988). First, we computed a similarity index for each dyad: (common links/[total links in both networks – common links]). Second, we computed the correlation between the two negotiators' relatedness judgments within each dyad. Because these two measures were correlated (r(53) = .48, $p < .001$), we performed a Fisher's r-to-z transformation on the correlations, standardized both measures, and averaged them into a single measure of mental model similarity within dyads. As expected, intra-dyad similarity was greater for solvers (M = .48) than for non-solvers (M = –.15) (t[53] = 2.37, $p < .05$, see Table 2).

Hypothesis 3

To test our hypothesis that experiential training is more effective than didactic training for helping people to understand integrative processes, we compared the mental models of participants in the experiential and didactic training conditions to the mental models of solvers and non-solvers. We expected that participants in the experiential training condition would resemble solvers more than non-solvers on our measures of integrative processes (trade-off insight and the percentage of links connected to *exchange information*), and participants in the didactic training condition would resemble non-solvers more than solvers.[2]

Table 2. Preference insight, trade-off insight, percentage of links connected to *exchange information*, network similarity, and similarity judgment correlation for solvers, non-solvers, participants in the didactic and experiential training conditions, and experienced negotiators

Condition	Preference insight	Trade-off insight	% links connected to *exchange information*	Network similarity	Relatedness judgment correlation
Solvers	.50	.33	19%	.27	.24
Non-solvers	.14	.10	15%	.20	.16
Didactic training	.69	.08	12%	—	—
Experiential training	.58	.45	17%	—	—
Experienced negotiators	.46	.39	21%	—	—

Notes: Means for preference insight and trade-off insight were adjusted for the number of links in a mental model. Adjusted means for non-solvers and solvers were computed in analyses of hypothesis 1. Adjusted means for didactic training and experiential training were computed in analyses of hypothesis 3. Adjusted means for experienced negotiators were computed in analyses of hypothesis 4.

To test our prediction, we analyzed the trade-off insight scores using an ANCOVA, controlling for the number of links ($F[4, 96] = 5.65$, $p < .01$), and the percentage scores using an ANOVA ($F[3, 97] = 5.36$, $p < .01$). We then computed three orthogonal, weighted contrasts. The first contrast tested whether the average of solvers and participants in the experiential training condition was different than the average of non-solvers and participants in the didactic training condition. The second contrast tested whether solvers were different from participants in the experiential training condition. The third contrast tested whether non-solvers were different from participants in the didactic training condition. We expected the first of these contrasts to be significant, but not the second or third contrasts.

As predicted, the average trade-off insight of solvers and participants in the experiential training condition ($M = .35$) was significantly greater than the average trade-off insight of non-solvers and participants in the didactic training condition ($M = .10$, $t = 3.93$, $p < .01$). The average trade-off insight scores of solvers and participants in the experiential training condition were not significantly different, nor were the average trade-off insight scores of non-solvers and participants in the didactic training condition *t*s < 1, see Table 2).

As for the percentage of links connected to *exchange information,* the average score of solvers and participants in the experiential training condition ($M = 18\%$) was significantly greater than the average score of non-solvers and participants in the didactic training condition ($M = 14\%$, $t = 3.77$, $p < .01$). There was no significant difference between the average scores of solvers and participants in the experiential training condition, or between non-solvers and participants in the didactic training condition (ts <1, see Table 2).

Hypothesis 4

Our fourth hypothesis was that the mental models of experienced negotiators, like those of solvers, would be more likely to have integrative features than the mental models of non-solvers. We also expected the mental models of experienced negotiators to be more abstract than the mental models of solvers. We first computed an average mental model for experienced negotiators, just as we did for the solvers and the non-solvers (see Figure 4). A qualitative analysis of this graph revealed differences from the graphs of both solvers and non-solvers. There are no pinwheel structures, indicating no central concepts. Instead, three clusters emphasize different aspects of the negotiation situation. The top cluster emphasizes the purely competitive aspect of negotiation. It contains *compromise, even split,* and the two competitive issues *platinum* and *crude oil.* The next cluster emphasizes the purely cooperative aspect of the negotiation situation: *both gain, surprise* (at discovering a compatible issue!), and *copper. Exchange information* connects this cluster to a 'trading' cluster that includes both brokers, *rice, wheat, trade-off,* and *give away.* Like the mental model of solvers, the experienced negotiators' mental model suggests an understanding of the payoff structure of the negotiation, of trading issues of differential importance, and of exchanging information.

We more rigorously analyzed the differences between the mental models of experienced negotiators, non-solvers, and solvers by computing a graph for each experienced negotiator and coding it for our three key insight scores (preference insight, trade-off insight, and percentage of links connected to *exchange information),* exactly as we did for non-solvers and solvers. As anticipated, ANCOVAs controlling for the number of links in each mental model revealed that the mental models of experienced negotiators had higher trade-off insight scores ($F[1, 50] = 19.17$) and higher preference insight scores ($F[1, 50] = 7.16$) than did non-solvers (both *p*s, $< .01$). Also as anticipated, an ANOVA revealed that the mental models of experienced negotiators had a greater percentage of links connected to *exchange information* than did the mental models of non-solvers ($F[1, 51] = 10.57$, $p < .01$). These findings indicate that experienced negotiators, like solvers, had mental models with more integrative features than those of non-solvers.

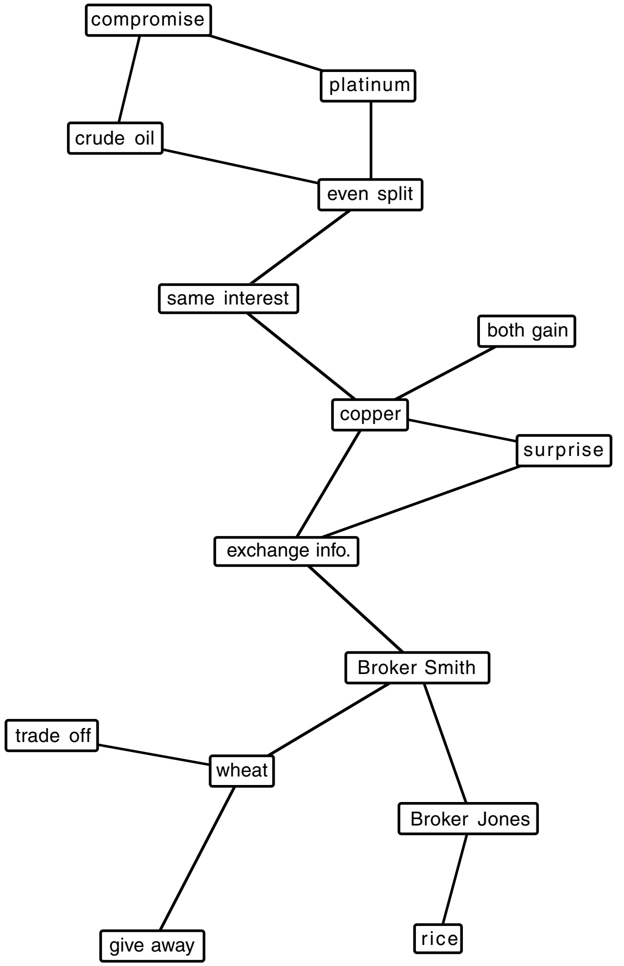

Figure 4. Experienced negotiators' average mental model.

We examined the relative abstraction of solvers' and experienced negotiators' mental models by comparing the number of links in their graphs. Because the number of nodes was constant, the number of links served as an (imperfect) index of abstraction. Models with fewer links are presumably more abstracted than models with more links. As expected, experienced negotiators' graphs had fewer links ($M = 28.00$) than did the graphs of solvers ($M = 38.50$, $t[23] = 2.50$, $p < .025$).

The graphs of experienced negotiators did not have significantly fewer links than the graphs of non-solvers ($t < 1$), which (it will be recalled) had fewer links than the graphs of solvers. This unanticipated pattern suggests that when novices first develop mental models with integrative features, as we believe happened for solvers, they may be less certain about those models, which are therefore less consolidated and abstracted. A newly acquired integrative mental model may contain more low-level details than a relatively well-established, fixed-pie mental model. This is an important issue for future research.

Discussion

Conceptualizing negotiation as a problem-solving (rather than decision-analytic) enterprise, in which negotiators' mental models influence their behavior, we examined the association between mental models and negotiation outcomes. Each of our four hypotheses was supported. First, negotiators who reached optimal settlements (solvers) had mental models that reflected greater understanding of the negotiation's payoff structure, and of the integrative processes of exchanging information and trading, than did negotiators who did not reach optimal settlements (non-solvers). Second, solvers had mental models that were more similar to their partners' mental models than did non-solvers. Third, negotiators who received experiential training had mental models that more closely resembled those of solvers (with respect to understanding integrative processes), whereas negotiators who received didactic training had mental models that more closely resembled those of non-solvers. Finally, the mental models of experienced negotiators, like those of solvers, had more integrative features than the mental models of non-solvers, and were more abstract than the mental models of novice solvers.

Contributions

Previous research on team mental models and on expert mental models has yielded two main findings. First, similarity among team members' mental models is associated with better team performance (Mathieu et al., 2000). Second, experts' mental models are more abstract than the mental models of novices or naive individuals (Chase & Simon, 1973; Chi et al., 1981, 1988; Smith-Jentsch et al., 2001; Wyman & Randel, 1998). Our findings reflect a unique contribution to the study of negotiators' mental models, and extend previous research in three ways.

First, to our knowledge, no researchers have examined the mental models of individuals engaged in a mixed-motive problem-solving task such as negotiation. The fact that solvers had more within-dyad mental model similarity than non-solvers, despite the fact that the parties had objectively different interests, implies that people do not need to be involved in a purely cooperative task for shared mental models to be advantageous. Future research might examine the relative importance of shared mental models in tasks with varying mixtures of competitive and cooperative elements.

Second, whereas previous negotiation research has typically focused on the effectiveness of one type of training, our research compared both, namely didactic (instruction-based) training and experiential training. Our results suggest that experiential training is more effective than didactic training in terms of developing mental models that reflect integrative processes. In most applied settings, of course, training is somewhat mixed, just as it was for participants in our experiential training condition, who received both experience and didactic training (the explanatory document). Future research might examine the effectiveness of various mixtures of didactic, experiential, and other forms of training.

Finally, our research examined the effectiveness of both brief and extended training. Previous work has almost always contrasted the behavior of experts and novices. We studied the effects of expertise that was acquired both quickly (the experiential training condition) and more slowly (the experienced negotiator).

Limitations

As with any research program, particularly one in its early stages, several unresolved and potentially problematic issues must be considered. One such issue involves the concepts included in our measure of negotiators' mental models. We may have omitted concepts that otherwise would have been included by participants, or included concepts that otherwise would have been omitted by them. Cognizant of these concerns, we only included terms that pretesting indicated were words that participants would use to describe the competitive and collaborative processes involved in this particular negotiation. Still, it is possible—likely even—that mental models differ not only in their structure, but also in the elements that they contain (Dorsey et al., 1999). Such differences could not be studied in our research because all our models included the same concepts. In this sense, our research was a conservative test of differences between the mental models of solvers and non-solvers. We held constant the concepts in the mental models and studied instead whether the connections between them were associated with different negotiation outcomes.

A second concern is the usual difficulty regarding causal inference in correlational research. This concern is most sharply targeted at our first hypothesis. Although it is plausible that negotiators' mental models influenced their behavior and outcomes, it is also possible that their behavior—which might have been caused by other factors—influenced their mental models. A similar critique could be made regarding our comparisons regarding the within dyad similarities of solvers' versus non-solvers' mental models. Establishing the causal priority of mental models and negotiation behavior and outcomes should be a priority for future research.

Conclusion

A mental models approach to problem solving provides a fresh perspective on the age-old problem of negotiation. Negotiation research has been conducted largely through the lens of behavioral decision making. This work has thus been highly outcome-focused (to the exclusion of process), highly bias- and error-focused (to the neglect of basic cognitive processes), and highly focused on individual judgments (rather than examining dyadic processes, independent of outcomes). The mental model approach constitutes a new way to examine old questions and offers a unique glimpse into the mind of the negotiator.

Notes

1. The triangle inequality states that for any three nodes, A, B, and C, the distance from A to B is less than or equal to the sum of the distances from A to C and from B to C. Consider, for instance, the paths connecting *Broker Jones*, *Broker Smith*, and *surprise*. Suppose that the distances from both *Broker Jones* and *Broker Smith* to *surprise* were both 1, and the distance from *Broker Jones* to *Broker Smith* was 10. In this case, both brokers would be directly linked to *surprise* in the resulting graph, but not to each other, because the shortest path from one broker to another involves traveling through *surprise* (a distance of 2), rather than taking the direct path (a distance of 10).
2. Recall that we made no predictions about the relative effectiveness of the two kinds of training when it comes to negotiators' understanding of the payoff structure of the negotiation (the preference insight score). Indeed, participants in both training conditions had higher average preference insight scores than did the non-solvers (ts > 3.0, ps < .01). This is not surprising given that the written analysis received by participants in the training conditions specified that the two negotiators had different priorities for rice and wheat.

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