10

Dialogue as Medium (and Message)

for Training Critical Thinking

Marvin S. Cohen

Cognitive Technologies, Inc., Arlington, VA

Leonard Adelman

George Mason University

Terry Bresnick

Innovative Decisions, Inc., Vienna, VA

F. Freeman Marvin

Innovative Decisions, Inc., Vienna, VA

Eduardo Salas

University of Central Florida

Sharon L. Riedel

Army Research Institute, Arlington, VA

CRITICAL THINKING

An NDM Approach to Individual and Joint Reasoning

Naturalistic decision making (NDM) has correctly emphasized the importance of non-deliberative, recognition-based decision making by experienced individuals in relatively unstructured and time-constrained situations (G. Klein, 1993; Orasanu & Connolly, 1993). This is, of course, not the whole story. Attention has also been paid to mental simulation (G. Klein, 1998); to metacognitive processes that critique, evaluate, and improve recognitional products when more time is available (Cohen, Freeman, & Wolf, 1996); and to collective processes that produce team adaptation (Serfaty, Entin, & Johnston, 1998), implicit coordination (Orasanu, 1993), shared mental models (Cannon-Bowers, Salas, & Converse, 1993), and the "team mind" (G. Klein, 1998). Still, it is probably fair to say that NDM has not yet evolved its own coherent approach to the more deliberative reasoning that sometimes occurs in non-routine real-world situations – often referred to as *critical thinking* and including the kinds of processes to which logic, probability theory, and decision theory are sometimes applied. Similarly, it is probably fair to say that NDM needs to look more deeply into how effective teams manage diverging perspectives and opinions, and lay the groundwork for coordination despite *differences* in their mental models.

The present chapter is meant to stimulate ideas about what a naturalistic approach might look like. In that approach, we argue, deliberative reasoning and disagreement are aspects of the same phenomenon. We propose a theory in which critical thinking is understood as dialogue with oneself or others, in which coordinated roles for questioning and defending mental models account for the structure associated with different types of reasoning, in which persuasion is the

counterpart of drawing an inferential conclusion, and in which normative evaluation in terms of reliability emerges as a natural perspective on the process as a whole. Mental models must ultimately originate in recognitional processes, but they can be evaluated, compared, and modified during critical dialogue, which aims at more complete and accurate judgment. In the team context, critical dialogue presupposes mutual knowledge but also seeks to expand the sphere in which mutual knowledge holds. The theory, therefore, helps bridge gaps between intuition and deliberation, between individual and team cognition, between thought and communication, and between description and evaluation.

This first section motivates a theory of critical thinking as dialogue, while the second section outlines the theory's basic elements and introduces an example. The next three sections discuss its major components: mental models, processes of challenging and defending, and monitoring for reliability. The final two sections briefly summarize preliminary training results and conclusions.

Limitations of the Internalist Paradigm

Definitions of critical thinking tend to have a common theme. Siegel (1997) says that "the beliefs and actions of the critical thinker, at least ideally, are *justified* by reasons for them which she has properly evaluated" (p. 14 italics in original). According to this and many other definitions of both critical thinking and rationality (Cohen, Salas, & Riedel, 2002; Johnson, 1996, ch. 12), critical thinking is the deliberate application of normative criteria *directly* to fully articulated conclusions and reasons. The purpose is to use "reason" to free individuals from habitual and conventional thought, which have no rational standing. The means of doing so are *individualist* and *internalist* because they assume that everything relevant to the rational justification of a belief or decision is found by inspecting the contents of one's own conscious mind (Feldman &

Conee, 2000; Plantinga, 1993a, pp. 3 - 29). In this chapter, we motivate, describe, and illustrate

an approach to critical thinking that applies pragmatic *externalist* criteria to what is, in some

important senses, a *collective* process.

Some persons know more than others, but according to the internalist paradigm everyone has

equal access to their own mental life and to the light of reason. It would be unfair, then, to fault

the rationality of a decision that fails only because of substantive ignorance or violation of non-

logical criteria. By the same token, rationality gets no credit for good intuitive judgment honed

by practice in a domain. Expert physicians who cannot explain diagnoses that save patient's lives

(Patel, Arocha, & Kaufman, 1999, p. 82) are not good critical thinkers. Unable to trace a logical

path to their decision, it is as if they got it right by accident (P. Klein, 2000). Sosa (1991) dubbed

this the "intellectualist model of justification" (p. 195); Evans and Over (1996) call it

"impersonal rationality"; Hammond (1996) refers to it as the "coherence theory of truth." Less

often noticed is the prominence it gives to universalism and egalitarianism over effectiveness.

Appropriate reasons and evaluative criteria must be experienced as such by all. Critical thinking

is an individual intellectual effort, but fairness places everyone at the same starting line

(Plantinga, 1993a, pp. 3 - 29; P. Klein, 2000).

This paradigm disregards he importance of recognitional skills in proficient problem solving

(Chase & Simon, 1973) and decision making (G. Klein, 1993). For both experts and non-experts,

most of the processes that generate judgments and decisions are tacit. "Reasons" for decisions, if

verbalizable at all, are implicit in experiences extending over long periods of time, and

sometimes over multiple generations. The habit of asking for reasons, if applied "systematically

and habitually" as critical-thinking proponents seem to urge (e.g., Siegel, 1997, p. 16), is either

endless or circular, and must come to a stop at acceptable assumptions rather than rock-solid

foundations (Day, 1989). There never will be an exhaustive set of criteria for directly certifying

rational judgments and decisions about the world. Instead, critical thinkers need a method for

determining *which* conclusions to critically examine on any particular occasion and *which*

reasons, if any, to try to articulate and defend (Evans & Over, 1996).

The internalist climate does not encourage prescriptive research about time-sensitive

cognition. Textbooks still regard critical-thinking as a form of inner intellectual purity, and tend

to emphasize rules from formal or informal logic, probability, or decision theory. The internalist

paradigm prompts questions about the usefulness of training individuals or teams to think

critically in practical domains like the Army tactical battlefield: Will assembling a "valid" chain

of reasons take too much time or weaken the will to fight? Will implicit egalitarianism supplant

experience and proven proficiency, stifle dissent and innovation, or disrupt leadership and

coordination? An alternative approach to critical thinking, from the outside in, provides more

encouraging answers.

An External Perspective

Our objective was to place critical thinking in a more realistic context for individual practitioners

and teams. To accomplish this, we sought a conceptualization that would:

- Capture the idea of thinking about thinking without demanding that all (or even most)

  decision making be deliberative, or that all (or even most) reasons be made explicit.

- Be adaptable in time-constrained situations (A case can be made that all thinking,

  even in science, involves tradeoffs with time and other resources).

- Take account of both opportunities and obstacles due to social and organizational

  relationships.

- Be easy to teach, practice, and evaluate in real-world contexts.

- Take account of and enhance the effectiveness of strategies already used successfully

  by proficient decision makers, such as recognition (G. Klein, 1993), story building

  (Cohen et al., 1996; Pennington & Hastie, 1988), metacognition (Cohen et al., 1996;

  Nelson, 1992), and consultation or constructive debate with others (Van Eemeren,

  Grootendorst, Blair, & Willard, 1987).

These objectives commit us to a *naturalized epistemology* (Kornblith, 1994) that focuses

evaluation on external facts about the world rather than "infallible" logical and introspective

truth (e.g., Lipshitz & Cohen, 2005; Papineau, 2003; Sosa & Kim, 2000). This should not be

confused with directly claiming, trivially, that the beliefs to be justified are factual. The

pragmatic approach focuses evaluation on other facts, about the *processes* or *mechanisms* (e.g.,

perception, memory, recognition, problem-solving, reasoning, testimony, and even habit and

custom) that contributed to a conclusion instead of the conclusion itself. Individual beliefs or

decisions receive their warrant indirectly based on the more general reliability of belief-

generating and belief-testing methods. Thus, an individual belief or decision is warranted if it

was produced (or is now sustained) by recognizable methods that yield a sufficiently high

proportion of confirmed beliefs or successful decisions under relevant conditions, including

available time and the costs of errors (Goldman, 1992, ch 6; Nozick, 1981; Plantinga, 1993b;

Rescher, 1977b). This turns justification into an empirical question that can be asked and

answered by outside observers and studied scientifically (Gigerenzer, 2000; Hammond &

Stewart, 2001).

Critical thinking has a different look and status in the externalist perspective. It is:

- *Context-sensitive*: The appropriate depth and structure of argument will vary with the

  economics of the situation, i.e., the costs and potential benefits of avoiding errors in that

context. Justification of judgments and decisions cannot be a matter of fixed formal criteria, because there is no *a priori* enforceable end to the demand for reasons.

- *Collective*: Nothing restricts critical thinking to an individual consciousness. Social practices that actively seek information, expose views to outside challenge, draw on past cases, or appeal to cultural and historical paradigms may increase the reliability of results (Goldman, 1992, ch 10). Judgments and decisions may be based on knowledge embedded in long-term cultural practices or artifacts, and distributed among group members (Hutchins, 1995).

- *Intuitive*: Because tacit processes are inherently non-verbalizable and because implicit reasons for a judgment can never be exhaustively spelled out, there will always be a major residual dependence on the reliability of relatively automatic perceptual and inferential processes, or *recognition*.

- *Feasible*: Feasibility is a prerequisite for effectiveness, so it is built into externalist criteria. They will often favor strategies that are closely related to the way people already think over formally rigorous methods that are "fair" but virtually impossible to implement (Lipshitz & Cohen, 2005).

- *Pluralistic*: No single method monopolizes reliability. Critical thinking itself is not necessary for rationality, because recognitional processes or customary practices may more reliably achieve individual or group goals in familiar situations or when time is limited (Cohen et al., 1996). Critical thinking itself encompasses a range of strategies that probe more or less deeply depending on the task and context.

The Disagreement Heuristic

Critical-thinking texts have surprisingly little to say about disagreements *among* critical thinkers.

They focus instead on finding faults in arguments by authors who are not present to respond (e.g., Govier, 1987; Johnson, 1996). Discussions of both formal and informal logic (Johnson & Blair, 1994) imply that if everyone reasoned correctly from shared premises, they would arrive at consistent conclusions. Because everyone has equal access to proper reasoning, the responsibility of the individual critical thinker extends no further than stating her premises and getting her own reasoning right. Once *my* arguments satisfy appropriate criteria, any disagreement must be due to *your* laziness or stupidity (or evil intent). To some extent, the pervasive interest in systematic mistakes, e.g., fallacies (Hansen & Pinto, 1995), reasoning errors (e.g., Wason & Johnson-Laird, 1972), and decision biases (e.g, Kahneman, Slovic, & Tversky, 1982), reinforces this condescending attitude toward those with differing views (an attitude that may be reflected in our current political discourse). It gives people a sense of intellectual rectitude that ill prepares them for constructive intellectual exchanges with others. Under the illusion that a single line of reasoning can be validated in isolation, there is scant motivation for seriously considering opposing points of view and little chance of intellectual synergy.

Unfortunately, the same attitude is sometimes adopted (for different reasons) by naturalistic researchers. The reasons include exaggerated emphasis on the role of pattern recognition and fast intuitive judgment in expertise (e.g., Gladwell, 2005), and on consensus and homogeneous knowledge in team research (see Cooke, Salas, Kiekel, & Bell, 2004, for the latter point). As Shanteau (1998) points out, consensus among experts in the same domain is not only expected, it is frequently regarded as part of the definition of expertise. Experts can have no use for exploration and evaluation of alternative viewpoints on the topics they have "mastered." This view assumes away the possibility of novel and complex situations that no learned pattern fits perfectly (Cohen et al., 1996) or problems that are at the cutting edge of experts' own

knowledge. Yet such situations are not uncommon in complex and dynamic domains, including science, some areas of medicine, and military tactics (Shanteau, 1992, 1998; Wineburg, 1998). Shanteau's (1992) research suggests that expert skills include the ability to identify exceptional situations or novel problems where previous methods do not apply, and to use appropriate strategies such as collaboration with other experts.

Suppose we take seriously the fallibility of *both* intuitive expert judgments *and* rational arguments about the physical and social world: No matter how expert or cogent they respectively are, their conclusions are incompletely grounded by evidence, experience, or any other reliable method, especially in unusual situations. We can no longer assume that if one argument or expert judgment by itself appears acceptable, then conflicting arguments or judgments can be rejected sight unseen. Viewed in isolation from one another, opposing arguments or expert judgments may each appear sufficient to establish their respective conclusions. Flaws such as overlooked evidence, hidden assumptions, or limitations in an expert's assumptions or range of experience may not surface except in the light shed by a *competing* argument or judgment – if we are lucky enough to have alternative perspectives available.

There is ample empirical evidence (e.g., Amason & Schweiger, 1997; Gigone & Hastie, 1997; Jehn, 1997) that groups make better decisions in complex, nonroutine tasks when there are disagreements among members. Empirically successful interventions in group decision making have generally worked by increasing either the likelihood of divergence among viewpoints or the awareness of preexisting inconsistency in opinions (Tasa & Whyte, 2005). As by-products, intragroup disagreement facilitates a more thorough understanding of the problem (Schweiger, Sandburg, & Ragan, 1986) and an expanded body of shared knowledge (Amason, 1996). The *disagreement heuristic*, then, is to focus individual and collective attention on issues where

views diverge. It works because both arguments and intuitions are fallible, because intrapersonal and interpersonal resources are limited, and, we hypothesize, because disagreement is more likely to surface on issues that are not yet reliably grounded enough in the relevant context.

The benefits of disagreement depend on the availability of others who have dissenting views. Groups can compensate at least partly for the absence of spontaneous dissent by *stimulating* it. The quality of group decisions is typically improved when some members are assigned the role of *devil's advocate* or *dialectical opponent* (Katzenstein, 1996; Schweiger et al., 1986; Schwenk, 1989; Schwenk & Cosier, 1980). Henry (1995) found that asking team members to critique one another led to a significantly higher probability that they would surface and use important information possessed uniquely by particular members. Individual critical thinkers can compensate by *simulating* dissent, that is, imaginatively constructing alternative perspectives from which to critique and improve their own solutions. On many occasions, the most reliable way for both teams and individual thinkers to organize, understand, and evaluate positions on complex or novel problems, when the stakes are high and time is available, is to conduct a dialogue with competent opponents – *actual* if possible, *stimulated or simulated* if not.

CRITICAL THINKING AS DIALOGUE

Walton (1998) defined a dialogue as any *characteristic type of multiperson exchange that depends on mutual expectations about purposes, roles, and constraints* (Walton, 1998; Walton & Krabbe, 1995, p. 66). The theory of dialogue blends descriptive and normative concerns (Van Eemeren & Grootendorst, 1992; Walton, 1998). Researchers start in bottom-up fashion with real-world conversations and the settings in which they occur, identify recurrent recognizable *types* and the *purposes* they serve, and build idealized models of the procedures that dialogues use to reliably achieve their purposes. Using that approach, Walton identified six dialogue types:

persuasion, negotiation, deliberation, inquiry, information seeking, and even quarreling.

Dialogue rules have normative force for participants who mutually recognize one another's desire to cooperate to achieve the relevant dialogue goal (Grice, 1989). Dialogue theory directly maps descriptive analyses of actual exchanges onto prescriptive process constraints to identify where they diverge and why. Real conversations can be compared to ideal models to evaluate the quality of the real-world conversations, to improve the models, or both. Dialogue theory thus provides an empirical basis for prescriptive evaluation of actual conversations. (For discussion of how normative and empirical concerns interact, see Cohen, 1993a, and Lipshitz & Cohen, 2005.)

Two related models – Walton's (1998) *persuasion dialogue* and Van Eemeren & Grootendorst's (1992) *critical discussion* – provide a starting point for our concept of critical thinking as critical dialogue. In each case, argument is examined as it actually occurs among participants with a difference of opinion and a shared task: not as logical relations among premises and conclusions but as a dynamic exchange of reasons for and against a conclusion (Hamblin, 1970; Rescher, 1977a; Van Eemeren & Grootendorst, 1983; Van Eemeren, Grootendorst, Jackson, & Jacobs, 1993). The result is an idealized description of the thinking *process* rather than of the thinking *product*, a schematization that specifies the purpose, the roles played, rules for each player, and criteria for determining the outcome.

Elements of the Theory

Critical thinking is critical dialogue – whether by a single individual, a co-located group, or team members distributed in time and place. Critical dialogue is a process of challenging and defending alternative possibilities to resolve a disagreement, with the long-term purpose of improving performance in a task. This definition implies the three layers shown in Figure 10.1. Alternative possibilities correspond to *mental models* of the situation or plan (Johnson-Laird,

1983). In practical contexts, these often take the form of stories that weave together evidence, hypotheses, actions, and desired or undesired outcomes (Pennington & Hastie, 1993a). Challenges are *questions* about mental models intended to multiply the number of possible scenarios (hence, increase doubt) by pointing out gaps in evidence, uncovering unreliable assumptions, or constructing conflicting accounts, while defenses are *answers* intended to eliminate those possibilities (hence, reduce doubt). Finally, the pragmatic purpose of the exchange implies the need for implicit or explicit *monitoring* to ensure its cost-effectiveness by selecting reliable methods and implementing them appropriately.

Implicit in the same definition is the orchestration of three *roles* or processes, corresponding roughly to pronouns *I*, *you*, and *they*. The *first-person* process recognizes, constructs, and reconstructs mental models of *my* situation understanding or plans. A *second-person* process takes a step back and iteratively critiques *your* hypotheses and plans, requiring a defense from the first-person role. A *third-person* role monitors and regulates what *they* are up to with respect to a larger task purpose.

These elements of critical dialogue combine to form a prototype rather than necessary and sufficient conditions (Lakoff, 1987): To the extent that an individual or collective process resembles critical dialogue in these respects, it is not only thinking but *critical thinking*. In particular, the first-person role requires the defense and repair of mental models; the second-person role requires the generation of competing mental models through the vivid enactment of alternative perspectives. The third-person role requires the use of strategies that reliably serve the relevant practical goals.

The Bridgeton Training Example

The following three sections elaborate on each component of critical dialogue. In doing so, they

draw on the example in Figure 10.2 and Figure 10.3. Figure 10.2 is the map for a tactical

decision game (TDG) called *Bridgeton Crossing*, from the *Marine Corps Gazette* (G. Klein,

McCloskey, Thordsen, Klinger, & Schmitt, 1998). We used tactical decision games, including

this one, for critical-dialogue training of active-duty Army officers. The task is to take the part of

the decision maker in the scenario (an officer at a specified echelon) and quickly come up with a

written plan in the form of a brief operations order and scheme of maneuver for subordinate units

(Schmidt, 1994). In pretests and posttests, officers first worked individually for 15 minutes, then

worked as a group for 30 minutes. Written products were collected from both phases.

In *Bridgeton Crossing*, the company's mission is to advance north without getting decisively

engaged and to secure a safe river crossing for the division. Bridgeton, the only known crossing

site, was the original objective, but the town was seized the previous night by an enemy

mechanized force. The latest orders from division were to scout for other fordable locations.

Since then, however, the situation has changed: (a) Only a few enemy scout vehicles (rather than

a full mechanized force) have been observed this morning in Bridgeton by 2nd Platoon; (b) an

enemy scout car was flushed by 1st Platoon on the south side of the river; (c) a different enemy

mech force is reported by 2nd platoon to be moving quickly down Route 6 toward Bridgeton.

The company commander must quickly decide what to do.

Figure 10.3 is an edited and compressed version of the conversation among a group of

officers during a post-training practice, who play the roles of (a) a *proponent*, (b) an *opponent*,

and (c) a dialogue *monitor*, respectively

MENTAL MODELS IN CRITICAL DIALOGUE

Mental models represent what critical dialogue is about. Each model is a possible understanding

of the situation, including observations, interpretations, actions, and predicted future events. A

claim is accepted if it is true in all the models under consideration, rejected if true in none, and *uncertain,* or subject to doubt, when it is true in some models and false in others. The *probability* of the claim can be represented by the proportion of mental models in which it is true (Johnson-Laird, Legrenzi, Girotto, Legrenzi, & Caverni, 1999) or the relative frequency of scenarios in which it occurs (Gigerenzer, 2000, ch 7). On the basis of these simple principles, different critical dialogue roles can be distinguished by their different attitudes toward the uncertainty of a claim. The opponent tries to increase uncertainty by introducing models in which the claim is false or by rejecting those in which it is true; the proponent tries to decrease uncertainty by rejecting models in which the claim is false or introducing models in which it is true. We can categorize dialogue moves at a more detailed level in terms of their preconditions and intended effects on participants' mental models, and track progress toward consensus as the number of models under consideration alternately increases and decreases under the influence of the participants' opposing strategies.

Mental model has sometimes been dismissed as merely another general term for knowledge representation (Rickheit & Sichelschmidt, 1999). While this may be true in some applications, our interest in the mental model concept is focused on distinctive features that expose deep connections between *reasoning* and *discourse* (Johnson-Laird, 1983; Oakhill & Garnham, 1996; Rickheit, & Habel, 1999), as well as between intuitive processing and reasoning (Evans & Over, 1996; Legrenzi, Girotto, & Johnson-Laird, 1993). The functional and structural features that distinguish mental models from other proposed knowledge structures precisely match the requirements of critical dialogue:

(1) Mental models of the situation are created by relatively automatic processes, which continue to modify the model as new information about the situation arrives via perception,

discourse comprehension, inference, memory, or imagination (Johnson-Laird, 1983; Kessler, Duwe, & Strohner, 1999). They account for the coherence of extended discourse by providing an enduring, evolving, and integrated representation of the situation being discussed (Anderson, Howe, & Tolmie, 1996; Oakhill, 1996). (Cognitive linguists such as Langacker (2000) are studying how syntactic devices function as instructions for the addition, deletion, or modification of model elements. By contrast, conventional linguistics posits a redundant, syntactically structured level of "sentence meaning" which cannot be integrated with perceptual, linguistic, or inferential inputs.) Linguistic support for mental models as semantic representations includes reference to objects understood only from the context rather than from surface constructions(Garnham, 1996, 2001). Experimental support includes prediction of memory centered on objects rather than surface descriptions, such as failure to recollect descriptions of items that are no longer part of the situation, and false recall of descriptions that apply to objects that were never explicitly described that way (Stevenson, 1996). Because mental models figure in both non-deliberative and deliberative processing, they predict reasoning errors caused by recognitional priming of irrelevant information (Evans & Over, 1996; Legrenzi et al., 1993), and by explicit representation of only the most salient possibilities consistent with a discourse (Johnson-Laird, 2003; Legrenzi et al., 1993).

(2) Once models are created, recognitional processes are applied to them to identify emergent relationships that were not explicit in any of the inputs. Mental models thus account for novel conclusions that people draw from a combination of information sources and background knowledge without explicit rules of inference, based on relational isomorphism with the represented situations (Rickheit& Sichelschmidt, 1999; Schnotz & Preuss, 1999). Mental models also account for errors that result from flawed understanding of the relational structure of the

domain (Anderson, et al., 1996). Mental models extend the isomorphism principle to logical and probabilistic relationships, allowing inferential conclusions to be recognitionally "read off" the set of mental models that results from combining all the premises (Johnson-Laird, 1983; Johnson-Laird & Byrne, 1991). Probability judgments based on the relative number of scenarios in which an event occurs will be dependent on the readiness with which scenarios come to mind, and can be affected by salience, recency, prototypicality, and other factors that may not be representative of the relevant population, especially in novel situations (Kahneman, Slovic, & Tversky, 1982).

(3) Once a candidate conclusion has been recognized, it can be verified by searching for mental models in which it is false – precisely the opponent's role in critical thinking. The common semantic foundation (models as possible states of affairs) and the common verification process (searching for counterexamples) provide an integrated account of deductive, assumption-based, and probabilistic inference (Tabossi, Bell, & Johnson-Laird, 1999). Differences are accounted for by different constraints on verification – viz., whether a counterexample is fatal, can be explained away, or quantified as risk, respectively – rather than by discrete normative rule systems. The failure to generate and consider relevant alternative possibilities is a frequent cause of errors in reasoning and decision making (Legrenzi & Girotto, 1996; Evans, 1996; Byrne, Espino, & Santamaria, 2000). For example, people interpret the probability of the evidence conditional on their initial hypothesis as support for that hypothesis; often, however, they do not even try to determine the probability of observing the same evidence in scenarios that embed alternative hypotheses (Legrenzi, et al., 1993; Doherty, Mynatt, Tweney, & Schiavo, 1979). Whether it is worthwhile trying to construct alternative scenarios, of course, is a function of the pragmatic context, which is seldom captured in laboratory studies of decision biases. Mental

models also support cognitive collaboration among individuals with divergent views by allowing each one to represent others' mental models of the same objects (Fauconnier, 1994; Johnson-Laird, 1983, pp 430 - 438).

Example

Figure 10.4, which illustrates some of the above functions, is a hypothesis about the opponent's mental model at the end of the exchange in Figure 10.3b. Different mental spaces or partitions (Fauconnier, 1994) correspond to time (the situation last night, the situation now, and the near future) and to alternative possibilities (corresponding to divergent views by the proponent and opponent about the present and future). Object identity as well as time can be tracked across these spaces, representing changes in relationships among the same objects (i.e., the proponent's belief that the enemy unit in Bridgeton last night has left) as well as different views about the same object at the same time (i.e., that the enemy unit is or is not in Bridgeton now). These features illustrate coherence of discourse rooted in a grounded representation of the situation under discussion and conversational interaction guided by representations of the other's beliefs about the same objects.

A participant is committed to a claim if it is true in each situation (mental model) that he or she is actively considering. According to Figure 10.4, the opponent believes there is agreement that an enemy mechanized unit was in Bridgeton last night. In addition, according to the opponent, the proponent is committed to the claim that the unit is no longer in Bridgeton and thus also to the claim that his company can attack and take the city without a fight. The opponent's *uncertainty* corresponds to active consideration of both the proponent's model, showing the unit not in Bridgeton, and an alternative model in which the proponent's claim is false.

To create this alternative model, the opponent, must show how the unit might still be in Bridgeton despite not being observed. He elaborates the original shared mental model by adding an observer corresponding to friendly forces on a hill south of the river, and by using a schematic spatial representation to mentally test whether buildings might conceal enemy forces from that observer (Figure 10.4, middle right). Because of its consistency with testimonial and observational evidence, and its satisfaction of constraints associated with relational isomorphism to a real situation, success in constructing such a model is prima facie evidence for the *possibility* that the enemy is concealed in Bridgeton (Johnson-Laird, Girotto, & Legrenzi, 2004). Moreover, in the course of his attempt to construct a model of the *proponent's* position (Figure 10.4, lower left), the opponent is able to "read off" conclusions implicit in its relational structure (for example, *If the unit left the town, it must be somewhere else.*) These implications raise questions about the plausibility of the proponent's model and thus supply ammunition for the opponent's subsequent challenges in Figure 10.3c: *If the unit left the town, where did it go? And why have we not observed it somewhere else?* These features illustrate error due to initially overlooking a possibility (i.e., concealment of the unit), the use of relational isomorphism to generate novel insights without inference rules, and assumption based reasoning (e.g., to accept the proponent's argument, one must assume that the enemy is not concealed).

CHALLENGING AND DEFENDING MENTAL MODELS

Types of Dialogue

A dialogue is a communicative exchange *of a recognizable type* (Walton, 1998) in which two or more individuals cooperate to bring about changes in their cognitive states. Some familiar dialogue types are distinguishable by whether the participants primarily want to change intentions, beliefs, or emotions, whether players in different dialogue roles are expected to

experience the same changes, and the balance of cooperation and competition in determining the

direction of change. In *inquiry* and *deliberation*, for example, participants cooperate to fill

collective gaps in their shared understanding (beliefs) and plans (intentions), respectively.

Information transfer (with roles of asking and telling) and *action commitment* (with roles of

requesting and offering) are cooperative responses to an imbalance across members of the team;

some parties are expected to exert an asymmetrical influence on the beliefs or intentions,

respectively, of others. By contrast, *negotiation* and *persuasion* highlight competition over

whose cognitive state will be most changed. Negotiation is prompted by divergence of values

and involves offers and counteroffers in symmetrical efforts by each side to steer decisions about

limited resources toward their own goals. Persuasion dialogue (of which critical dialogue is a

special case) is prompted by divergence of claims rather than values, and participants use

challenges and defenses to steer one another's beliefs toward a favored conclusion. In practical

contexts, critical dialogues target decisions as well, since divergent beliefs typically include

predictions of action outcomes or inferences about action preconditions. In a *simple* critical or

persuasion dialogue, there is an asymmetry between the role of proponent, who has the burden of

proof, and the role of opponent or challenger, who only needs to create doubt about the

proponent's claim. In a *compound* persuasion or critical dialogue, however, each participant

plays both roles, as proponent for his or her favored claim and as opponent for claims by others

(Von Eemeren et al., 1992). As in sports, a cooperative goal of playing the game coexists with a

competitive goal of winning it, and all players reap benefits from skillful effort.

Rules of Argumentation

A move is permissible in critical dialogue if it promotes the participants' shared purpose,

convergence of belief on true claims (Walton & Krabbe, 1995). Not surprisingly, these rules

systematically enforce the *disagreement heuristic*. For example, a challenge is ruled irrelevant

unless it targets claims to which the defender is committed and to which the challenger is not,

and which have a bearing on a task decision. When a commitment is challenged, the recipient of

the challenge must on the next turn either defend it by providing reasons (i.e., try to remove the

opponent's doubt by introducing claims that are inconsistent with the alternative possibilities) or

retract it (i.e., accept the alternative possibilities). If reasons are offered in defense of a

commitment, the reasons in turn become commitments and are themselves subject to subsequent

challenge. If a commitment is retracted, other commitments that depended upon it are in

jeopardy (because it eliminated mental models in which they were false). They may be given a

new defense, retracted, or retained subject to later challenge. Commitments cannot be defended

or retracted, however, *unless* they have been either directly challenged or indirectly placed in

jeopardy (the disagreement heuristic again). If a party does not directly or indirectly challenge

the other party's assertion at the first opportunity (i.e., the next turn), it is *conceded*. Concessions

allow other parties to get on with their case without stopping to defend every step. Later,

however, with a larger view of how a step relates to the claim of interest, a challenger may go

back and probe key elements of the other party's case more vigorously. Thus, a concession is

unlike a commitment in being retractable at any time, even in the absence of a challenge or

threat. These rules force participants to set aside areas of agreement and inconsequential

disagreement and focus attention and discussion on disagreements that most strongly influence

shared task outcomes, in pursuit of both consensus and accuracy.

Knowledge, Risk, and Ignorance

Critical dialogue alternately increases the number of possible scenarios under consideration

(through the opponent's challenges and the proponent's retractions) and decreases them (through

the proponent's defenses and the opponent's concessions). Nevertheless, both participants tend

to increase the total number of claims under discussion, hence, the number of dimensions along

which mental models vary (Rescher, 1977a). The aim to persuade means that each has an

incentive to introduce factors not considered by the other but which the other is likely to

understand, believe, and find convincing as a reason to accept, doubt, or deny a claim. (An

exception is that the challenger may occasionally only request reasons for a claim or point out an

apparent incoherence in the proponent's case, without adding a substantive new issue herself.)

Despite opposing short-term goals, therefore, the parties generally collaborate to increase the

fineness of discriminations among possible situations (i.e., the *resolution* of the situation picture)

and indirectly, the scope of the knowledge network brought to bear on the disputed claims.

Critical dialogue should mitigate the *common knowledge effect*, a phenomenon in which group

members tend to focus on information that other group members already have (Stasser, 1999)

and make more use of it in decisions (Gigone & Hastie, 1997), even when unshared information

is more important. Whether or not consensus is achieved, critical dialogue should increase the

participant's understanding of the situation, increase the amount and impact of shared

knowledge, and (at the very least), improve their understanding of what the other participants

believe or want.

Mental models generalize the notion of a *commitment store* found in current theories of

dialogical reasoning (Hamblin, 1970; Rescher, 1977a; Walton & Krabbe, 1995) and as a result,

provide a better formulation of rules for permissible dialogue moves (such as *assert*, *challenge*,

and *concede*). Rules are conditional on a participant's commitment store, which is usually

envisaged as a single list of propositions that the participant has asserted and not subsequently

retracted. If instead we identify it with the *set* of mental models that the participant is currently

entertaining, we can conditionalize role-specific dialogue rules and objectives on the possible combinations of propositions entertained by each participant. For example, the opponent in simple critical dialogue needs to demonstrate not the falsity but merely the *possibility* that the proponent's claim is false, i.e., that there is at least one plausible mental model in which it fails. By contrast, the proponent's burden of proof requires her to show the *falsity* of claims whose mere possibility weakens her case. Treating an opponent's challenge or a proponent's retraction as equivalent to a negative assertion (that is, including the *negation* of the challenged or retracted claim in a single list of commitments) is too strong, while dropping both the claim and its negation from the list throws away the fact that the claim has received attention and been challenged (hence, if the proponent wants to retain it or reintroduce it later, she must offer a positive defense). Adding alternative mental models in which the claim is false captures this distinction well.

Model-based commitment stores also clarify the semantics of concessions, as an element in assumption-based reasoning. A claim is conceded, or accepted as a provisional assumption, when it is true in all or most mental models *considered by the participant thus far*, but the participant is unwilling to bet that a more thorough search of relevant cases, or discovery of hitherto neglected key variables, would not yield counterexamples. A commitment on the other hand *is* a bet that exploration of additional variables and scenarios will not overturn the claim.

The generalized notion of commitment store corresponds to an expanded notion of *situation awareness*. It includes not just perceptions, interpretations, and predictions (Endsley, 2000), but also awareness of what questions are currently *relevant* and the present degree and type of *uncertainty* regarding them. Shared awareness of relevant issues and their associated uncertainty is important in implicit coordination skills like *pushing* needed information to team members

without being asked (Serfaty et al., 1998). Pushing information depends on shared awareness of relevance and uncertainty, not specific beliefs about the issue in question.

Mental models and dialogue rules help provide a unified framework for thinking strategies that people use in different contexts. For example, in a well-understood domain, challenges may be implicitly restricted to a known set of issues, and each party aims for the other's commitment. The limiting case of this is deductive reasoning, where the relevant knowledge can be encapsulated in a fixed set of premises. Neither party is allowed to add or subtract information during this part of the discussion, exhaustive search for counterexamples is therefore feasible, and the proponent must show that each case in which the claim is false is inconsistent with the premises (Hintikka, 1999). In a less structured or more novel situation, when there is no clear way to limit the processes of proposing and rebutting counterexamples, the parties may aim merely for a *concession* by the other side: a willingness to act on the overall set of assumptions that is currently the most plausible.

In probabilistic reasoning, the participants aim to converge on a *probability* – effectively, a willingness to bet at certain odds – rather than on a conclusion. Counterexamples (i.e., scenarios in which the claim is false) are not fatal as in deductive reasoning, and do not need to be explained as in assumption-based reasoning, but help quantify risk (the proportion of scenarios in which the claim is true). New factors, or conditioning variables, are introduced into the discussion until the proponent and opponent are in sufficiently close agreement on how to bet (Shafer & Vovk, 2001). In domains where there is substantial ignorance about what the critical factors are and how they influence the claim, agreement on a particular probability may be arrived at more by concession (i.e., as the most plausible current estimate) than by firm commitment.

Example

Figure 10.5 illustrates the way commitment stores evolve via challenges and defenses. Rows correspond to claims whose truth and falsity differentiate among possible views of the situation. Time in the real world flows from top to bottom, and arrows represent cause-effect relationships among the corresponding states of affairs and events. Time in the dialogue, on the other hand, flows from left to right. Shading indicates the dialogue phases in which a proposition is present in the commitment store of a particular party, either by assertion or concession. Stippled shading represents disagreement (i.e., a challenge without a retraction); thus, the claim is present in one commitment store while its negation is present in the alternative.

This diagram makes three features of critical dialogue evident: (a) Mental models are elaborated by introducing new variables (represented by the increased shading further to the right). (b) Shared awareness grows as each participant introduces factors that the other participant concedes as a basis for further reasoning and action (represented by the proportion of non-stippled shading). (c) Newly introduced factors are inferentially relevant because of their causal links to disputed claims. Most of the reasoning in this dialogue can be construed as either explanatory (inferring causes from effects) or predictive (inferring effects from causes).

Figure 10.5 also supports a more detailed analysis of the tactics of the two participants. In particular, three kinds of challenges by the opponent stimulate model development by the proponent:

(1) Exposing *gaps* in the proponent's case. The proponent's first turn (Figure 10.5a) leaves him committed to a simple causal scenario: *Bridgeton is undefended & We attack → We take Bridgeton without a fight.* The opponent's first challenge (Figure 10.5a) *Why do you think it's undefended?* is a request for reasons that implicitly raises the possibility that *Bridgeton is*

defended and that if we attack, *there will be a fight* (based on the Gricean, 1989, assumption that the opponent is cooperatively playing his role in the dialogue). The proponent attempts to eliminate this alternative model by adding *No heavy forces seen in Bridgeton*, an observation whose most natural causal explanation is that *Bridgeton is undefended.*

(2) Exposing and challenging the proponent's *assumptions*. In Figure 10.5b, the opponent concedes *No heavy forces seen* but adds that there was *Room for concealment.* The latter offers an alternative explanation of the former and thus makes it consistent with the possibility that *Bridgeton is defended*. (The proponent's original argument, based on *No heavy forces seen*, implicitly assumed room for concealment was not available.) In his next turn (Figure 10.5c), the proponent uses the same tactic. He concedes *Room for concealment* but denies an assumption (that the enemy had enough time to hide) implicit in its use by the opponent to explain *No heavy forces seen*. The proponent now has a coherent causal sequence: *Bridgeton is undefended & Enemy was not aware of us in time to hide (despite room for concealment)→ No heavy forces seen in Bridgeton.* Support for *Enemy was not aware of us in time to hide* comes from the fact that it nicely explains the perceptual judgment that *The scout car was surprised*. In case this is still insufficient to eliminate the opponent's alternative model, the proponent adds another perceptual judgment, *Enemy mech unit racing toward Bridgeton*, whose most obvious explanation is that *Bridgeton is undefended* (in combination with the assumption that the enemy has just learned of our presence from the scout car). At this point in the dialogue, the proponent's disputed claim that *Bridgeton is undefended* has been situated within a more detailed, coherent, and observationally grounded causal picture.

(3) Offering evidence that directly *conflicts* with the original claim (rather than demanding or attacking one of the proponent's arguments for the claim). The opponent now goes on the

offensive (Figure 10.5c), offering one claim, *Enemy knows importance of Bridgeton*, that

predicts *Bridgeton is defended* and another claim, *Enemy unit not seen elsewhere*, that is

explained by it. In his final turn (Figure 10.5d), the proponent again concedes these new claims,

but exposes hidden assumptions in their inferential use. *Enemy knows importance of Bridgeton*

does not predict *Bridgeton is defended* if there is a better way to achieve the same end, for

example, to *Protect Bridgeton from our side of river.* He also offers an alternative explanation of

Enemy unit not seen elsewhere by pointing out that *Our side of river is less densely settled.*

MONITORING CRITICAL DIALOGUE

Decisions about process reliability require a third role in critical dialogue, which we call the

dialogue monitor. Although this corresponds to a more objective, *third-person* stance, it does not

offer certainty or infallibility, but rather a distinctive *perspective* – that of an external, neutral

observer (Brandom, 2000; Shafer, 2001). The outer layer of critical dialogue, *control decisions*

(Figure 10.1)*,* corresponds to individual or team *metacognition*, i.e., cognition about cognition

(Cohen et al., 1996; Hinsz, 2004). Metacognition includes (a) dynamic awareness of particular

dialogue processes in real time and (b) general knowledge about such processes and their

outcomes (Nelson, 1992; Metcalf & Shimura, 1994). Accumulated metacognitive knowledge

assesses the reliability of judgment and decision processes by the relative frequency of

confirmed beliefs and successful outcomes that they produce (Brunswick, 2001; Hammond,

1993; Gigerenzer, 2000), or indirectly, by comparison with expert performance (Orasanu &

Connolly, 1993; Cohen et al. 1996; Lipshitz & Cohen, 2005). This perspective is as different

from those of the proponent and opponent as they are from one another, although the roles may

in practice be combined in a single person or distributed across team members.

Critical dialogue, as a coordinated activity, presupposes shared knowledge of how it is to be

carried out. This knowledge can be summarized as a set of state variables and their causal

relationships, as shown in Figure 10.6. The transitions in Figure 10.6 can be divided into four

functional phases, which need not be entirely discrete in time (Cohen, 2004): (1) Recognition of

the initial state involving disagreement about a significant claim, (2) formulation of a cognitive

and communicative intent to resolve the disagreement by critical dialogue, (3) exchange of

challenges and defenses, and (4) resolution of the disagreement. These phases are further

elaborated in Table 1.

The dialogue monitor's job includes three regulatory functions – *facilitator*, *referee*, and

judge – focused on enforcing constraints associated with different phases (Figure 10.6). The

monitor is a *facilitator* in Phases 1 and 2, when a problem is recognized and a dialogue type is

selected to resolve it, and in Phases 3e and 4a, when the problem is resolved and the dialogue is

concluded. The monitor functions as a *referee* during the exchange of challenges and defenses in

Phase 3. Finally, the monitor serves as a *judge* when determining how disagreement is settled in

Phase 4.

Facilitator

The *facilitator* is the top-level control of the dialogue process. This function is especially

prominent in Phase 1, where the facilitator detects and diagnoses a pragmatically problematic

cognitive state, and in Phase 2, where the facilitator assesses such conditions as motive, means,

opportunity, and intention to determine what method will be used to resolve the problem, by

whom, and at what time and place.

Selection of an appropriate dialogue method requires matching features of the situation to

templates for different types of dialogue (Cohen, 2004). Thus, the facilitator begins Phase 1 by

recognizing the initial state or problem: Is there an imbalance of information, intentions, or affect

among individuals within the group; a collective gap with respect to external knowledge, plans, or affect; or a divergence among team members in task-relevant beliefs, values, or emotions? Different types of dialogues correspond to different symptoms. In the case of critical dialogue, the initiating problem is disagreement in beliefs or decisions that are consequential for a task.

Having identified a problem, in Phase 2 the facilitator assesses whether other preconditions for the candidate dialogue type are satisfied. For example, how much does the imbalance, gap, or divergence of views matter for the task at hand? In the case of critical dialogue, are the parties *motivated* to resolve their disagreement or do they have a hidden agenda, such as challenging authority? Do they have the *means* to make a persuasive case, including requisite knowledge skills, and aptitudes? With regards to *opportunity*: Is an immediate decision required? What are the costs of delaying action? How much time will be needed for discussion? Are the time and place appropriate? Are there obstacles to critical discussion such as status differences and personality?

An initial problem state, together with motive, means, and an actual or anticipated opportunity, leads to a *cognitive intention* on the part of one or more of the parties to remove the imbalance, gap, or divergence by initiating an appropriate type of dialogue. This cognitive intention gives rise to a *communicative intention* (Sperber & Wilson, 199; Grice, 1989), to make other individuals aware of the cognitive intention and invite them to share it by taking on complementary dialogue roles. The verbal and nonverbal cues used to initiate critical dialogue may be quite subtle and indirect, because of potential loss of face in the process of challenging and being challenged (Brown & Levinson, 1987; Cohen, 2004). Critical discussion may be invited by remarks that just barely evoke the schema, such as "If we're wrong, we're in trouble" (partially matching the motive component), "Are you sure?" (partially matching the motive and

means conditions), or even more indirectly, "We have a few minutes before we have to go" (partially matching the opportunity component). Conversely, an invitation to critical dialogue may be signaled by jumping straight into Phase 3 (e.g., the opponent's question, *Why do you believe that Bridgeton is undefended?*) and may be accepted in the same manner (e.g., the fact that the proponent answers with a reason). The communicative intention is achieved when the appropriate cognitive intent is mutually understood and shared.

Facilitation can proactively test for and *shape* conditions favorable for different types of dialogue. When employed skillfully by team leaders, proactive facilitation is likely to improve mutual trust and coordination among team members (Cohen, 2004). A proactive facilitator learns to detect and even elicit consequential disagreements in social contexts where politeness, personality, custom, or deference to authority may discourage dissent (Brown et al., 1987). For example, is someone's body language signaling discomfort with a decision? Does someone's background or previously expressed views suggest that she might disagree with a decision? Other proactive skills include mitigation of the intimidating effects of status differences, active creation of times and places where discussion is possible, efforts to motivate individuals to express and defend their views, and techniques for *declining* to engage in dialogue when conditions are not right without discouraging open discussion when appropriate in the future.

The facilitator continues to monitor dialogue conditions during Phase 3, to determine when the exchange of challenges and defenses should conclude. Phase 3 questions are: Is the dialogue still productive? Has the importance of the issues under discussion changed, either based on external information or on results of the dialogue itself? Has the cost of delaying action changed? Does the cost of further delay still outweigh the importance of the issues? Here too the facilitator may be more proactive, as shown in Table 2 (among the materials we used in training). Part of

the facilitator's skill is stimulating productive discussion when it seems to have petered out. Phase 4 begins when the facilitator declares time up.

According to Paul (1987), Siegel (1997), Missmer (1994), and others, critical thinking is not simply a set of skills, but implies a more enduring disposition (including temperament and motivation) to put the relevant skills to use. This notion is captured in the idea of proactive facilitation of internal dialogue. To be an effective individual critical thinker, a person must internalize and enact that role, including both sensitivity to signs of doubt about her own beliefs and decisions and (we emphasize) recognition of the need, at an appropriate point, to stop questioning and act.

After the dialogue ends, the facilitator's function is to *learn*: to track and record outcomes, including the effects of the resulting cognitive state changes on on-going or future tasks. The facilitator thereby enhances knowledge about the benefits and costs of different dialogue methods under different conditions. A proactive facilitator actively creates opportunities to develop better ways of thinking and deciding.

Referee

Although the facilitator has selected the most reliable method for the purpose at hand, performance can be degraded if participants violate constraints conducive to the shared purpose. It is necessary, then, to supplement the facilitator's role with the function of a *referee*, who calls "fouls" when the contending parties violate norms associated with a particular dialogue type. The referee's task is to keep the exchange of challenges and defenses on track in Phase 3.

Critical-thinking and informal-logic textbooks identify numerous supposed *fallacies* in ordinary reasoning (e.g., Govier, 1997; Johnson & Blair, 1994). These include, for example: attacking a strawman position, arguing with respect to an issue other than the one under

discussion, attacking the motives or character of opponents rather than their reasons, assuming

what is to be proven, and appealing to authority, pity, passions, threats, or the popularity of a

viewpoint to make one's case. More specific errors include inferring causality from association,

affirming the consequent (viz., concluding *A* from *B* and *If A then B*), false analogy,

overgeneralization, overlooking distinctions, and slippery slope. Some simple examples of fouls

that were defined and illustrated for our dialogue training are shown in Table 3.

Efforts to provide a unified "theory of fallacies," generally from an internalist point of view,

have been unsuccessful (Hamblin, 1970; Woods & Walton, 1989). Fallacies cannot be formally

defined as errors in logic, probability, or decision theory. Some fallacies, like begging the

question, are logically correct, and others (e.g., affirming the consequent) may be correct if

understood within a different inferential framework, such as causal reasoning instead of

deductive logic. As Walton (1995) points out, for virtually any so-called fallacy there are

contexts in which arguments of the same apparent form make perfect sense; similar points have

been made about alleged decision and judgment biases (Gigerenzer & Murray, 1987; Cohen,

1993b). An alternative, quasi-externalist approach is to characterize fallacies as violations of

Grice's (1958) principle of cooperation in conversation (or dialogue). This has been pursued by

Van Eemeren & Grootendorst (1992) for fallacies of reasoning and by Schwarz (1996) for

decision and judgment biases. A problem pointed out by Walton (1995) is that the granularity of

Grice's principles is too coarse by themselves to account for standard distinctions among

fallacies. Moreover, while principles of cooperation seem to apply directly to some fallacies,

such as begging the question, using threats to suppress disagreement, changing the subject,

reversing the burden of proof, or attacks on character, there does not seem to be a necessary

connection to other errors (e.g., false analogy, slippery slope). Finally, this proposal seems to

make social convention the entire basis for argument evaluation to the exclusion of reliably fitting reality.

Cooperation can, however, be combined with externalist reliability to produce a general explanation of so-called fallacies. A unified classification scheme emerges when we identify different levels at which moves by dialogue participants might threaten the reliability of a dialogue process:

(1) Some fallacies involve moves belonging to the *wrong dialogue type*, resulting in an interaction that will not reliably achieve the presumptive shared goal (Walton, 1998). For example, citing one's own authority to cause a cognitive change in another person may be appropriate when giving orders (a special case of requesting action commitment) or imparting specialized information, but not under conditions appropriate for deliberation, inquiry, negotiation, or persuasion. Appealing to consequences (e.g., threats) or emotions is appropriate in negotiation and quarreling, but generally not in persuasion. Bargaining about the conclusion of a critical discussion (*I'll accept your view on issue A if you'll accept my view on issue B*) may be very cooperative, but it is out of bounds in critical dialogue – because the outcomes of a bargaining process are unreliably linked, if at all, to the truth of what is finally agreed upon.

(2) Another class of fallacies involves importing behavior from a *different dialogue phase*. For example, it is the facilitator's job in Phases 1 and 2 to determine the topics, times, and participants that are most likely to yield a productive critical dialogue. It is fallacious, however, during challenge and defense in Phase 3 for the *opponent* or *proponent* to change the topic, claim that the answer is obvious, cut off the discussion, or personally attack the motives or character of other participants. The dialogue monitor makes such decisions on pragmatic grounds from a perspective that does not favor one side over the other, while the contenders (when acting in

those roles) are liable to be influenced by partisan factors not correlated with reliability.

(3) Within the challenge and defend phase, fallacies may be associated with the proponent's refusal to defend arguments or the opponent's use of inappropriate challenges (Walton, 1996a). Walton encapsulates these ideas in the notion of an *argumentation scheme* (1996a): that is, a characteristic way of reasoning that specifies (i) a presumptive conclusion, (ii) evidence whose presence is typically sufficient for creating the presumption of truth and shifting the burden of proof to the opponent, and (c) a set of critical questions that an opponent can ask to shift the burden of proof back to the proponent. For example, an argument from analogy may be challenged by pointing out differences between the current problem and the supposed analog, or by bringing forward different analogies that point toward different conclusions; expert testimony may be challenged by asking whether the expert's opinion is clear, if other experts agree, if the claim is really in the expert's area of specialization, and so on; a slippery slope argument can be challenged by asking what process, if any, would lead from a small compromise to an unacceptable extreme; generalization from cases may be challenged by questioning the sample size or by pointing out relevant but overlooked distinctions. Named fallacies like these (false analogy, appeal to expertise, slippery slope, overgeneralization, and neglecting distinctions) cannot be automatically identified based on surface features of an argument. They come into being in a dialogical context, when opponents raise questions associated with a particular type of argument *and* proponents fail to answer (while also refusing to retract the challenged claim). It is plausible to suppose that such maneuvers – to the degree that opponents' questions are informed and well motivated – reduce the reliability of the dialogue as a generator of accurate beliefs.

The same principle works in reverse to prevent the opponent from using frivolous questions to prolong a critical dialogue indefinitely (Walton, 1996a). Once an argument of a certain type

has been made, the proponent is entitled to the associated default conclusion at least as a working assumption. The opponent must either concede it or challenge it by means of specifically appropriate types of questions. For example, the opponent's first challenge merely asked for reasons (*Why do you believe Bridgeton is undefended?*) and was answered by citing visual observations (*We only saw scout vehicles there*). The report of visual observation, however, cannot be challenged merely by asking for reasons, e.g., *Why do you believe you saw only scout vehicles there?* Challenges to a visual observation would have to introduce appropriate substantive issues, e.g., *Were the viewing conditions good? Has the observation been confirmed by multiple observers?*

Non-substantive challenges are inappropriate against arguments based on the normal operation of sense perception, deeply entrenched common sense, an accepted tenet of the proponent and opponent's shared community, or a belief manifested in the opponent's own statements or actions (Walton, 1996a). If the opponent is unable or unwilling to explain why she finds beliefs such as these unconvincing, the proponent cannot know where to *begin* in providing reasons that the opponent *would* accept. The opponent leaves the proponent no ground to stand on unless she states her reasons for doubt in such cases, to which the proponent can then respond. Legitimate questions target the reliability of the connection between the evidence presented and the truth of the presumptive conclusion. In combination with the evidence, therefore, the answers to critical questions should form a coherent, *linked* argument for the claim (Walton, 1996b).

Questions the referee asks during Phase 3 include: Are the participants interacting within the constraints associated with the current dialogue's purpose, setting, and phase? Does each participant understand and correctly describe the other's positions and arguments? Is the

opponent upholding her responsibility to present relevant counterarguments or concede? Is the proponent upholding her responsibility to answer relevant challenges or retract?

Judge

The facilitator regulates the time taken for dialogue, and the referee regulates how the exchange of challenges and defenses is conducted. But there is no guarantee that the available time, as determined by the facilitator, is sufficient for the contending parties themselves to reach agreement. Reliability thus requires the function of a *judge*, authorized to review the outcome of the exchange and if necessary, decide the issue unilaterally. As in other aspects of the monitor's job, the specific method of judging should be reliably associated with true or successful results under the prevailing circumstances.

Time constraints are not the only reason to have a judge. Even if the contenders reach an accord, it may be based on factors that are not reliably correlated with the truth of the views in question. There are two sets of factors that contribute to this result: the *local* nature of argumentation and the *inside* perspective of the contenders. A more holistic and external point of view may enable the judge (or the participants themselves in the role of judge) to reach more reliable conclusions than the participants in the roles of proponent and opponent.

Argumentation stimulates the construction of mental models, but it is flawed as a method for evaluating them (Pennington & Hastie, 1993b). Points won in debate need not correspond to overall plausibility. For example, suppose the proponent offers two independently sufficient reasons, *A* and *B*, for the conclusion *C*. The opponent rebuts *A* by evidence *R1* and rebuts *B* by evidence *R2*. Neither party notices that *R1* and *R2* are mutually incompatible. Thus, the opponent appears to have won on points, but the proponent's claim, *C*, remains plausible because at most only one of the ways it could be true has been refuted. Similarly, the proponent's case may

contain an inconsistency that escapes the opponent's notice. For example, as Pearl (1986) points

out, an argument from evidence *A* to conclusion *B* may be quite plausible (e.g., *A* almost always

has *B* as an effect); and an argument from *B* to conclusion *C* may also be quite plausible (e.g., *B*

is almost always due to *C*); but the proponent cannot concatenate these two arguments to yield an

inference of *C* from *A* because, in this example, *A* and *C* are competing explanations of *B*.

Opponent and proponent in critical dialogue are free to challenge the overall coherence of

the other's position. An advantage of mental models is that they encourage critical dialogue

participants to look at the case as a whole and ask whether the other participant has succeeded in

putting together a complete, plausible, and consistent story (cf. Pennington & Hastie, 1988,

1993b). The local character of most argument can distract the proponent and opponent from

doing this, however, and the judge may have a better view of what each has accomplished.

The second advantage of the judge is an external point of view. The output of critical

dialogue is a cognitive product, including new beliefs or intentions and the reasons for adopting

them. One of the unique characteristics of a *cognitive* product is that there may be two

complementary approaches to trusting it. *Internal trust* is the likelihood that an assessment is

accurate or that a plan will achieve desired outcomes as seen from inside the situation model or

plan itself, e.g., the proportion of envisioned scenarios that end in accomplishment of the specific

mission. *External trust* is an estimate of the relative frequency of satisfactory outcomes

associated with similar decision processes, pursued for a similar amount of time by similarly

qualified participants under similar circumstances (Cohen, Parasuraman, Serfaty, & Andes,

1997).

The proponent and opponent are likely to base their estimates of trust only on the internal

model space. In doing so, they neglect the past record. For example, inexperienced planners may

be confident that all foreseeable contingencies have been accounted for. Experienced

implementers, however, who have executed plans developed under similar circumstances, are

sure that something unexpected will go wrong (even if they do not know precisely what) unless

the plan is vetted far more thoroughly. Even experienced planners are likely to overestimate of

the current chances of success because they discount others' experiences and emphasize the

unique aspects of the present case (Buehler, Griffin, & Ross, 2002). John Leddo (unpublished

experiment) found that people playing the role of implementer were less overconfident than

planners. The judge in critical dialogue calibrates the outputs of the proponent and opponent with

respect to reality, just as an experienced implementer grounds the ideas of a novice planner. In

such circumstances, general strategies suggested by the judge, such as buying extra time and

maintaining operational flexibility, may be associated with more reliable achievement of

objectives.

    Questions the judge might ask during Phase 4 are: Did the participants agree on the issue in

question? What is their degree of confidence? To what degree is the outcome of the plan

predictable based on their confidence and other indicators? What is the quality of the

participants' final mental models? Are they complete, plausible, and consistent? Are any

characteristics of the topic, time, place, participants, or process associated with errors in

conclusions or confidence? Under these conditions, what is the best procedure for reconciling the

opinions of the participants?

Example

What conclusion should be drawn from the dialogue shown in Figure 10.3? Standard critical-

thinking and informal logic texts decide by applying internalist criteria to individual arguments,

e.g., by assessing the *acceptability* of premises, their individual *relevance*, and their collective

sufficiency for the conclusion. From this point of view, we might conclude that the proponent comes out ahead, since he has rebutted every one of the opponent's arguments, while the opponent has left some of the proponent's arguments unanswered (those in Phase (c)). Most of our trained groups, however, were not confident enough on this basis to risk a flat out attack against Bridgeton. The reason can be discovered by reading down the rightmost proponent and opponent columns in Figure 10.5, including all propositions and causal relationships to which that participant has become committed (and not retracted) along the way.

For the opponent, three claims were conceded but not woven into his scenario's explanatory web: *Scout car was surprised*, *Enemy mech force racing toward Bridgeton*, and *Enemy was not aware of us in time to hide*. These stand out like sore thumbs in the alternative scenario and detract from its plausibility. By the same token, a holistic look at the proponent's story raises interesting *new* questions: Is it consistent to say that the enemy did not have time to hide in Bridgeton but did have time to launch an initiative across the river? Is it consistent to say that such an initiative across the river is a way of protecting Bridgeton, while at the same time explaining the mech force racing down Highway 6 as a response to Bridgeton's vulnerability? Would it be safe to attack Bridgeton with part of our force if there were an enemy force on our side of the river? A mental model display like Figure 10.5 encourages recognition of emergent relationships that influence plausibility but remain invisible in the serial examination of arguments (cf. Pennington & Hastie, 1988).

Under these circumstances, a judge might fairly conclude, an attack on Bridgeton must include careful planning for contingencies, and if possible, steps should be taken to avoid decisive engagement if the town is still occupied. After training, several groups decided to buy time by destroying the mech force on Highway 6 from positions on our side of the river before

approaching the town, and to hedge against the possibility of decisive engagement by having

engineer units simultaneously continue the search for alternate crossing sites.

TRAINING CRITICAL DIALOGUE

Our training package, called *Critical Thinking through Dialogue*, begins with facilitator skills: a

discussion of what a critical dialogue is, the conditions under which it may be appropriate, and

how it can improve accuracy and consensus. The instructor then explains the four phases of

critical dialogue in terms of characteristic tasks and rules (Table 1), provides examples of how

rules tend to be violated (Table 2), elaborates the role of the dialogue monitor in facilitating and

refereeing (Table 3), and provides guided dialogue practice and feedback in all three roles. An

especially important point for military participants is helping them understand that dialogue roles

are not associated with rank.

Training took 60 minutes in our initial test, preceded and followed by tests with tactical

decision game scenarios, as described previously. One of two lead instructors conducted each

session, with support from one of two retired Army officers. Fifty-four active duty Army officers

participated, in 20 groups of 2 to 4 officers each. Variation in group size was outside our control,

but critical dialogue is designed to work with variable numbers of participants sharing roles in

different ways. The following tentative conclusions are based on analysis of seven randomly

chosen groups.

Findings

A dialogue is evaluated, from an externalist point of view, by measuring how well the constraints

associated with the three monitor functions were satisfied: (1) *Was the correct process chosen?*

(2) *Was it carried out properly by opponents and proponents?* (3) *Were conclusions*

satisfactory? Dialogue training appeared to have a positive effect on all three of these categories.

Significant differences between groups before and after training included the following:

(1) In accord with *facilitator* functions in Phases 1 and 2, groups were better at choosing relevant topics to discuss. They were significantly more likely after training to explicitly note areas of agreement and disagreement, setting aside areas of agreement and focusing discussion on disagreements.

(2) In accord with *referee* functions in Phase 3, proponents and opponents were significantly less likely to interrupt one another after training. Moreover, they were significantly more likely to ask for and give reasons rather than merely assert positions.

(3) Critical dialogue also affected the substance of group decisions, in accordance with *judge* functions in Phase 4. After training, groups generated and accepted significantly more new options than before training. More precisely, when we compared the maps and operations orders that participants produced as individuals with those produced by the group acting as a whole, we found that trained groups were more likely to adopt courses of action for major ground maneuver units that no individual group member had used when working individually. The reasons for this result need further investigation. First, note that there was no explicit requirement or encouragement in training to perform an "option generation" step. Thinking up more courses of action need not always be the best way to improve decisions; it may steal time that could be put to better use improving a single good option in response to specifically identified problems (Simon, 1997). However, new courses of action *should* be generated or recalled by trained groups when previous solutions are no longer salvageable. We do not know whether the novel courses of action adopted by trained groups were generated for the first time in the group or had been silently considered and rejected by individuals working alone. The most likely cause in either case was exposure of team members' individual proposals to serious challenge. In any

case, it is clear that these groups did not rely on either a bargaining strategy or a cherry-picking strategy, which would have merely traded off and combined pieces of their individual proposals.

CONCLUSIONS

Disagreement in a group or team sometimes leads to an exchange of reasons for and against a viewpoint, i.e., argumentation. A consequence of argumentation, when properly conducted, is the surfacing of assumptions about the domain that participants do and do not share, and the refinement and elaboration of knowledge. Even if the disagreement is not resolved, the exchange may increase the base of knowledge brought to bear on a decision, and improve the degree to which knowledge is shared, thus improving coordination in the future. If argumentation does resolve a disagreement, it may correct errors in the beliefs of one or more of the parties, augmenting both the accuracy and the consistency of shared knowledge and increasing the chances of mission success.

The rationale for framing individual critical thinking as a type of dialogue is the functional similarity between persuading another individual to accept or reject a position and determining for oneself whether the position is acceptable or not (Walton, & Krabbe, 1995, p. 26). The primary goal of our research was to determine the practical value of critical dialogue training for improving *both* individual critical-thinking *and* cognitive collaboration in real-world contexts. Several substantive hypotheses are implicit in the critical dialogue theory:

(1) Effective critical thinking demands a vivid interplay between real or imagined opposing perspectives on the issue in question (cf. Vocate, 1994). Mental model representations capture different levels and types of uncertainty, permit holistic comparisons, stimulate new challenges and defenses, and show how the process and its results relate to the world.

(2) Theories of reasoning and decision making must draw on principles from both discourse

and cognition. Different types of reasoning (e.g., deduction, induction, or assumption-based) and decision making (e.g., optimizing or satisficing) correspond to variations in implicit constraints on how mental models may be challenged and defended by participants playing different roles: for example, how burden of proof is allocated, the ability to introduce new information and to retract or revise claims, handling of inconsistency and counterexamples, the standard of proof, the depth to which underlying assumptions may be challenged, and the stopping rule. Mental models and dialogue rules together afford a general, unified, and naturalistically plausible account of critical thinking – which contrasts sharply with the conventional picture of a heterogeneous set of discrete reasoning frameworks (e.g., predicate calculus, propositional calculus, and probability) that untutored individuals must somehow chose from.

(3) Critical thinking is regulated by the *reliability* and *cost-effectiveness* with which it produces successful beliefs and actions in the relevant types of situations (Gigerenzer, 2000; Hammond, 1996; Lipshitz & Cohen, 2005; Rescher, 1977b, 2001). There is no *logically* enforceable end to potential challenges and defenses and no *formal* criterion for the completeness or sufficiency of an argument. This is why critical thinking cannot be fully understood or evaluated as a product, i.e., a fixed set of premises that either do or do not entail a conclusion, but only pragmatically in terms of context-sensitive costs and benefits.

The functional analogy between critical thinking and specific types of dialogue may be more than coincidence. Some developmental psychologists (e.g., Rogoff, 1990; Tomasello, 1999; Vygotsky, 1986) propose that thought first develops as internalized speech and that we learn to reflect on and evaluate our own thoughts by responding to the questions and answers of others. Moreover, as noted by Rieke and Sillars (1997), dialogue *continues* to be the natural format of adult thinking: "Research suggests that critical thinking is really a mini-debate that you carry on

with yourself. What is often mistaken for private thought is more likely an 'internalized conversation' (Mead [1967]), an 'internal dialogue' (Mukarovsky [1978]), or an 'imagined interaction' (Gotcher and Honeycutt [1989])."

There is an even simpler, practical reason for a dialogue-based theory of critical thinking. Thinking skills are not only shaped by social interaction but continue to be manifested in social contexts (Hutchins, 1995). Much critical thinking takes place in a team or group context, in which dialogue plays a direct role in decision making. Dialogues are the interactions by means of which members of a team pool information and insights to solve a problem, resolve competing goals, build up shared understanding of the situation and task, and over time construct relationships and commitments that improve team cohesiveness and trust as well as coordination (Amason & Schweiger, 1997; Cohen, 2004). Our fourth and final substantive hypothesis is that the fastest road to improving critical thinking in both an individual and a team is training for critical dialogue.

The cognitive and social skills required by reasoning together in conversation have drawn increasing interdisciplinary attention from experimental, developmental, and social psychologists (e.g., Anderson et al., 1996; Clark, 1996, 1992; Koslowski, 1996; Kuhn, 1991; Molder & Potter, 2005). The perspective on critical thinking as critical dialogue may be an opportunity for naturalistic decision-making researchers to add their own distinctive contributions to those efforts, by looking at how critical discussions are carried off in the real world.

Technologies, Inc., from the Army Research Institute, Fort Leavenworth Field Unit,

Leavenworth, Kansas.

REFERENCES

Amason, A. C. (1996). Distinguishing the effects of functional and dysfunctional conflict on strategic decision making: Resolving a paradox for top management teams. *Academy of Management Journal, 39*, 123 - 148.

Amason, A. C. & Schweiger, D. M. (1997). The effects of conflict on strategic decision making effectiveness and organizational performance. In C. K. W. De Dreu & E. van de Vliert (Eds.) *Using conflict in organizations* (101 - 115). London: Sage.

Anderson, T., Howe, C. & Tolmie, A. (1996). Interaction and mental models of physics phenomena: Evidence from dialogues. In Oakhill, J. and Garnham, A. (Eds.), *Mental models in cognitive science* (pp. 247 - 74). East Sussex, England: Psychology Press..

Brandom, R. (2000). Knowledge and the social articulation of the space of reasons. In E. Sosa, and J. Kim, (Eds.), *Epistemology: An anthology* (pp. 424 – 432). Malden, MA: Blackwell Publishers.

Brown, P. & Levinson, S. C. (1987). *Politeness: Some universals in language usage*. Cambridge: Cambridge University Press.

Brunswick, E. (2001). Representative design and probabilistic theory in a functional psychology. In K. R. Hammond & T. R. Stewart (Eds.), *The Essential Brunswick* (pp. 135 - 156). Oxford: Oxford University Press.

Buehler, R., Griffin, D. & Ross, M. (2002). Inside the planning fallacy: The causes and

consequences of optimistic time predictions. In T. Gilovich, , D. Griffin, and D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment* (pp. 250 - 70). Cambridge, England: Cambridge University Press.

Byrne, R. M. J., Espino, O. & Santamari, C. (2000). Counterexample availability. In W. Schaeken, G. De Vooght, A. Vandierendonck, & G. d'Ydewalle (Eds.), *Deductive reasoning and Strategies* (pp. 97 - 110). Mahwah, NJ: Lawrence Erlbaum Associates.

Cannon-Bowers, J., Salas, E., & Converse, S. (1993). Shared mental models in expert team decision making. In N. Castellan (Ed.), *Individual and group decision making* (pp. 221 - 46). Hillsdale, NJ: Lawrence Erlbaum Associates.

Chase, W., & Simon, H.A. (1973). Perception in chess. *Cognitive psychology, 4*, 55-81.

Clark, H. (1992). *Arenas of language use*. Chicago, IL: University of Chicago Press.

Clark, H. (1996). *Using language*. Cambridge, England: Cambridge University Press.

Cohen, M. S. (1993a). Three paradigms for viewing decision biases. In G. A. Klein, J. Orasanu, R. Calderwood, & C. E. Zsambok (Ed.), *Decision making in action: Models and methods.* Norwood, NJ: Ablex.

Cohen, M. S. (1993b). The naturalistic basis of decision biases. In G. A. Klein, J. Orasanu, R. Calderwood, & C. E. Zsambok (Eds.), *Decision making in action: Models and methods* (pp. 51 - 99). Norwood, NJ: Ablex.

Cohen, M. S. (2004). Leadership as the orchestration and improvisation of dialogue: Cognitive and communicative skills in conversations among leaders and subordinates. In D. V. Day, S. J. Zaccaro, & S. M. Halpin (Eds.). *Leader development for transforming organizations: Growing leaders for tomorrow.* Mahwah, NJ: Lawrence Erlbaum Associates.

Cohen, M. S., Freeman, J. T., & Wolf, S. (1996). Meta-Recognition in Time Stressed Decision Making: Recognizing, Critiquing, and Correcting. *Human Factors, 38*(2), pp. 206 - 219.

Cohen, M. S., Parasuraman, R., Serfaty, D. & Andes, R. (1997). *Trust in decision aids: A model and a training strategy*. Arlington, VA: Cognitive Technologies Inc.

Cohen, M. S., Salas, E. & Riedel, S. (2002). *Critical thinking: Challenges, possibilities, and purpose*. Arlington, VA: Cognitive Technologies, Inc.

Cooke, N., Salas, E., Cannon-Bowers, J. A. & Stout, R. J. (2000). Measuring Team Knowledge. *Human Factors 42*(1), 151 - 173.

Day, T. J. (1989). Circularity, non-linear justification, and holistic coherentism. In J. W Bender,. (Ed.), *The current state of the coherence theory*. Dordecht-Holland: Kluwer Academic Publishers.

DeKleer, J. (1986). An assumption-based truth maintenance system. *Artificial Intelligence, 28* 127-162.

Doherty, M., Mynatt, R., Tweney, R. & Schiavo, M. (1979). Pseudodiagnosticity. *Acta Psychologica* 43 111-121.

Ehrlich. (1996). Applied mental models in human-computer interaction. In J. Oakhill & A. Garnham (Eds.), *Mental models in cognitive science* (pp. 223 - 45). East Sussex, England: Psychology Press.

Endsley, M. R. (2000). Theoretical underpinnings of situation awareness: A critical review. In M. R Endsley. and D. J. Garland (Eds.), *Situation awareness analysis and measurement* (pp. 3 - 32). Mahwah, NJ: Lawrence Erlbaum Associates.

Endsley, M. R. & Garland, D. J. (Eds.). (2000). *Situation awareness analysis and measurement*.

Mahwah, NJ: Lawrence Erlbaum Associates.

Evans, J. S. T. & Over, D. E. (1996). *Rationality and reasoning*. East Sussex, England: Psychology Press.

Evans, J. S. T. (1996). Afterword: The model theory of reasoning: Current standing and future prospects. In J. Oakhill & A. Garland (Ed.), *Mental models in cognitive science* (pp. 319 - 27). East Sussex, England: Psychology Press.

Fauconnier, G. (1994). *Mental spaces: Aspects of meaning construction in natural language*. Cambridge, England: Cambridge University Press.

Feldman, R., & Conee, E. (2000). Evidentialism. In E. Sosa & J. Kim (Eds.), *Epistemology: An anthology*. Oxford England: Blackwell.

Garnham, A. (1996). The other side of mental models: Theories of language comprehension. In J. Oakhill, & A. Garnham (Eds.), *Mental models in cognitive science* (pp. 35-52). East Sussex, England: Psychology Press.

Garnham, A. (2001). *Mental models and the interpretation of anaphora*. East Sussex, England: Psychology Press.

Gentner, D. & Stevens, A. (1983). *Mental models*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Gigerenzer, G. (2000). *Adaptive thinking: Rationality in the real world.* Oxford: Oxford University Press.

Gigerenzer, G. & Murray, D. J. (1987). *Cognition as intuitive statistics*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Gigone, D. & Hastie, R. (1997). The impact of information on small group choice. *Journal of*

Personality and Social Psychology, 72(1), 132-140.

Gladwell, M. (2005). *Blink: The power of thinking without thinking*. New York: Little, Brown.

Goldman, A. I. (1992). *Liaisons: Philosophy meets the cognitive and social sciences*. Cambridge
MA: MIT Press.

Gotcher, J. M. & Honeycutt, J. M. (1989). An analysis of imagined interactions of forensic
participants. *The National Forensic Journal, 7*, 1-20.

Govier, T. (1987). *Problems in argument analysis and evaluation*. Dordrecht, Netherlands: Foris
Publications.

Govier, T. (1997). *A practical study of argument*. Belmont, CA: Wadsworth Publishing.

Grice, P. (1989). *Studies in the way of words*. Cambridge, MA: Harvard University Press.

Hamblin, C. H. (1970). *Fallacies*. Newport News, VA: Vale Press.

Hammond, K. R. (1996). *Human judgment and social policy: Irreducible uncertainty, inevitable
error, unavoidable injustice.* Oxford, England: Oxford University Press.

Hammond, K. R. & Stewart, T. R. (Eds.). (2001). *The Essential Brunswick: Beginnings,
explications, applications*. Oxford, England: Oxford University Press.

Hansen, H. V., & Pinto, R. C. (1995). *Fallacies: Classical and contemporary readings*.
University Park: Pennsylvania State University.

Hinsz, V. B. (2004). Metacognition and mental models in groups: An illustration with
metamemory of group recognition memory. In E. Salas, and S. M Fiore (Eds.), *Team
cognition: Understanding the factors that drive process and performance* (pp. 33 - 58).
Washington, DC: American Psychological Association.

Hintikka, J. (1999). *Inquiry as inquiry: A logic of scientific discovery*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA: The MIT Press.

Jehn, K. A. (1997). Affective and cognitive conflict in work groups: Increasing performance through value-based intragroup conflict. In C. K. W. De Dreu & E. van de Vliert (Eds.) *Using conflict in organizations* (pp. 87 - 100). London: Sage.

Johnson, R. H. (1996). *The rise of informal logic: Essays on argumentation, critical thinking, reasoning and politics*. Newport News, VA: Vale Press.

Johnson, R. H. & Blair, J. A. (1994). *Logical self-defense*. New York: McGraw-Hill.

Johnson-Laird, P. N. (1983). *Mental models*. Cambridge, MA: Harvard University Press.

Johnson-Laird, P. N. (2003). Illusions of Understanding. In Sanford, A.J. (Ed.), *The Nature and limits of human understanding: The 2001 Gifford Lectures at the University of Glasgow* (pp. 3 - 25). London: T & T Clark.

Johnson-Laird, P. N., Girotto, V. & Legrenzi, P. (2004). Reasoning from inconsistency to consistency. *Psychological Review, 111,* 640-661.

Johnson-Laird, P. N. & Byrne, R.M. (1991). *Deduction*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Johnson-Laird, P. N., Legrenzi, P., Girotto, V., Legrenzi, M. S., & Caverni, J.-P. (1999). Naive probability: A mental model theory of extensional reasoning. *Psychological Review, 106,* 62 - 88.

Johnson-Laird, P. & Shafir, E. (1993). *Reasoning and decision making*. Amsterdam: Elsevier.

Kahneman, D., Slovic, & Tversky, A. (1982). *Judgment under uncertainty: Heuristics and biases*. New York: Cambridge University Press.

Kahneman, D. & Tversky, A. (1982). Intuitive prediction: Biases and corrective procedures. In Kahneman, D., Slovic, P. and Tversky, A. (Eds.), *Judgment under uncertainty: heuristics and biases* (pp. 414 - 21). Cambridge, England: Cambridge University Press.

Katzenstein, G. (1996). The debate on structured debate: Toward a unified theory. *Organizational Behavior and Human Decision Processes, 66*(3), 316 - 332.

Kessler, K., Duwe, I. & Strohner, H. (1999). Grounding mental models - Subconceptual dynamics in the resolution of linguistic reference in discourse. In G. Rickheit, and C. Habel (Eds.), *Mental models in discourse processing and reasoning* (pp. 169 - 94). Amsterdam: Elsevier.

Klein, G. (1993). A Recognition-Primed Decision (RPD) model of rapid decision making. In G. A. Klein, J. R. Orasanu, R. Calderwood, & C. E. Zsambok (Eds.), *Decision making in action: Models and methods* (pp. 138 - 147). Norwood, NJ: Ablex.

Klein, G. (1998). *Sources of Power*. Cambridge, MA.: M.I.T. Press.

Klein, G., McCloskey, M., Thordsen, M., Klinger, D. & Schmitt, J. F. (1998). Bridgeton Crossing: Tactical Decision Game #98-4. *Marine Corps Gazette*(4), 86.

Klein, P. (2000). A proposed definition of propositional knowledge. In E. Sosa & J. Kim (Eds.) *Epistemology: An anthology*. (pp. 60 - 66). Oxford, England: Blackwell.

Kornblith, H. (1994). *Naturalizing epistemology*. Cambridge, MA: MIT Press.

Koslowski, B. (1996). *Theory and evidence: the development of scientific reasoning*. Cambridge: MIT Press.

Kuhn, D. (1991). *The skills of reasoning*. Cambridge, England: Cambridge University Press.

Lakoff, G. (1987). *Women, fire, and dangerous things: What categories reveal about the human mind*. Chicago, IL: University of Chicago Press.

Langacker, R. W. (2000). *Grammar and conceptualization*. The Hague: Mouton de Gruyner.

Legrenzi, P. & Girotto, V. (1996). Mental models in reasoning and decision-making processes. In &. A. G. J. Oakhill (Ed.), *Mental models in cognitive science* (pp. 95 - 118). East Sussex, England: Psychology Press.

Lipshitz, R. & Cohen, M. S. (2005). Warrants for prescription: Analytically and empirically based approaches to improving decision making. *Human Factors, 47*(1), 121-130.

McDermott, D. & Doyle, J. (1980). Non-monotonic Logic. *Artificial Intelligence, 13,* 41-72.

Mead, G. H. (1967). *Mind, self, and society: From the standpoint of a social behaviorist*. Chicago, IL: University of Chicago Press.

Metcalfe, J., & Shimamura, A.P. (1994). *Metacognition*. Cambridge, MA: MIT Press.

Missimer, C. (1994). Why two heads are better than one: Philosophical and pedagogical implications of a social view of critical thinking. In Walters, K.S. (Ed.), *Re-thinking reason: New perspectives in critical thinking.* Albany: State University of New York Press.

Molder, H. t. & Potter, J. (Eds.). (2005). *Conversation and cognition*. Cambridge, England: Cambridge University Press.

Mukarovsky, J. (1978). *Structure, sign and function: Selected essays*. New Haven, CT: Yale University Press.

Nelson, T. (1992). *Metacognition: Core readings*. Boston: Allyn and Bacon.

Nozick, R. (1981). *Philosophical explanations*. Cambridge MA: Harvard University Press.

Oakhill, J. & Garnham, A. (Eds.). (1996). *Mental models in cognitive science*. East Sussex, England: Psychology Press.

Oakhill, J. (1996). Mental models in children's text comprehension. In J. Oakhill, &.A. Garnham (Ed.), *Mental models in cognitive science* (pp. 77 - 94). East Sussex, England: Psychology Press.

Orasanu, J. (1993). Decision making in the cockpit. In E.L. Wiener, R.H., & B.G. Kanki (Ed.), *Cockpit resource management* (pp. 137 - 72). New York: Academic Press, Inc.

Orasanu, J., & Connolly, T. (1993). The reinvention of decision making. In G. Klein, J. Orasanu, R. Calderwood, & C. Zsambok (Eds.), *Decision making in action: Models and methods* (pp. 3 - 20). Norwood, NJ: Ablex.

Papineau, D. (2003). *The roots of reason: Philosophical essays on rationality, evolution, and probability*. Oxford: Clarendon Press.

Patel, V. L., Arocha, J. F. & Kaufman, D. R. (1999). Expertise and tacit knowledge in medicine. In R. H. Sternberg, and J. A Horvath (Eds.), *Tacit knowledge in professional practice.* Mahwah NJ: Lawrence Erlbaum Associates.

Paul, R. W. (1987). Critical thinking in the strong sense and the role of argumentation in everyday life. In F. H Eemeren, R. Grootendorst, , J. A. Blair, and C. A Willard (Eds.), *Argumentation: Across the lines of discipline.* Dordrecht, Netherlands: Foris Publications.

Pearl, J. (1989). *Probabilistic reasoning in intelligent systems: Networks of plausible inference*. San Mateo, CA: Morgan Kaufmann Publishers.

Pennington, N., & Hastie, R. (1988). Explanation-based decision making: Effects of memory

structure on judgment. *Journal of Experimental Psychology: Learning, Memory, & Cognition 14*(3), 521-533.

Pennington, N., & Hastie, R. (1993a). A theory of explanation-based decision making. In G. Klein, J. Orasanu, R. Calderwood, & C. Zsambok (Eds.), *Decision making in action: Models and methods* (pp. 188 - 201). Norwood, NJ: Ablex.

Pennington, N., & Hastie, R. (1993b). Reasoning in explanation-based decision making. In P. Johnson-Laird, and E. Shafir (Eds.), *Reasoning and decision making* (pp. 123 - 65). Amsterdam: Elsevier.

Plantinga, A. (1993a). *Warrant: The current debate*. New York: Oxford University Press.

Plantinga, A. (1993b). *Warrant and proper function*. New York: Oxford University Press.

Rescher, N. (1977a). *Dialectics: A controversy-oriented approach to the theory of knowledge*. Albany: State University of New York Press.

Rescher, N. (1977b). *Methodological pragmatism: A systems -theoretic approach to the theory of knowledge*. New York, NY: New York University Press.

Rescher, N. (2001). *Cognitive pragmatism: The theory of knowledge in pragmatic perspective.* Pittsburgh, PA: University of Pittsburgh Press.

Rickheit, G. & Habel, C. (Eds.). (1999). *Mental models in discourse processing and reasoning*. Amsterdam: Elsevier.

Rickheit, G. & Sichelschmidt, L. (1999). Mental models: Some answers, some questions, some suggestions. In G. Rickheit & C. Habel (Eds.) *Mental models in discourse processing and reasoning* (pp. 9 - 41). Amsterdam: Elsevier.

Rieke, R. D. & Sillars, M. O. (1997). *Argumentation and critical decision making*. New York: Addison-Wesley Educational Publishers.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context*. Oxford, England: Oxford University Press.

Schmitt, J. F. C. (1994). *Marine Corps Gazette's mastering tactics: A tactical decision games workbook*. Quantico, VA: Marine Corps Association.

Schnotz, W. & Preuss, A. (1999). Task-dependent construction of mental models as a basis for conceptual change. In G. Rickheit, and C. Habel, (Eds.), *Mental models in discourse processing and reasoning* (pp. 131 - 68). Amsterdam: Elsevier.

Schwarz, N. (1996). *Cognition and communication: Judgmental biases, research methods, and the logic of conversation*. Mahwah, NJ: Lawrence Erlbaum Associates.

Schweiger, D., Sandburg, W., & Ragan, J. W. (1986). Group approaches for improving strategic decision making: A comparative analysis of dialectical inquiry, devil's advocacy and consensus. *Academy of Management Journal, 29,* 51 - 71.

Schwenk, C. (1989). A meta-analysis on the cooperative effectiveness of devil's advocacy and dialectical inquiry. *Strategic Management Journal, 10,* 303 - 306.

Schwenk, C. & Cosier, R. (1980). Effects of the expert, devil's advocate, and dialectical inquiry methods on prediction performance. *Organizational Behavior and Human Performance, 26,* 409-424.

Serfaty, D., Entin, E. E. & Johnston, J. (1998). Team adaptation and coordination training. In Cannon-Bowers, J., A. and Salas, E. (Eds.), *Decision making under stress: Implications for training and simulation* (pp. 221 - 45). Washington, DC: American Psychological

Association.

Shafer, G. (2001). Nature's Possibilities and Expectations. In V. F. Hendriks, , S. A. Pedersen, and K. F. Jorgensen, (Eds.), *Probability theory: Philosophy, recent history and relations to science* (pp. 147-66). Dordrecht, Netherlands: Kluwer.

Shafer, G. & Vovk, V. (2001). *Probability and finance*. New York, NY: John Wiley & Sons.

Shanteau, J. (1992). The psychology of experts: An alternative view. In G. Wright & F. Bolger (Eds.) *Expertise and decision support* (pp. 11 – 23). New York: Plenum.

Shanteau, J. (1998). *Why do experts disagree with each other?* Paper presented at the fourth conference on naturalistic decision making, Washington, DC.

Siegel, H. (1997). *Rationality redeemed: Further dialogues on an educational ideal*. New York: Routledge.

Simon, H. A. (1997). *Models of bounded rationality: Empirically grounded economic reason*. Cambridge MA: MIT Press.

Sosa, E. (1991). *Knowledge in perspective: Selected essays in epistemology*. New York: Cambridge University Press.

Sosa, E. & Kim, J. (2000). *Epistemology: An anthology*. Malden MA: Blackwell Publishers.

Sperber, D. & Wilson, D. A. (1995). *Relevance: Communication and cognition*. Oxford: Blackwell.

Stasser, G. (1999). The uncertain role of unshared information in collective choice. In L. L. Thompson, J. M. Levine, and D. M. Messick, (Eds.), *Shared cognition in organizations: The management of knowledge* (pp. 49 - 69). Mahwah, NJ: Lawrence Erlbaum Associates.

Tabossi, P., Bell, V. A. & Johnson-Laird, P. N. (1999). Mental models in deductive, modal, and

    probabilistic reasoning. In G. Rickheit, and C. Habel, (Eds.), *Mental models in discourse*

    processing and reasoning (pp. 299 - 332). Amsterdam: Elsevier.

Tasa, K. & Whyte, G. (2005). Collective efficacy and vigilant problem solving in group decision

    making: A non-linear model. *Organizational behavior and human decision processes* 96(2),

    119-129.

Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, MA: Harvard

    University Press.

Van Eemeren, F. H., & Grootendorst, R. (1983). *Speech acts in argumentative discussions*.

    Dordrecht, Holland: Foris.

Van Eemeren, F. H. & Grootendorst, R. (1992). *Argumentation, communication, and fallacies: A*

    pragma-dialectical perspective. Mahwah, NJ: Lawrence Erlbaum Associates.

Van Eemeren, F. H., Grootendorst, R., Blair, J. A. & Willard, C. A. (Eds.). (1987).

    Argumentation: Perspectives and approaches. Dordecht, Netherlands: Foris Publications.

Van Eemeren, F. H., Grootendorst, R., Jackson, S., & Jacobs, S. (1993). *Reconstructing*

    argumentative discourse. Tuscaloosa: University of Alabama Press.

Vocate, D. R. (1994). *Intrapersonal communication: Different voices, different minds*. Hillsdale,

    NJ: Lawrence Erlbaum Associates.

Vygotsky, L. (1986). *Thought and language*. Cambridge, MA: MIT Press.

Walton, D. N. (1995). *A pragmatic theory of fallacy*. Tuscaloosa AL: University of Alabama

    Press.

Walton, D. N. (1996a). *Argumentation schemes for presumptive reasoning*. Mahwah, NJ:

   Lawrence Erlbaum Associates.

Walton, D. N. (1996b). *Argument structure: A pragmatic theory*. Toronto: University of Toronto

   Press.

Walton, D. N. (1998). *The new dialectic: Conversational contexts of argument*. Toronto:

   University of Toronto Press.

Walton, D. N. & Krabbe, E. C.W. (1995). *Commitment in dialogue: Basic concepts of

   interpersonal reasoning*. Albany: State University of New York Press.

Wason, P. & Johnson-Laird, P. N. (1972). *Psychology of reasoning: Structure and content*.

   Cambridge, MA: Harvard University Press.

Wineburg, S. (1998). Reading Abraham Lincoln: An expert/expert study in the interpretation of

   historical texts. *Cognitive Science, 22*(3), 319 - 346.

Woods, J., & Walton, D. N. (1989). *Fallacies: Selected papers 1972 -1982*. Dordecht-Holland:

   Foris Publications.

Table 1. Phases and Tasks in Critical Discussion.

Stage	Tasks
1 **Recognizing disagreement**	a. Individuals think about problem separately. (Group is more effective after members have thought about issues independently, even if just for a short time.) b. Express own views. c. Learn what others' positions are and why. Ask for clarification if not clear.
2 **Prioritize issues for critical discussion**	a. Recognize and expand areas of agreement (e.g., quickly settle minor differences and distinctions without a difference). a. Recognize and understand significant disagreements, that is, those that have implications for actions and outcomes. b. Determine what disagreements are important enough to critically discuss. Prioritize them. If there is no disagreement, determine the most important issues for which there is uncertainty. (Look at actual disagreements first, because an uncertainty is more likely to be significant if people have actually adopted different positions on it.) c. For high priority issue(s), quickly: Decide approximately how much time you have. Decide who plays primary roles of proponent and opponent. (If players have competing claims, each plays both roles.) Designate someone to be the monitor. This may be someone with no other role, or it may be the proponent and opponent jointly. If more than three people, assign teams to roles.
3 **Challenge-defend**	a. Parties take turns and do not interrupt one another. b. On each turn, for each claim that has been challenged, the proponent must defend it with reasons, modify it or other claims to avoid the objection, or retract it. c. On each turn, the opponent must challenge the proponent's position or else give up opposition. A challenge may demand a reason for any claim, present reasons against any claim, question the soundness of any inference from some claims to others, point out an incoherence among claims, or present an alternative coherent viewpoint. d. Monitor makes sure rules are being followed. e. Monitor watches time, keeps discussion going when appropriate, and closes it when costs outweigh benefits.
4 **Resolution**	a. End the discussion when parties resolve initial disagreement, or Monitor declares time is up. b. Identify recommendation of the group: This may be by concession of one of the parties, or else a decision by the monitor (or in some cases, an external superior). c. Monitor summarizes the strengths and weaknesses of each side, and explains why decision was made.

Table 2. Guidelines for Stimulating Critical Discussion.

Guideline	Example
Prioritize use of time	*What are the top priority issues? Which need an immediate decision? What do we already agree on, and where do we disagree?*
Keep discussion going if someone concedes too soon	*We still have some time. Don't give up yet. Work harder to come up with a better defense or a modification that meets the objections. An infallible crystal ball says your position is correct – Explain how this can be so despite the objections. If it is true, how could you show it?*
Energize discussion if it gets into a rut or peters out.	*Don't repeat the same points. Come up with new ideas. An infallible crystal ball says the position is false despite this evidence – Explain how that could be so. The crystal ball says there are other problems with the position – What are they?*
Call foul if a party violates the rules	*Aren't you changing the subject? Let's stay on this another moment.*

Table 3. Two Rules for Critical Dialogue, With Examples.

Rule	Fouls to avoid	Examples of foul
A **Don't suppress disagreement, or prevent each other from defending or challenging positions.**	No intimidation by use of authority or expertise	*If I want your views, I'll ask for them.*
	Don't distort others' views (create a strawman)	*So, you cowards just want to cut and run?*
	No personal attacks on competence or motives	
	No appeals to sympathy of other party	*Give me a break! No one ever accepts my ideas. Just go along with me this one time!*
B **Whoever makes a claim has to defend it if asked to do so, or else concede.**	Don't ask others to rely on your personal guarantee.	*I'm the expert here. I don't have to defend my views.*
	Don't declare your conclusion to be obvious.	*Everybody knows that...*
	Don't turn the tables.	*Well, I'd like to see you prove that I'm wrong.*
	Don't bargain. Settle issues on the merits.	*I'll let you have your way on the 1st platoon if you'll accept my suggestion on the tanks.*

Figure Captions

Figure 10.1. Overview of the theory of critical thinking as dialogue.

Figure 10.2. Map for tactical decision game *Bridgeton Crossing* taken with permission from the *Marine Corps Gazette* (April 1998). Annotations (not present in training) are numbered in the order in which the corresponding information is obtained in the scenario.

Figure 10.3. An illustrative critical dialogue for the tactical decision game in Figure 10.2. P = Proponent. O = Opponent. M = Monitor.

Figure 10.4. A spatial view of the opponent's situation understanding at phase (b) in Figure 10.3. Time in the scenario is represented from top to bottom.

Figure 10.5. Over the course of the dialogue in Figure 10.2, proponent and opponent flesh out a pair of alternative scenarios or mental models. Stripes indicate disagreement, and shading indicates consensus. Arrows indicate causal relationships. Events introduced by the opponent are in italics; causal relationships used by opponent are represented by dotted-line arrows.

Figure 10.6. A schema for critical dialogue, which functions as a shared plan, an explanatory pattern, and a source of normative constraints.

Control Decisions

Critical Exchange

| Evolving Commitments of Participants to Mental Models | Dynamic Process of Challenging & Defending Alternative Possibliities | Regulation of Process to Achieve Objectives |

Enemy mechanized force is moving toward Bridgeton.

6

Enemy mechanized force, seen in Bridgeton last night, is no longer visible.

4

Enemy scout car was surprised south of river this morning.

5

Bridgeton is the best river crossing site.

3

2

Your company has armored, mechanized infantry, engineer, and artillery elements.

The division (not shown) is moving north. Your company's mission is to find a river crossing for it.

TDG #98-4

1

Opponent's 's Model

Last night — **Shared model**
buildings **mech_unit**
buildings

This morning — **Proponent's claims** / **Alternative possibility**

Proponent's claims:
buildings   **mech_unit**
buildings
↑
observer

Alternative possibility:
Mech_unit
buildings   buildings
↑
observer

Near future —

Proponent's claims:
buildings   **mech_unit**
buildings
⇑
attack

Alternative possibility:
Mech_unit
buildings   buildings
⇑
attack

Dialogue Time

Scenario time	a Proponent	*Opponent*	b Proponent	*Opponent*	c Proponent	*Opponent*	d Proponent

Prior — *Room to conceal in Br.*

Enemy knows Br. important

Our side not as densely settled
Unit crossed river

Last night

This morning — Enemy had no time to hide

Br. undefended — *Br. defended* — No heavy forces seen in Br.

Scout car was surprised

Unit not seen elsewhere

Now — Other mech unit is racing to Br.

Near future — If attack no fight — *If attack, fight.*

Critical Dialogue Schema

Initial State (Before Dialogue)

PROP accepts a claim, OP doubts or rejects it, and it has implications for task decisions and outcomes.

Phase 1

Motive

PROP and OP want to resolve disagreement about claim, to improve task performance.

Means

PROP may have knowledge that will cause OP to concede claim. OP may have knowledge that will cause PROP to drop claim.

Opportunity

Relationship: OP has appropriate standing with PROP to challenge claim.
Situation: Time and place are appropriate for evaluating claim.

Facilitator Selects dialogue type

Phase 2

Cognitive Intent (Start of dialogue)

PROP intends to convince OP to concede claim. OP intends to convince PROP to drop claim.

Communicative Intent (Throughout dialogue)

PROP & OP each intend to speak & act according to this plan, so that the other recognizes their cognitive intent to cooperate in critical dialogue.

Phase 3

Referee Enforces dialogue rules

Exchange (Core of dialogue)

PROP defends claim by giving reasons. OP challenges claim or reasons for claim.

Phase 4

Judge decides dialogue outcome

Expected Results (End of dialogue)

OP concedes claim or PROP drops claim.

Expected Longer-Term Outcomes

If OP concedes claim, OP can be held accountable for supporting decisions based on the claim.