WORKING
PAPER

The Group Matters

A Review of the Effects of Group Interaction on Processes and Outcomes in Analytic Teams

SUSAN G. STRAUS, ANDREW M. PARKER,
JAMES B. BRUCE, AND JACOB W. DEMBOSKY

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PREFACE

This Working Paper explores the implications of using groups to perform intelligence analysis. This report reviews theory and research on the effects of group interaction processes on judgment and decision making in analytical teams. It describes the benefits and drawbacks of using groups for analytical work, common processes that prevent groups from reaching optimal levels of performance, and strategies to improve processes and outcomes in intelligence analysis teams.

This work is based on a review of the literature in social and experimental psychology, organizational behavior, behavioral decision science, and other social science disciplines, as well as the limited amount of group research in the intelligence literature. Included in this review is a bibliography consisting of key references organized by topic, with annotations for selected articles based on relevance to group processes in intelligence analysis. This report should be of interest to intelligence agencies that provide analysis to policymakers as well as to other organizations that use analytical teams.

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SUMMARY

Overview

Intelligence analysis fundamentally involves cognitive activities. It consists largely of tasks such as identifying problems, generating and evaluating hypotheses and ideas, identifying, providing, and assessing factual information and opinions, judging the probability of events, aggregating information, and making decisions. However, intelligence analysis often occurs in group settings and therefore also involves social processes.

Social science research documents a number of process gains, or benefits of using groups, for tasks such as problem solving, judgment, and decision making. For instance, groups provide opportunities for division of labor and therefore can be more efficient than individuals, and groups are generally more effective at solving problems and making decisions than the average of the individuals within the group, in part because the group can draw on more diverse knowledge and skills. In fact, a number of experts have emphasized the importance of using teams for conducting intelligence analysis (Hackman & O'Connor, 2004; Johnston, 2005; Medina, 2008; Smith, 2008; Sunstein, 2006).

At the same time, groups consistently fail to meet their full potential. *Process losses* refer to factors that prevent groups from reaching optimal levels of performance. When performing intellectual work, process losses *generally arise from the group interaction* and reflect failures to adequately *collect, share*, *integrate,* or *apply* relevant information.

This report reviews the research literature on group processes that are most relevant to the work of intelligence analysts. In this review, we describe a number of common process losses (and gains), discuss their underlying causes, and present possible methods to improve group processes and performance on analytical tasks. Included in our review is a bibliography consisting of key references by topic, with annotations for selected articles based on relevance to intelligence analysis.

Common Process Losses in Groups

We focus on six common and robust process losses in analytic teams. These include productivity losses in brainstorming, the common knowledge effect, group polarization, confirmation bias, overconfidence, and pressures toward uniformity.

Productivity Losses in Brainstorming. Generating ideas is a fundamental aspect of intelligence analysis. For example, intelligence analysts are called on to provide forecasts to policy officials about events such as a surprise attack or a government collapse. Successful forecasting requires creativity - generating novel ideas, using unconventional approaches, and an ability to think outside the box.

Many types of groups rely on brainstorming for idea generation. Despite the popularity of the method, research has demonstrated repeatedly that interacting groups produce fewer ideas than the same number of individuals working alone, or "nominal" groups. These productivity losses are due largely to a phenomenon called *production blocking* such that listening to others and waiting for one's turn to speak blocks the production of new ideas among participants. Despite the cognitive stimulation provided by exposure to others' ideas, production blocking usually overrides these gains in groups interacting orally.

The Common Knowledge Effect. The complexity of intelligence problems requires input from analysts with a broad range of knowledge. Although group outcomes can benefit from diverse perspectives and expertise, groups frequently fail to capitalize on their intellectual assets. Relevant information that is held by a minority of group members (unshared or unique information) often fails to be introduced into the group discussion, and when it is mentioned, it is often overlooked. Groups are more likely to mention and discuss information that is held by all group members (shared information). This well-replicated phenomenon is called the *common knowledge effect*. It is problematic when the unshared information, when combined, favors a different alternative than the shared information (called a "hidden profile"). The preponderance of studies shows that groups fail to solve hidden profiles; they select the

alternative that is supported by the shared information, even when all of the unshared information is introduced into the discussion.

The common knowledge effect occurs, in part, because more members have shared information, and therefore it is more likely to be sampled than is unshared information. Group members also prefer to exchange shared information because they are evaluated more favorably when they discuss information that others already know. Another contributing factor to this phenomenon is that most group members enter the discussion with preferences that are supported by shared information. The group discussion and decision are subsequently biased toward these preferences. Furthermore, this bias is exacerbated by a tendency for people to resist changing their initial judgments, choices, or attitudes, even in light of information showing that their preferences are no longer appropriate or have negative consequences.

Group Polarization. Intelligence analysts are often called on to make judgments involving more aggressive or cautious policy choices. Numerous studies show that group interaction tends to exacerbate attitudes held by individuals, particularly in groups that are homogeneous in prior beliefs and values. Because group-level decisions are likely to be affected by shifts in group member attitudes, the implication is that group decisions will become more extreme, such that a group of modestly risk-seeking individuals will become much more risk-seeking, and a group of mildly risk-averse individuals will yield a more highly risk-averse decision. The tendency for groups to make more extreme decisions than individuals is called *group polarization*. One explanation for group polarization, referred to as social comparison, suggests that when individuals learn the positions of other group members, they succumb to normative pressure and shift their attitudes in the direction that the group is leaning. A second explanation, called persuasive arguments, proposes that polarized arguments are made in proportion to the prior positions of group members. Hence, a more homogeneous group will quickly build a weight of evidence in their initially-leaning direction. Evidence supports both hypotheses, with stronger support for persuasive arguments.

Confirmation Bias. In the course of group deliberation, evidence both supporting and contradicting particular points of view will inevitably arise. In such situations, however, both groups and individuals have a disproportionate tendency to search for and focus on information that supports pre-existing hypotheses, or confirming evidence, and tend to fail to search for or give sufficient attention to disconfirming evidence. As a result, individuals or groups often make decisions based on incomplete information. In addition, this biased information search tends to lead groups to unwarranted confidence in their stated hypothesis.

The confirmation bias may be due to a more basic tendency to seek out instances where events occur, rather than when they do not occur. It also is related to the relative diversity of prior opinions in the group, whereby groups that are composed of members with different perspectives are less likely to exhibit the confirmation bias.

Overconfidence. In intelligence analysis, where information is often accompanied by varying degrees of uncertainty, knowing how much one truly knows can be a challenge. Unfortunately, individuals, including some intelligence analysts, have a tendency to overestimate the extent of their knowledge (or other aspects of performance), particularly in difficult domains (such as those with high uncertainty) – a robust phenomenon called *overconfidence*. Overconfident individuals may be less willing to seek out additional information or incorporate the opinions of others, thereby failing to collect or apply task-relevant information. Overconfidence appears to worsen in groups, particularly when groups face situations that do not have demonstrably right or wrong answers. It also tends to be worse in larger groups and in homogenous groups. Overconfidence may be due, in part, to the convergence of both the common knowledge effect and confirmation bias, given that these processes falsely reinforce commonly and strongly-held perspectives in groups.

Pressures Toward Uniformity and Groupthink. Because intelligence analysis occurs in group settings, social influence processes are inevitable. Decades of research has documented the power of groups to change the attitudes and judgments of individual members. Groups

pressure their members to go along with the dominant view, and individual members often conform to the group's opinion. Such pressures toward uniformity inhibit members from sharing dissenting information, challenging others, and considering alternative solutions or courses of action — thereby eliminating or reducing the benefits of cognitive diversity in groups.

There are a number of reasons why pressures toward uniformity and conformity to such pressures occur. Uniformity helps groups define their social reality and establish norms for behavior, which allow groups to function more efficiently. Research also shows that members who refuse to conform experience social pressure, and ultimately, rejection. Given that even brief episodes of ostracism produce intense psychological distress, group members may go along with the group to avoid being rejected. Low status members of groups (e.g., members with less experience) tend to conform more than do high status members. If low status members also hold critical information, then performance outcomes (e.g., judgments or decisions) may suffer.

The idea that group cohesion creates pressures toward uniformity is one of the underlying tenets of Janis's (1972) influential theory of *groupthink*. Despite the acceptance of groupthink as valid by lay audiences, academic researchers, and policy analysts, the model has been called into question by numerous scholars in the scientific community. This skepticism is due, in part, to the methods used to evaluate groupthink, such as analysis of selected case studies, which can be subject to a variety of biases, and in part to the lack of support for basic principles of the model from more rigorous research approaches. There is little question that processes such as pressures toward uniformity and self-censorship are associated with ineffective judgment and decision making. However these phenomena do not support the groupthink model in that they often occur in the absence of antecedents and symptoms of groupthink; likewise, purported antecedent conditions of groupthink (e.g., cohesiveness, stressful conditions) do not necessarily lead to defective decision making.

Improving Group Processes

Many of the process losses we have reviewed are not independent phenomena. The processes can be mutually reinforcing in that when one type of loss is present, there is a greater likelihood that the group will experience other losses; conversely, when groups are able to avert one type of loss, they may be less prone to experiencing others.

Consequently, solutions directed at one type of loss may reduce the incidence of other problems. In particular, solutions that foster task-based dissent can alleviate multiple process losses by encouraging members to better identify, generate, share, and use relevant information. We describe a number of strategies to facilitate divergent thinking in groups. We have classified these strategies into three categories: (1) modifications to group structure; (2) adoption of specific procedures; and (3) facilitation and training.

Modifying Group Structure. The group structure can be modified by changing the team's composition, member roles, and size. Perhaps the most powerful structural intervention to promote the generation and use of divergent information is to compose groups to be heterogeneous in the opinions and expertise that they bring to the team. However, as groups work together over long periods of time, they tend to become more homogeneous in their perspectives. Bringing in experienced (versus novice) members from other teams can help groups be more productive and creative. In fact, some organizations intentionally vary composition to enhance innovation in groups.

Groups can also modify their structure to increase cognitive diversity by creating and emphasizing member roles. For instance, members can be assigned to various information roles (e.g., by having each member research a different problem) within the group. Another strategy is to assign group members to serve as the devil's advocate. A related technique is to rotate responsibility to advocate for particular hypotheses or alternatives. Rotating advocacy positions prevents members from selecting information that supports only one alternative. Whether diversity in functional specialties is natural or contrived, members should be made aware of each others' expertise.

Finally, whereas there is no known optimal number of members in a group, organizations should avoid composing groups that are so large that they preclude true interdependence and meaningful interactions among members. Large groups also tend to experience other unfavorable phenomena including greater overconfidence, larger productivity losses, and lower cohesiveness.

Procedures. Groups can also adopt procedures or protocols to reduce process losses. Productivity in brainstorming groups can be enhanced by using methods that do not require group members to take turns. Examples include brainwriting, in which group members write their ideas on slips of paper and exchange them in a round-robin fashion, and electronic brainstorming, which is a computerized version of brainwriting. Analytical "tradecraft" provides structured approaches that can aid groups in a variety of intelligence analysis activities. Such approaches can improve diagnostic processes, facilitate divergent views, and encourage imaginative thinking. Examples include Analysis of Competing Hypotheses, Team A/Team B Analysis, Red Teaming, and "What-if?" Analysis. A number of these methods require the use of groups, and others can be enhanced by using groups rather than individuals.

Other less formal procedures can be used to increase identification, exchange, and consideration of diverse information, thereby reducing process losses such as the common knowledge effect, conformity, polarization, and overconfidence. These include:

- restricting group members from stating their preferences until all known relevant information about alternatives has been shared;
- encouraging group members to present or consider opinions or information simultaneously rather than sequentially;
- framing the discussion as a problem to be solved rather than as a decision to be made;
- extending discussion time;
- instructing individuals to consider more alternatives and unexpected outcomes;
- requiring individuals to make judgments about their level of uncertainty prior to group interaction and presenting this information to the group.

Facilitation and Training. Although a review of research on leadership is beyond the scope of this report, some of the studies we have included speak to the importance of the role of a group leader or facilitator in helping groups achieve more effective analytical processes. Providing trained facilitators can help groups overcome productivity losses in interactive brainstorming and be more creative. In other types of analytic tasks, leaders or facilitators can enhance group effectiveness by focusing on the decision process rather than the content of the decision. Leaders who encourage open discussion are likely to enhance the expression of divergent information and improve group decision quality, whereas leaders who focus on the substance of the group decision are most likely to lead their groups to poorer decisions. Leaders also serve a key role in creating a context that facilitates effective group processes. Elements of a supportive context include interdependence for a common goal; a clear and compelling purpose; appropriate task design, team composition, and group norms; sufficient organizational resources (e.g., rewards, information) to support desired behaviors, and access to effective team coaching.

Process losses also can be reduced by training group members to avoid common pitfalls of group decision making. Intelligence agencies tend to rely on on-the-job training and informal mentoring. However, formal training interventions can be used to help groups improve their processes. For instance, groups can be trained to develop a strategy for their discussion, to be cognizant of member expertise, and to be vigilant to information, particularly when the information diverges from the direction the group is leaning.

Like process losses, however, these strategies for improvement are interrelated. Techniques to increase dissent can have negative consequences, particularly if implemented independently. For example, membership changes, while promoting divergent thinking, create inefficiencies and coordination problems for groups, such as the need to train or socialize new members. Strategies designed to increase cognitive diversity in groups can result in reduced cohesion, greater conflict, and reduced member satisfaction. However, these negative effects can be mitigated if these strategies are accompanied by clear

group norms that value cognitive diversity and access to coaches can help teams engage in optimal processes.

Future Directions

The literature reviewed for this report focuses on controlled laboratory studies. The processes examined are well-replicated, and we can be confident in the internal validity of the findings. An important question for future research is whether the process losses discussed in this report generalize to intelligence analysis teams. Given that intelligence analysis consists largely of cognitive tasks, and such tasks are often conducted in interdependent groups, we expect that intelligence analyst teams exhibit the types of processes we have described. At the same time, there are some differences between these teams and the kinds of groups that are prevalent in psychological research. Key differences include group size (intelligence analyst teams may be larger); the experience of members of real teams, both with each other and with the task, as well as their level of engagement or commitment to the task; and unique characteristics of intelligence analysts' jobs, including high levels of risk and secrecy, and conditions of considerable stress involving time urgency, a dynamic context, and intense organizational pressures to avoid failure.

Ultimately, research is needed to investigate the dynamics of intelligence analysis teams and the efficacy of strategies to improve their group processes and outcomes. A program of research that uses a variety of methods (e.g., controlled studies, field studies, observation, and interviews) can establish convergent validity, or triangulation of results, as well as reveal boundary conditions, thereby increasing confidence in the accuracy of research findings. Examples of specific research questions include:

- To what extent, and under what circumstances, do the process gains and losses described in this report occur in intelligence analyst teams?
- What is the effect of diversity in members' knowledge and skills on information identification, knowledge sharing, and opinion change in the group?

- How do characteristics of individuals in the group, such as longer tenure, higher status, or affiliation, affect changes in members' judgments?
- What is the effect of providing trained facilitators on processes and outcomes?
- Does level of classification or compartmentation affect analysts' appraisal of the validity or importance of the information? Does information source contribute to systematic biases in group judgment?
- How does pressure to avoid failure affect collection, sharing, and use of divergent information?
- To what extent are the types of interventions reviewed in this report appropriate in light of the extant structure and culture of intelligence analyst teams?

Many experts argue for the need for groups to conduct intelligence analysis, but systematic studies of teams in this context are rare. The topic of group intelligence analysis is fertile ground for research, and a program of research on group dynamics in intelligence teams has the potential to make a significant impact on improving analytical processes and outcomes in the U.S. Intelligence Community.

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LIST OF ACRONYMS

Acronym	**Definition**
ACH	Analysis of Competing Hypotheses
CIA	Central Intelligence Agency
DNI	Director of National Intelligence
NIE	National Intelligence Estimate
NGT	Nominal Group Technique
WMD	Weapons of Mass Destruction

1. INTRODUCTION

Intelligence analysis fundamentally involves cognitive activities. It consists largely of tasks such as identifying problems, generating and evaluating hypotheses and ideas, identifying and assessing open source and classified information, recognizing patterns in large sets of data, judging the probability of events, aggregating information, and providing analysis to policymakers consisting chiefly of insights, judgments, and forecasts.

Whereas intelligence analysis is often conducted by individuals, greater collaboration among analysts is an explicit goal of the Director of National Intelligence (DNI, 2007), and recent advocates for collaboration have argued persuasively for the benefits of using groups in intelligence analysis. For example, Central Intelligence Agency's (CIA) Carmen Medina has argued that information overload requires teams of analysts to do an initial exploitation of mountains of data. Lauding such recent collaborative innovations as the DNI's Expeditionary Analysis Teams and the DNI's three new wiki-like Intellipedias, she noted that "…the shift from a largely individual model of work to one that places greater emphasis upon collaboration among many represents a significant change in and challenge to the culture of the analytical community" (Medina, 2008). Medina urges that managers of analysts "…create incentives for collaboration on difficult problems with the goal of generating insight, not just product." (Medina, 2008). Similarly, Johnston (2005) argues that the knowledge requirements in intelligence analysis exceed the capabilities of individual experts; intelligence analysis requires a variety of different types of expertise, each of which is highly specialized. Without collaboration, an expert in one domain often will not know whether or how particular information has value for an expert in another domain. Elsewhere in the U.S. Intelligence Community Office of Naval Intelligence analyst Tim Smith has called for the establishment of "computational collaboratories" to foster integrated teaming on high-level intelligence projects such as National Intelligence Estimates (NIEs; Smith, 2008). Smith urges cross-functional

team collaboration and the establishment of Integrated Project Teams (Smith, 2008).

These arguments for collaboration are supported by a history of research in social psychology, decision sciences, and related domains that has documented a number of *process gains*, or benefits of using groups for tasks such as problem solving, judgment, and decision making. Group interaction provides opportunities for synergistic effects, such that the group's product can be better than the sum of its parts (i.e., than the simple combination of individual members' contributions) (Hackman, 1987; 2002). Examples of process gains include:

Efficiency: Groups offer opportunities for division of labor, including "division of cognitive labor" (Surowiecki, 2004 p. 161).

Quality: Groups are generally more effective at solving problems and making decisions in comparison to the average of the individual members' judgments or decisions. This occurs, in part, because groups can draw on a range of knowledge, skills, and abilities of their members. Diversity in members' knowledge, skills, and abilities enhances creativity, problem solving, and decision quality (McGrath, 1984; Laughlin, 1999). In some circumstances, groups perform even better than the best individual in the group (Sniezek & Henry, 1989).

Commitment: Participation fosters decision understanding and acceptance (e.g., Sniezek, 1992) as well as commitment to the team and its goals (Hackman, 2002).

Error-checking: Groups are more effective than are individuals at identifying errors (Shaw, 1932).

Skill-building: Participation helps build members' knowledge and skills (Hackman & O'Connor, 2004; Straus & Olivera, 2000).

The synergistic effect of groups, however, can be negative as well as positive (Hackman, 1987; 2002). Despite the appeals for increased group collaboration in analysis, research in the social sciences shows that groups in many settings consistently fail to meet their full potential—or worse—produce extreme failures in judgment or other outcomes (Hackman, 1987). *Process losses* (Steiner, 1972) refer to factors that prevent groups from reaching optimal levels of performance. For example, a robust finding is that while groups perform better than

the average of the individual members, they typically fail to perform as well as the "best" or most skilled member of the group.[1] When performing intellectual work, process losses *generally arise from the group interaction* and concern failures to adequately *collect, share*, *integrate*, or *apply* relevant information.

Thus, by using groups, the cognitive activities involved in intelligence analysis are subject to social processes (Hackman & O'Connor, 2004). The primary purpose of this report is to review the research literature on the process losses (and gains) that are most relevant to the work of intelligence analysts. In this review, we describe each phenomenon, discuss theory and research regarding its underlying causes, and present possible methods to improve processes and outcomes in analytical teams. Included in our review are both classic studies of these phenomena and more recent research. In the final section of this report, we identify topics for future research on intelligence analysis teams. We also provide two bibliographies – one that lists key references by topic, and the other that lists all references cited in the report. In the former bibliography, we have annotated select articles based on relevance to group processes in intelligence analysis (see Appendix A).

We limit the scope of this report to small group phenomena. We do not review, for instance, the cognitive psychology literature or individual biases in judgment beyond studies that have examined such phenomena in group settings. (See Heuer, 1999, for a review of how findings from cognitive psychology apply to the work of intelligence analysis.) We also do not review behavior of "crowds" or collectives of

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[1] Groups performing tasks with demonstrably correct answers ("eureka tasks"; Laughlin, VanderStoep, & Hollingshead, 1991) tend to outperform their average members and approach the performance of their best members (i.e., "truth wins," Laughlin, Kerr, Munch, & Haggarty, 1976). However, in the preponderance of tasks in actual work groups, accuracy is not known until after a judgment or decision is made (e.g., as in predicting a future event). In these tasks, groups tend to perform at the level of their average members.

independent individuals, such as prediction markets and informational cascades, as discussed in Surowiecki (2004) and Sunstein (2006).[2]

ASSUMPTIONS

Tetlock (2005) asserts that the quality of judgment or decision making can be considered in terms of both *correspondence* to some external criterion (e.g., how well judgments predict actual future events) or logical *coherence* or consistency among judgments or decisions (e.g., whether judgments of the probabilities of possible events sum to 100 percent; whether people make the same choices when outcomes are framed in terms of gains or losses). An example of a correspondence criterion that has been used extensively in the group decision-making literature is to define the "potential" or optimal level of group performance as the performance of the best member. Given that groups often fail to perform as well as their best member, this might suggest that one should identify the best member and have that individual do the work – an approach that may also appear to be more efficient, as individuals often take less time to make decisions than do groups. However, we believe that this approach is both impractical and counterproductive.[3] We concur with a variety of experts that some intelligence analysis may be best performed by teams (Hackman & O'Connor, 2004; Johnston, 2005; Medina, 2008; Smith, 2008; Sunstein,

[2] Surowiecki (2004) focuses primarily the power of large, statistical groups of independent individuals, with a lesser emphasis on small, interacting groups. Sunstein (2006) includes deliberating groups as one of four types of collectives, along with statistical aggregations, markets, and loose information networks, such as the Internet. Because of the interdependence of analysts and the size of the analytic groups making judgments, our analysis focuses most closely on deliberating groups. Indeed, Surowiecki's consideration of "Committees, Juries, and Teams" (Surowiecki, 2004, Chapter 9) and Sunstein's "Four Big Problems" (Sunstein, 2006, Chapter 3) are well represented in our discussions of process losses in this report.

[3] In addition to the powerful arguments for using groups, there are other reasons not to rely on individual experts. First, it may be difficult to identify the best member, and the best member may vary across tasks and situations. Second, relying on individuals makes the organization vulnerable if the "best" individuals are not available or leave the organization. Putting judgment processes in the hands (or minds) of individuals or independent experts also limits the opportunities for learning that come about through group interaction.

2006; Surowiecki, 2004). Thus, an underlying premise of our report is that groups, rather than individuals, should be used in select intelligence analysis activities. Moreover, we assume that such analysis generally should be conducted in *interdependent work teams* (whereby members work together closely and the final product is the result of a group effort) or "surgical" teams (whereby team members work together in real time to generate analysis, but a single individual is responsible for the group product) rather than co-acting groups (whereby analysts operate mostly independently and the final product is an aggregation of their individual efforts) (Hackman & O'Connor, 2004; Hackman & Wageman, 2005). A challenge, then, is how to use these teams in such a way that minimizes process losses and maximizes process gains.

When groups make complex judgments or decisions, it may be infeasible to evaluate correspondence and coherence standards. An alternative way to assess group effectiveness is to apply process criteria. The Analytic Standards published by the Office of the DNI (2007) provides a number of such criteria. Examples include considering alternative and contrary perspectives, using all available source of information as a basis for judgments, expressing uncertainties and confidence in judgments, and identifying assumptions and the implications for judgments if those assumptions are incorrect. Thus, a second premise of this report is that correspondence, coherence, and process standards are all important. Correspondence speaks to how well judgments and choices meet external criteria, such as accuracy, timeliness, and usefulness to the customer (policymaker). In many ways, such standards are the ultimate goal. However, achieving these standards is dependent on processes internal to group interaction. Coherence (consistency) and process criteria directly address these internal processes. The phenomena reviewed here provide the opportunity for all three forms of assessment. Some apply correspondence standards, others invoke coherence, and still others reflect group processes as the criterion for team effectiveness.

There are few studies of intelligence analysis in group settings. However, intelligence analysis involves a variety of cognitive tasks, and the study of cognitive tasks in collective settings has been the

subject of substantial research in social psychology, organizational behavior, behavioral decision science, economics, and other social science disciplines. Thus, a third premise of this report is that many of the research findings involving similar types of tasks in other domains are applicable to the work of intelligence analysts.

DEFINITIONS

We define a *group* following McGrath's (1984) conceptualization as, "an aggregation of two or more people who are to some degree in dynamic interrelation with each other" (p. 8; see also Shaw, 1981). Implied are a shared history, an expectation for a common future, and interdependence among the group members. Heuristically, we consider groups as consisting of no more than about 10 people, since aggregations larger than that are characterized by an inability to interact meaningfully and limited interdependence (Hackman & O'Connor, 2004). Most of the research discussed in this review is limited to much smaller groups, typically consisting of 3-5 members.

We draw a distinction between a *decision*, defined as "a commitment to a course of action that is intended to yield satisfying states of affairs for particular parties" (Yates, 2003, p. 24), and a judgment, which entails an opinion about a state of affairs or future condition (Yates, 1990). Judgments can be thought of as an intermediate step leading to a decision. Judgments are the product of intelligence analysts; decisions are the product of policymakers. Furthermore, consistent with a view of groups as information processors (Hinsz, Tindale, & Vollrath, 1997), we propose that the processes that lead up to analytical judgment (e.g., generating ideas or hypotheses, sharing information about alternatives, evaluating alternatives, integrating information) are integral to understanding and improving group judgment and decision making in intelligence analysis.

2. PROCESS LOSSES

Group interaction affects both cognitive and social processes and can result in a wide range of process losses. Process losses are a function of what individuals bring to the group and what occurs during group interaction. Below we delineate some of the most robust and well-understood process losses relevant to the work of intelligence analysts and we review hypothesized causes of these phenomena.

PRODUCTIVITY LOSSES IN BRAINSTORMING

Intelligence analysts are called on to provide warnings or forecasts to policy officials. Successful forecasting requires creativity - generating novel ideas, using unconventional approaches, and an ability to think outside the box to reliably hypothesize about a surprise attack, a government collapse, or other events that should inform policymaking and policy planning. Conversely, the failure to generate ideas can have significant negative consequences. Deficiencies in imagination left the Intelligence Community unprepared to anticipate the surprise attacks at Pearl Harbor, the Yom Kippur War, and September 11 (The 9/11 Commission, 2004; Bruce, 2008).

Many types of groups in organizations, including those in the Intelligence Community, rely on brainstorming for idea generation. In the original method of brainstorming proposed by Osborn (1957), groups were instructed to generate as many ideas as possible, generate unusual ideas, combine and improve on others' ideas, and withhold criticism of others' ideas. An underlying assumption of this approach is that generating more ideas increases the chance of generating creative and high quality ideas.

Research on brainstorming, however, has demonstrated repeatedly that interacting groups produce fewer ideas than the same number of individuals working alone (called "nominal" groups; see Diehl & Stroebe, 1987, for a summary of this work), an effect that is small for dyads but increases with group size (Mullen, Johnson, & Salas, 1991; Nijstad, Stroebe, & Lodewijkx, 1999). However, people in a variety of groups and

organizations continue to believe that generating ideas in interacting groups is more effective than individual brainstorming (e.g., Paulus & Dzindolet, 1993; Paulus, Dzindolet, Poletes, & Camacho, 1993); a phenomenon that has been labeled "the illusion of productivity" (Paulus et al., 1993) and "the illusion of group effectivity" (Stroebe, Diehl & Abakoumkin, 1992).

Initially, researchers attributed the productivity loss in brainstorming groups to: (a) evaluation apprehension, or the idea that individuals felt inhibited from sharing ideas in a group setting due to concerns about negative evaluations (despite instructions to withhold criticism); or (b) the tendency for members to free ride on the efforts of others because their contributions were less identifiable and more dispensable in interacting groups than in nominal groups. However, in their seminal research, Diehl and Stroebe (1987) demonstrated that the productivity loss is caused by a phenomenon called *production blocking*. That is, listening to others and waiting for one's turn to speak in interacting groups blocks the production of new ideas among participants (see also Nijstad, Stroebe, & Lodewijkx, 2003). Although exposure to others' ideas can be cognitively stimulating (Dugosh, Paulus, Roland, & Yang, 2000; Nijstad, Stroebe, & Lodewijkx, 2002) and can enhance productivity in some conditions (such as in electronic brainstorming, e.g., Dennis & Valacich, 1993; Gallupe, Cooper, Grisse, & Bastianutti, 1994; Straus & McGrath, 1994), production blocking overrides these gains in groups interacting orally.

Following Hackman's (1987) call to identify ways in which groups can achieve positive, synergistic effects rather than simply reduce process losses, a number of studies have examined how to make brainstorming groups more effective. For instance, several studies have found that using a trained facilitator can eliminate productivity losses in interacting groups and, in some cases, make them more productive than nominal groups (Kramer, Fleming, & Mannis, 2001; Offner, Kramer, & Winters, 1996; Oxley, Dzindolet, & Paulus, 1996). Choi and Thompson (2005) investigated the effects of changes in membership on creative processes in interacting groups. Their hypothesis, that membership changes would enhance creativity, was based on previous research

demonstrating that changes in composition increase diversity in a group's knowledge base and serve as a stimulating event that brings about social change. In a study of 3-person teams, they found that groups that experienced a change in membership generated more unique ideas and more diverse ideas when compared with groups that experienced no membership change. In addition, they showed that the productivity of the newcomers accounted for the positive impact on group creativity and stimulated increased creativity of the "oldtimers", i.e., the members that remained in the groups.

THE COMMON KNOWLEDGE EFFECT

The complexity of intelligence problems requires input from analysts with a broad range of knowledge. In intelligence analysis, diversity in expertise often is achieved by including participants from different agencies or different components from the same agency – including ones that may have conflicting viewpoints. Although group outcomes can benefit from diverse perspectives and expertise, groups frequently fail to capitalize on their intellectual assets. Relevant information that is held by a minority of group members (unshared or unique information) often fails to be introduced into the group discussion, and when it is mentioned, it often is overlooked. Groups are more likely to mention and discuss information that is common among all group members (shared information). This well-replicated phenomenon is called the *common knowledge effect* (Gigone & Hastie, 1993).

In their landmark study, Stasser and Titus (1985) presented four-person groups with information about three hypothetical candidates for student body president using a *hidden profile* paradigm (Stasser, 1988). In a hidden profile, information about alternatives is distributed such that no one member can determine the best alternative; information must be exchanged to detect the optimal solution. Stasser and Titus distributed information about each candidate so that it was either shared (all group members had all information about each candidate) or unshared (each person had partial information, although when aggregated the group had full information, i.e., a hidden profile). They found that shared information tended to dominate decisions, even when unshared

information favored another option. Likewise, groups decided in favor of the candidate supported by the shared information rather than selecting the most qualified candidate. Subsequent research has revealed that groups rarely solve hidden profiles; instead, they select the alternative that is supported by the shared information, even when all of the unshared information is introduced into the discussion (e.g., Gigone & Hastie, 1993; Greitemeyer & Schulz-Hardt, 2003).

As discussed by Kerr and Tindale (2004), there are several reasons why groups focus on shared information. First, shared information is more likely to be mentioned because more members have this information, and therefore it is more likely to be sampled than is unshared information (e.g., Stasser & Titus, 1985, 1987; Larson, Foster-Fishman, & Keys, 1994).[4] Second, discussing shared information is socially validating. Group members tend to prefer exchanging shared information because they are perceived more favorably when they discuss information that others already know (Wittenbaum, Hubbell, & Zuckerman, 1999). Third, most group members enter the discussion with preferences that are supported by shared information — information that does not necessarily favor the optimal solution. The group discussion and decision are subsequently biased toward these preferences (e.g., Gigone & Hastie, 1993, 1997; Greitemeyer & Schulz-Hardt, 2003; Greitemeyer, Schulz-Hardt, Brodbeck, & Frey, 2006). Because the optimal solution in a hidden profile situation is not apparent to individuals prior to group discussion, it is unlikely that members will prefer this alternative or exchange information that supports it; they also de-value information that is inconsistent with the preferred alternative. Finally, a number of different lines of research show that people resist changing their initial judgments, choices, or attitudes (Hogarth & Einhorn, 1992; Phillips & Edwards, 1966; Wright & Drinkwater, 1997) even in light of information showing that their preferences are no longer appropriate or have negative consequences (Betsch, Haberstroh, Glöckner, Haar, &

[4] The sampling explanation only partially explains the common knowledge effect because it is based on the assumption that all pieces of information are weighted equally – an assumption that is not supported by empirical studies (Gigone & Hastie, 1993).

Fiedler, 2001; Brockner & Rubin, 1985). The latter effect characterizes escalation of commitment, also discussed later in this report.

GROUP POLARIZATION

Intelligence analysts are often called to make judgments or forecasts that bear on policy events or choices that involve considerable risk (Johnston, 2005). Policymakers use this intelligence information to decide on implementing more aggressive or cautious alternatives. Numerous studies show that groups tend to exacerbate attitudes held by individuals, particularly in groups that are homogeneous in prior beliefs and values (Isenberg, 1986). That is, following group interaction, a group of modestly risk-seeking individuals will became much more risk-seeking, and a group of mildly risk-averse individuals will typically yield a highly risk-averse decision (Myers & Lamm, 1976).[5] Because group-level decisions are likely to be affected by shifts in group member attitudes, the implication is that group decisions will become more extreme. The tendency for groups to make more extreme decisions is called *group polarization*, whereby group interaction leads to an amplification of the positions of group members in the direction of, and in proportion to, individuals' pre-discussion attitudes or judgments.

Researchers have proposed two explanations for the group polarization effect. The first, based on social comparison, suggests that when individuals learn the positions of other group members, they succumb to normative pressure and shift their attitudes in the direction that the group is leaning. The second, called persuasive arguments,

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[5] Originally, research suggested that groups make riskier decisions than do individuals, a process labeled "the risky shift" by Stoner (1961). Risk-seeking in groups was originally attributed to two processes. One theory suggested that working in groups creates a sense of deindividuation (Festinger, Pepitone, & Newcomb, 1952), which in turn leads to diffusion of responsibility and subsequent risky decisions. A second explanation, "risk as value", asserted that risk is positively valued in society. When discussions reveal that other group members favor a riskier option, an individual shifts his or her preference to keep up with the group. These explanations, however, could not account for later research findings showing that risk-averse individuals tend to be more caution-seeking following group interaction.

proposes that polarized arguments are made in proportion to the prior position of group members. Hence, a more homogeneous group will quickly build a weight of evidence in the direction that they initially lean. In one striking example, Sunstein, Schkade, and Ellman (2004) analyzed past rulings by Federal Court of Appeals judges. Considering the party affiliation of the appointing President, the authors found that more homogeneous panels of judges made more extreme judgments than did heterogeneous panels across a variety of judgment domains.

Research findings support both explanations for group polarization, with stronger support for persuasive arguments (Isenberg, 1986; Myers & Lamm, 1976). A more recent study by Brauer, Judd, and Gliner (1995) lends further support for the persuasive arguments hypothesis: the researchers found that greater polarization occurred when group members repeated each others' opinions about particular issues and used them in their own arguments.

CONFIRMATION BIAS

In the course of group deliberation, evidence both supporting and contradicting particular points of view will inevitably arise. In such situations, however, both groups and individuals have a disproportionate tendency to search for and focus on information that supports pre-existing hypotheses, or confirming evidence, and tend to fail to search for or give sufficient attention to disconfirming information (Heuer, 1999; Klayman & Ha, 1987; Schulz-Hardt, Frey, Luthgens, & Moscovici, 2000; Skov & Sherman, 1986). Johnston's (2005) interviews reveal the pervasiveness of confirmation bias among intelligence analysts. For example, in the run-up to Operation Iraqi Freedom, especially in the failed October 2002 NIE on Iraqi weapons of mass destruction (WMD), analysts tended to view all available evidence, including ambiguous and even contradictory evidence, as confirming support for the view that Saddam Hussein was hiding a robust program on WMD (WMD Commission Report, 2005).

One consequence of confirmation bias is that individuals or groups often make decisions based on incomplete information. Studies of hidden profiles show that the resistance against disconfirming evidence can be

so strong that groups typically fail to select the optimal solution even if presented with a sufficient amount of unshared information to solve the hidden profile (Greitemeyer & Schulz-Hardt, 2003). In addition, this biased information search tends to lead individuals (or groups) to unwarranted confidence in their stated hypothesis (an issue addressed later in this report).

The confirmation bias may be due to a more basic tendency to seek out instances where events occur, rather than where they do not occur (Klayman & Ha, 1987; Wason, 1960).[6] The search for confirming evidence occurs both in stages of hypothesis generation and after decisions have been made (Fischhoff, 1975; Tetlock, 2005), which serves to justify such decisions.

One factor that appears to inhibit confirmation bias in groups is the relative diversity of prior opinions in the group. For instance, Schulz-Hardt, Jochims, and Frey (2002) asked respondents to assess the validity of a hypothesis about whether a new corporate opportunity was a good investment. They found that groups that were naturally heterogeneous (i.e., came to the group with different opinions) requested less confirming evidence and more disconfirming evidence than did individuals, homogeneous groups, and groups with "contrived" heterogeneity (i.e., were homogeneous in prior opinion but were instructed to use a devil's advocacy procedure to create dissent).

OVERCONFIDENCE

High confidence frees people to act based on their knowledge (or other perceived abilities), whereas low confidence breeds caution (and rightly so). In intelligence analysis, where information is often accompanied by high degrees of uncertainty, knowing how much one truly

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[6] In one of the earliest experiments demonstrating confirmation bias, Wason (1960) presented subjects with a sequence of three numbers, i.e., 2 4 6, and asked them to generate their own sequences that conformed to the same rule. Subjects were told "yes" or "no" after each rule they generated. Wason found that subjects had a very difficult time identifying the correct rule (which was "any ascending sequence"). In addition, they tended to generate sequences that conformed to their hypothesis, such as ascending even numbers, rather than rules that would disconfirm their hypothesis. Numerous subsequent studies have replicated this effect using a variety of different tasks.

knows can be a challenge. Unfortunately, individuals, including intelligence analysts (Heuer, 1999), have a tendency to overestimate the extent of their knowledge or other aspects of performance, particularly in difficult domains such as those with high uncertainty (see Yates, 1990) – a robust phenomenon called *overconfidence*. Overconfidence appears to worsen in groups, particularly when groups face situations that do not have verifiably right or wrong answers (because correctness is either value-dependent or unknowable at the time that the decisions are made; Sneizek, 1992). In fact, in some instances, groups who are wrong exhibit higher confidence than do groups who are correct (Punochar & Fox, 2004). This phenomenon is problematic because overconfident individuals may be less willing to seek out additional information or incorporate the opinions of others (Sieck & Arkes, 2005). Hence, heightened group overconfidence could stifle systematic information consideration and productive interaction, two crucial components of intelligence analysis.

Overconfidence is often measured as the difference between people's confidence, or how correct they think they are, and their actual accuracy.[7] Individuals or groups whose perceived accuracy corresponds to their actual accuracy are said to be well-calibrated. Overconfidence occurs when the difference between perceived and actual accuracy is positive.

When considering problems that do not have demonstrably correct answers (i.e., "judgment" tasks), this difference between group confidence and accuracy actually worsens as groups get bigger. Zarnoth and Sneizek (1997) presented groups of two or five individuals with performance tasks that ranged from those with an intuitive and demonstrably correct answer ("intellective" tasks; e.g., a moderately difficult math problem) to those that required greater judgment and did

[7] For example, if presented with problems that have two alternatives, one of which is correct, individuals or groups would be asked to judge the likelihood that they had chosen the correct option on a scale ranging from 50% = "just guessing" to 100% = "certain". A simple measure of overconfidence is the difference between the average score on perceptions of accuracy, or confidence, (averaged over all problems) and actual percent correct.

not have demonstrably correct answers (e.g., forecasts of future events). They found that confidence increased with group size on all tasks, but that accuracy increased accordingly only on intellective tasks. For judgment tasks, confidence increased as groups got larger, but performance did not. Hence, there was greater *over*confidence in larger groups on judgment tasks. Furthermore, both accuracy and confidence can exert forms of social influence on the group. Zarnoth and Sniezek found that highly knowledgeable or accurate individuals had greater influence on group outcomes in intellective tasks than in judgment tasks. The influence of individuals' confidence on group outcomes, on the other hand, was constant across tasks.

Group composition also appears to influence group confidence. In the study of natural and contrived dissent discussed earlier, Schulz-Hardt et al. (2002) found that groups that were homogeneous in their initial perceptions of the alternatives were more confident than were heterogeneous groups. This paralleled a confirmation-bias effect – where homogeneous groups were disproportionately more likely than were heterogeneous groups to seek out information that supported their preconceptions. Furthermore, this effect of group homogeneity on group confirmation bias appeared to work through (i.e., was mediated by) group confidence.

Examples of overconfidence (and underconfidence) have long been documented in the individual decision-making literature (Lichtenstein, Fischhoff, & Phillips, 1982; Oskamp, 1965; Yates, 1990), where it has similarly been linked to willingness to seek out and consider available information (e.g., Sieck & Arkes, 2005). This could especially plague groups if more confidently-held ideas or more confident individuals dominate group deliberations, and if such confidence does not correspond to greater accuracy (Hastie, 1986).

PRESSURES TOWARD UNIFORMITY AND GROUPTHINK

Pressures toward Uniformity

Because intelligence analysis occurs in group settings, social influence processes are inevitable. Decades of research has documented the power of groups to change the attitudes and judgments of individual

members (e.g., Asch, 1951; Lewin, 1948, 1953; Sherif, 1936). For example, in his classic study of conformity, Asch (1951) found that individuals changed their judgments to go along with the group, even in light of clear, objective evidence that the group's judgment was wrong. Not surprisingly, conformity is more extreme under more ambiguous conditions (Baron, 2005), which is characteristic of problems in intelligence analysis. Pressures toward uniformity, as well as confirmation bias, discussed earlier, also appear to be more extreme when group members consider opinions or information sequentially rather than simultaneously (Asch, 1951; Jonas, Schulz-Hardt, Frey, & Thelen, 2001). Pressures toward uniformity inhibit members from sharing dissenting information, challenging others, and considering alternative solutions or courses of action — thereby eliminating or reducing the benefits of cognitive diversity in groups.

Early work by Asch, Sherif, and others led many social psychologists to examine topics such as majority and minority influence, dissonance, obedience, risky shift, polarization, and other processes by which groups influence changes in members' attitudes (see McGrath, 2004, for a review). A series of studies by Festinger, Schachter, and colleagues investigated the hypothesis that groups create pressures toward uniformity in attitudes among members (e.g., Festinger, Schachter, & Back, 1950; Festinger, Back, Schachter, Kelly, & Thibaut, 1952; Schachter, 1951). Uniformity helps groups define their social reality, establish norms for behavior, and achieve their goals (e.g., make decisions) (e.g., Schachter, 1951). Consequently, groups exert social pressure on members who threaten consensus, particularly in cohesive groups and on matters of relevance to the group. Schachter (1951) found that group members directed more communication to dissenters (presumably in an attempt to convince them to change their opinion), but if the deviates refused to change, they were ultimately rejected by the rest of the group. More recent research shows that even brief episodes of social exclusion or rejection results in intense psychological distress (Williams, 2007). Thus, group members may go along with the group in order to avoid being ostracized.

As discussed by Hollingshead (1996), group member status also is associated with conformity responses. In comparison to high status members, lower status members care more about social acceptance (Humphreys & Berger, 1981), participate less in group discussions, and have less influence (Bonito & Hollingshead, 1997). Lower status members also are more likely to focus on shared information (Wittenbaum, 1998). These dynamics are particularly problematic when lower status members hold critical information. In these cases, mixed-status groups make poorer decisions than do groups with uniform levels of status (i.e., uniformly low-status groups) (Hollingshead, 1996).

Groupthink

The idea that group cohesion creates pressures toward uniformity is one of the underlying tenets of Janis's theory of *groupthink* (Janis, 1972, 1982; Janis & Mann, 1977). Janis's theory is perhaps the most well-known application of psychological principles to policy decision-making groups. It has wide appeal in the popular press and is cited extensively in scholarly publications and in social psychology and management textbooks (see Baron, 2005). It also has been identified as a major cause of intelligence failures, such as faulty conclusions concerning Iraqi WMD in 2002 (Senate Select Committee on Intelligence, 2004) and a number of foreign policy fiascos (Janis, 1982).

Janis posited that strong group cohesion is the primary antecedent for groupthink. However, groupthink is likely to occur only when highly cohesive groups operate under other group and situational conditions. These secondary antecedent conditions include high levels of stress, a directive leader, insulation from outside expert opinions, a lack of norms for systematic search and evaluation of information, and low member self-esteem or confidence. According to Janis, these antecedents lead the group to seek concurrence, which in turn leads to symptoms of groupthink. Symptoms of groupthink include a sense of invulnerability of the group, a belief in the inherent morality of the group, stereotypes of outgroups, collective rationalization, pressure on dissenters, self-censorship, and self-appointment of mindguards who shield the group from outside sources of dissonant information. These symptoms, in turn, lead to defective decision making processes, such as

failure to conduct a comprehensive search and evaluation of alternatives, confirmation bias, and a failure to develop contingency plans.

Despite the widespread acceptance of groupthink as valid by both lay and academic audiences (e.g., see Baron, 2005; Fuller & Aldag, 1998; Turner & Pratkanis, 1998a), the model has been called into question by numerous social psychologists (e.g., Baron, 2005; Esser, 1998; Fuller & Aldag, 1998; Kerr & Tindale, 2004; Longley & Pruitt, 1980; McCauley, 1989; Turner & Pratkanis, 1998b; Whyte, 1998). This skepticism is due, in part, to (a) the methods used to evaluate groupthink; and (b) to the lack of support for basic principles of the model from more rigorous research approaches. Historical case studies have found support for some aspects of groupthink (e.g., see Turner & Pratkanis, 1998a), but this approach has generally involved analysis of failed policy decisions, which is subject to selection biases (Fuller & Aldag, 1998). Controlled experiments, which are needed to demonstrate the causal relationships among constructs in the model, are relatively scarce (which is particularly surprising in light of the widespread impact of the model). Results of laboratory experiments testing the effects of cohesiveness – the principal antecedent of groupthink – on group processes and decision quality are mixed and often inconsistent with predictions of the groupthink model (e.g., Flowers, 1977; Hogg & Hains, 1998; Mullen, Anthony, Salas, & Driskell, 1994).

There is little question that many of the dynamics described by Janis are associated with ineffective decision process and outcomes. As we have described in this report, processes such as confirmation bias, group polarization, pressures toward uniformity, and conformity to group pressures can precipitate poor decisions. However, these sorts of phenomena do not support the groupthink model given that they often occur in absence of antecedents and symptoms of groupthink. Similarly, purported antecedent conditions of groupthink (e.g., cohesiveness, stressful conditions) do not necessarily lead to defective group processes or outcomes.

Whereas some scholars have recommended abandoning the groupthink model (Fuller & Aldag, 1998), others have called for the need for

revisions to the theory (e.g., Baron, 2005; Flowers, 1977; Turner, Pratkanis, Probasco, & Leve, 1992; Turner & Pratkanis, 1998b; Whyte, 1998). Although a review of alternatives models is beyond the scope of this report, we note a couple of examples here. For example, Whyte (1998) proposes that the primary antecedent of groupthink is unrealistically high collective efficacy, i.e., the collective belief about the group's ability to successfully perform a task. He argues that in response to an aversive event, groups frame alternatives as losses, which in turn leads to risk-seeking. These effects, in combination with structural faults of the organization, lead to concurrence seeking and polarized group decisions, resulting in defective decisions. In the Intelligence Community, Davis (2008) posits that analysts are often reluctant or unable to introduce new information due to three types of conformity pressure, including pressure in the form of a veteran manager who exhibits excessive caution or inertia; the presence of a coalition of analysts who are psychologically invested in a paradigm (a phenomenon that may share common features with confirmation bias or overconfidence); and situations in which groups have attained hard-won consensus on a controversial issue and do not want to risk losing it. Davis also identifies the potential for politicization and external pressures on analysis. These occur in the form of implicit or explicit messages from senior policymakers that intelligence contrary to an emerging policy line may be received as unwelcome or counterproductive. Empirical research is needed to validate these alternative explanations for conformity in intelligence analysis teams.

INTERDEPENDENCIES AMONG PROCESS LOSSES

The process losses we have reviewed are not independent phenomena. For example, by withholding unshared information, group members may fail to introduce disconfirming evidence into the discussion; likewise, the tendency to search for confirming information may reduce the likelihood that unshared information is mentioned and discussed. Thus, the common knowledge effect may exacerbate confirmation bias. Confirmation bias and the common knowledge effect may intensify group polarization, since

by the persuasive arguments explanation, group members will already be disproportionately arguing for their own prior opinions. If the group is relatively homogeneous, these arguments will already be one-sided (and hence confirming). To the extent that shared information favors an extreme alternative, the common knowledge effect also may produce more polarized judgments. Group discussions that are biased toward shared and confirming evidence may falsely reinforce commonly - and strongly-held – beliefs, leading to overconfidence in those beliefs. Overconfidence is also connected to escalation of commitment — the tendency to persist in a course of action despite evidence against it (i.e., throw good money after bad; Bazerman, Guiliano, & Appelman, 1984). In short, these processes can be mutually reinforcing, resulting in more extreme group performance – either negative or positive. When one type of loss is present, there is a greater likelihood that the group will experience other losses; conversely, when groups are able to avert one type of loss, they may be less prone to developing others, and they stand a better chance of exhibiting process gains.

3. IMPROVING GROUP PROCESSES

Whereas some of the process losses we have describe have different underlying causes, they tend to reflect the tendencies for groups to fail to *identify, generate, share, integrate, and apply dissenting information*. A common theme in the research on small groups is that dissent can reduce some of these sub-optimal processes (e.g., Brodbeck, Kerschreiter, Mojzisch, Frey, & Schulz-Hardt, 2002; De Dreu & De Vries, 2001; Moscovici, 1985; Moscovici & Nemeth, 1974; Nemeth, 1986; Schulz-Hardt, Brodbeck, Mojzisch, Kerschreiter, & Frey, 2006; Winquist & Larson, 1998). Likewise, experts in intelligence analysis call for a change in the Intelligence Community's mindset from a culture that is resistant to change, to one that encourages and values questioning of the status quo, constructive criticism, and investigating alternative solutions (e.g., Barger, 2005; Bruce, 2004). There are a number of strategies that groups can use to increase dissent and enhance the identification, discussion, and use of divergent information. We classify these strategies into three categories consisting of modifications of group structure, adoption of specific procedures, and facilitation and training.

MODIFYING GROUP STRUCTURE

The group structure can be modified by changing the team's composition, member roles, and size.

Perhaps one of the most powerful structural interventions that can promote the generation and use of divergent information is to compose groups to be heterogeneous in the opinions and expertise that they bring to the team. For instance, composing groups with members who are likely to have diverse opinions prior to group interaction can increase the range of perspectives discussed (Isenberg, 1986; Myers & Lamm, 1976; Sniezek, 1992) and reduce confirmation bias (Schulz-Hardt et al., 2002).

Even if groups are composed to be heterogeneous, the benefits for judgment and decision making may be short-lived. As groups work together over long periods of time, they tend to become more homogeneous

in their opinions and perspectives (Dunbar, 1995; Gruenfeld, Mannix, Williams, & Neale, 1996; Katz, 1982; Phillips, Mannix, Neale, & Gruenfeld, 2004). Thus, another strategy for increasing diversity in groups is to bring in members from other teams. Choi and Thompson (2005), discussed earlier in this report, found that membership changes helped interacting brainstorming groups be more productive and creative. (They recommend bringing in experienced group members, because novices often lack relevant skills and therefore undermine the group's ability to perform its task.) In fact, some organizations intentionally vary composition to enhance innovation in groups (e.g., Ancona, Bresman, & Kaeufer, 2002; Ancona & Caldwell, 1998). However, as we discuss later in this report, organizations must be prepared to deal with potential negative consequences of increasing cognitive diversity in groups.

Groups can also modify their structure to increase cognitive diversity by creating and emphasizing member roles. For instance, Stewart and Stasser (1995) found that the common knowledge effect was reduced when they assigned members to various information roles within the group and ensured that everyone was aware of each member's area of expertise. In extant groups, differentiated roles may occur naturally via variation in members' functional specialties, or they can be created (e.g., by having each member research a different problems, provide evidence for a different hypothesis, etc.). Whether these roles are natural or contrived, members should be made aware of each others' expertise.

Assigning group members to serve as the devil's advocate also can help groups question their positions and stimulate divergent thinking, particularly in the absence of natural heterogeneity in groups (Schulz-Hardt et al., 2002; Schweiger, Sandberg, & Ragan, 1986). A related technique is to rotate roles advocating for particular hypotheses or alternatives. Greitemeyer et al. (2006) assigned members to present the evidence for different decision options and rotated those roles so that each member had a turn representing every alternative. In contrast to using fixed roles, rotating advocacy positions prevents members from selecting information that supports only one alternative.

Finally, whereas there is no known optimal number of members in a group, organizations should avoid composing groups that are so large that they preclude true interdependence and meaningful interactions among members. Some of the research reviewed in this report also indicates that overconfidence is exacerbated in larger groups.

One technique that is specific to idea generation is to use small groups (no more than four members) (Nijstad et al., 1999). Nijstad et al. found that smaller groups had reduced productivity losses yet still experienced some of the positive outcomes that arise from participating in groups, including high levels of persistence and satisfaction. However, small groups may not bring sufficient diversity in expertise to deal with complex problems. Other techniques to enhance productivity in idea generation are discussed in the following section.

PROCEDURES

Studies show that even simple procedures or instructions to groups can enhance information sharing and the quality of collective analyses and decisions (e.g., Henry, 1995; Okhuysen, 2002). There are a number of procedures or protocols for reducing process losses that have been examined in controlled studies of groups. For instance, productivity in brainstorming groups can be enhanced by using methods that do not require group members to take turns. Examples include brainwriting (Paulus & Yang, 2000) in which group members write their ideas on slips of paper and exchange them in a round-robin fashion, and electronic brainstorming (e.g., Dennis & Valacich, 1993), which is a computerized version of brainwriting.

Other procedures can be used to increase identification, exchange, and consideration of diverse information, thereby reducing process losses such as the common knowledge effect, conformity, polarization, and overconfidence:

- restricting group members from stating their preferences until all known relevant information about alternatives has been shared (e.g., Greitemeyer et al., 2006; Sawyer, Houlette, & Yeagley, 2006) can reduce biased information search and

conformity and can increase presentation and discussion of divergent information and foster decision accuracy;

- encouraging group members to present or consider opinions or information simultaneously rather than sequentially can reduce pressures toward uniformity and confirmation bias (Asch, 1951; Jonas et al., 2001);
- framing the discussion as a problem to be solved rather than as a decision to be made (Stasser & Stewart, 1992) can increase the exchange of unshared information;
- extending discussion time can increase the presentation of divergent information (Larson et al., 1994, 1996) because unshared information tends to be mentioned later in the discussion. This method can be particularly effective in combination with rotating advocacy, describe earlier (Greitemeyer et al., 2006);
- requiring individuals to consider more alternatives and unexpected outcomes (e.g., Koriat, Lichtenstein, & Fischhoff, 1980; Ronis & Yates, 1987) can improve calibration (reduce overconfidence) and may reduce confirmation bias;
- instructing group members to question each other about possible causes of the problem being analyzed can enhance knowledge integration among members with specialized knowledge (Okhuysen & Eisenhardt, 2002);
- requiring individuals to make judgments about their level of uncertainty prior to group interaction and presenting this information to the group can result in superior calibration (Sniezek & Paese, 1989; cited in Sniezek, 1992);
- avoiding a norm or mandate for groups to reach consensus may reduce conformity among minority factions and a reluctance to mention divergent information, as the short-term pressure to achieve consensus may outweigh longer-term desires to improve decision making (Loewenstein, 1996; Thorne, Massey, & Jones, 2004).

Studies of small groups often treat group activities such as generating ideas, solving intellective problems, and making judgments as

discrete tasks. There is good reason for this approach, as it enables researchers to isolate and test underlying processes and interventions. In extant groups, however, these tasks are not independent; rather, they tend to occur in a nonlinear, iterative cycle (Treverton, 2001). Structured methods involve techniques to improve information gathering and use for a range of tasks that occur in analytical teams.

The Delphi method (e.g., Dalkey & Helmer, 1963) and the Nominal Group Technique (Delbecq & Van de Den, 1971) are two well-known methods for structuring group interaction. By disassociating members' ideas or judgments from their advocates, these methods attempt to eliminate some of the pitfalls of unstructured face-to-face discussions, such as social influence and conformity. Both methods require direction by a facilitator. The Delphi method is an iterative approach used to attain consensus and improve accuracy among experts' estimates or predictions of quantitative judgments. It was developed at RAND in the early 1950s to forecast bombing targets but has since been applied in thousands of studies across a variety of domains. The Delphi method involves no direct interaction. Participants provide estimates anonymously; their judgments are combined (e.g., averaged) and subsequently fed back to the group members. This process is repeated until some criterion, such as consensus, is met.

The Nominal Group Technique (NGT) is a multi-step process that was designed to enhance identification and evaluation of problems or ideas. In the first step, group members generate ideas (or plans or judgments) individually. Group members then collectively list their ideas in a round-robin fashion. When all ideas have been presented, the group discusses them for purposes of evaluation. In the final step, members independently vote on priorities for the group. The pooled ratings or rankings determine the group's decision.

Although a review of research on these techniques is beyond the scope of this report, we note that studies comparing the Delphi technique with other methods (e.g., unstructured group discussions) have produced mixed results. Whereas numerous studies report benefits of using the Delphi method, a systematic comparison of approaches by Rohrbaugh (1979) found that it did not do better than the second best

individual in the group and it did much worse than the best member's judgment. Thus, the Delphi technique did not fully eliminate process losses. Based on published reports, use of the NGT is far less prevalent, although there is some evidence that groups using the NGT perform as well as their best member in judgment tasks (Rohrbaugh, 1981). We also note that by using nominal groups (i.e., having individuals generate ideas independently), the NGT should reduce or eliminate production blocking.

The Intelligence Community also has developed a number of structured analytical techniques, or "tradecraft," to facilitate analytic tasks. For example, analysis of competing hypotheses (ACH; Heuer, 1999) encompasses generating ideas (hypotheses), identifying and evaluating evidence, and drawing conclusions. By explicitly requiring participants to consider and evaluate all available evidence and how well or poorly different evidence matches up with alternative hypotheses, ACH may counteract process losses such as confirmation bias, suppression of unshared information, conformity, and overconfidence. ACH, as well as other structured analytic techniques, are intended to help analysts overcome cognitive limitations imposed by *mindset*, or mental models that are inherent in the analytical process. Whereas mental models are necessary to conceptualize reality, they also can cause analysts to ignore, overlook, exaggerate, or distort data and information used in assessing intelligence problems. Analysts who do not guard against mindset traps (cognitive vulnerabilities) increase their likelihood of producing faulty analysis.

Is there any evidence that such techniques actually work? And do they work in intelligence analysis? Heuer (personal communication, January 29, 2008) argues that structured techniques have face validity, as they were developed precisely to mitigate weaknesses in non-structured interactions. While the techniques do not guarantee a correct judgment, they do help ensure that alternative voices are heard and seriously considered when making the judgment. Based on his preliminary research, Heuer (2007) concluded that "the use of any structured technique improves the quality of analysis as compared with

analysis by a single individual or by a group that does not use a structured process" (p. 26).

Of course, empirical studies are needed to assess the extent to which these methods improve group processes as well as the comparative value of these techniques. A study of ACH at the DIA represents an early effort to examine structured analytic techniques in a controlled setting (Folker, 2000),[8] but experimental and field research on these techniques in the Intelligence Community is in its infancy. As noted earlier, there have been studies of some of these methods in other domains. In a controlled study of devil's advocacy, Schulz-Hardt et al. (2002) found that composing groups to be naturally heterogeneous in opinion ("genuine dissent") was more effective than appointing a devil's advocate ("contrived dissent"); however, in homogeneous groups, devil's advocacy resulted in more balanced information search compared to using no discussion procedure. Schweiger et al (1986) compared devil's advocacy, dialectal inquiry, and consensus approaches to decision making.[9] They found that groups using devil's advocacy and dialectal inquiry generated higher quality decisions than consensus groups.[10] Finally, as we have reviewed in detail, interacting groups engaged in unstructured brainstorming exhibit productivity losses, although structured methods, such as the NGT, brainwriting, and electronic brainstorming, can overcome these losses.

FACILITATION AND TRAINING

Although we have not reviewed the vast literature on leadership, some of the studies included in this report speak to the importance of the role of group leader or facilitator in helping groups achieve more effective analytical processes. Providing trained facilitators can help

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[8] This experiment compared two groups: one using a structured analytic technique and another using unstructured techniques. While the results provide some support for structured techniques, the findings are open to question given methodological issues in the study.

[9] In devil's advocacy, a group member or subgroup critiques the group's arguments, whereas in dialectical inquiry, the group member or subgroup critiques the arguments and proposes counterarguments.

[10] Groups using dialectal inquiry generated more valid assumptions than did groups using devil's advocacy, although there were no differences between these groups in the quality of their decisions.

groups overcome productivity losses in interactive brainstorming. In other types of tasks (e.g., discussing and evaluating alternatives, solving problems, making decisions), leaders or facilitators can help groups be more effective by focusing on the decision process rather than the content of the decision (Hackman & Woolley, in press; Peterson, 1997). In a series of studies using multiple types of groups, including real policy decision teams, Peterson (1997) concluded that leaders who focus on how decisions are made rather than the content of the decisions engender better group processes and outcomes. In particular, leaders who encourage open discussion and dissent are likely to enhance the expression of divergent information and improve group decision quality. In contrast, leaders who focus their attention on the substance of the group decision are most likely to lead their groups to poorer decisions.

Perhaps more important, leaders play a crucial role in designing an effective group structure and ensuring that the group's context supports its goals (Wageman, 1997). Hackman (1987; 2002) has identified key design factors contributing to effective teams, including whether the group:

- is a real team, i.e., members are interdependent and membership is stable;
- has a clear and compelling purpose;
- has a facilitating structure in terms of task design, team composition, and group norms;
- works in an organizational context that provides rewards, information, training, and material resources to support desired behaviors; and
- has a coach who is expert, available, and helps the group focus on effective task processes.

To the extent that the first four design factors are present, and team leaders exhibit positive coaching behaviors, teams will be more capable of self-management and will engage in higher quality group processes (Wageman, 2001).[11] [12]

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[11] Self-management reflects the extent to which the team takes collective responsibility for work outcomes, actively seeks information about its performance, and manages its own process by taking the

Finally, formal training can help group members learn to engage in more effective interactions. Formal training in analysis at such facilities as CIA's Sherman Kent School of Intelligence Analysis, and the Office of the DNI's recent Intelligence Community training initiative "Analysis 101," will reduce past reliance on on-the-job training, an earlier deficiency noted by Johnston (2005). Still, these efforts do not presently appear to include training in group approaches to analysis. We believe that this kind of training could appreciably improve intelligence analysis. Some studies show that process losses can be reduced by training group members to avoid common pitfalls of group analysis. For example, Larson et al., (1994) found that groups that were trained to engage in strategic planning for their discussions and to be more vigilant to information exchanged more unshared information than did groups without training. Woolley, Gerbasi, Chabris, Kosslyn, & Hackman (2007) reported that groups who received training in effective collaboration strategies outperformed untrained groups on an analytical task involving a counterterrorism scenario. The effect of the control condition (no training) was especially pronounced for teams that were composed of members with specialized expertise (compared to teams of average ability), which suggests that higher ability teams without collaboration training had difficulty recognizing the expertise in their groups.

SOME BOUNDARY CONDITIONS

It should be noted that techniques to increase dissent in groups can have negative consequences. For instance, membership changes, while promoting divergent thinking, are at odds with creating stable, bounded

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initiative to solve problems and enhance its capability to work as a team (Wageman, 2001).

[12] Effective team design is a critical factor in group performance. Wageman (2001) found that effective coaching has a bigger (and positive) impact on well-designed teams than on poorly-designed teams, whereas ineffective coaching has a greater negative impact on poorly-designed teams than on well-designed teams. Thus, good leaders can not overcome the effects of poor team design, but well-designed teams can withstand the effects of poor leadership.

groups (Hackman, 2002; Hackman & O'Connor, 2004). Changes in composition require group members to spend time and effort training and socializing newcomers (Moreland & Levine, 1982) and can disrupt mechanisms that help groups process information and coordinate their actions, such as transactive memory systems (Argote, Moreland, & Krishnan, 1996) and shared mental models (Cannon-Bowers & Salas, 2001). In addition, groups prefer to work in more homogeneous teams; they would rather discuss shared versus unshared information; they suppress divergent information to avoid social exclusion (particularly lower status members, even if they hold critical information); they prefer consensus to conflict; and they are uncomfortable dealing with uncertainty in alternatives. Strategies designed to increase cognitive diversity in groups often result in reduced cohesion, greater conflict, and reduced member satisfaction (e.g., Moreland, Levine, & Wingert, 1996; Schultz-Hardt et al., 2002; Schweiger et al., 1986; Williams & O'Reilly, 1998; see also Mannix & Neale, 2005).

Nonetheless, groups in organizations are not static entities. They often have permeable boundaries (e.g., Ancona et al., 2002; Ancona & Caldwell, 1988), and changes in membership due unplanned events are inevitable. Therefore, we argue that group members must be prepared to deal with such disruptions and to understand how altering composition and other techniques that create dissent can have positive outcomes. This raises the point that like process losses, measures to improve group processes are not independent. For example, composing groups to be heterogeneous or using a devil's advocacy procedure may be counterproductive if appropriate supporting conditions are not in place. However, if groups have clear norms that value cognitive diversity and access to coaches who can help them engage in effective task strategies (e.g., Hackman, 2002; Hackman & Woolley, in press), they can adapt to – and make the most of – techniques and events that result in divergent views. (See also Mannix and Neale, 2005, for ways to reap the benefits of diversity in teams).[13]

[13] At the same time, there are boundary conditions to the value of dissent; it should not be encouraged to the point of causing

4. SUMMARY AND DIRECTIONS FOR FUTURE RESEARCH

In this report, we reviewed a number of common and well-understood process losses in groups including the common knowledge effect, productivity losses in idea generation, group polarization, confirmation bias, overconfidence, and pressures toward uniformity. Whereas the particular dynamics underlying some of these processes may differ, several of these phenomena share similar properties in that they concern failures of group members to adequately collect, generate, share, integrate, or apply task-relevant information. Many of the strategies designed to reduce these losses also have similar goals in that their aim is to enhance the identification and use of information by creating or bringing out divergence in groups.

The majority of studies we reviewed are based on controlled experiments. This method allows researchers to cleanly identify and demonstrate process losses and isolate their underlying causes. Thus, we have confidence in the internal validity of the findings. In addition, the process losses (and countermeasures) we have reviewed here have been well-replicated using different types of research participants and a variety of problems or scenarios. [14] Therefore, we also have a reasonable degree of confidence in the external validity of these phenomena.

Given that intelligence analysis consists largely of cognitive tasks, and such tasks are often conducted in interdependent groups, we also anticipate that these processes will generalize to intelligence analysis teams. At the same time, research is needed to test the external validity of these findings and identify potential moderating and boundary conditions of these phenomena for intelligence analysis

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divisiveness, and there are some conditions (e.g., acute time pressure) where it must be used with discretion (Peterson, 1997).

[14] Although the majority of the studies we have reviewed use student participants, a number of studies use non-student samples. Examples include Hackman & O'Connor, 2004; Larson et al., 1996; Peterson, 1997; Schulz-Hardt et al., 2000, 2002; Sunstein et al., 2004; and Wageman, 2001.

teams. Heurer (personal communication, January 29, 2008) argues that any program of empirical testing of structured techniques needs to take into account the level of skill that is required for the technique, the skill level of the study participants, how the technique is applied in intelligence, and the environment for which the technique was developed. Likewise, Johnston's (2005) rich analysis suggests that some aspects of the context in which analysts operate may uniquely affect how they collect, share, and use information. Johnston argues that the cognitive demands in intelligence analysis are distinct from those in other complex, high-risk professions (e.g., surgical teams or astronaut crews) because analysts constantly face adversaries who attempt to conceal or manipulate information. This situation is exacerbated by operating under conditions of secrecy, which ultimately limits access to information that is needed to make accurate predictions. Cultural values that favor secret information further aggravate this situation; although classified information is often screened or filtered before it reaches analysts, Johnston found that analysts frequently view it as somehow better or more meaningful than open source information.

Johnston also identified other characteristics of analysts' jobs that are likely to affect how information is identified and used. Analysts often operate in dynamic situations and face substantial time pressure. Some analysts in Johnston's study reported that their work is largely reactive; they do not have the time to be strategic, nor do they have the time to engage in formal analytic methods such as ACH or red team exercises. Analysts also make judgments and analytical decisions where the consequences of failure are potentially great. Therefore, there are intense organizational pressures to avoid failure. Political forces intensify these pressures (see also Davis, 2008). Changing an opinion or hypothesis can lead to a loss of trust or respect within the group and perceptions of incompetence and indecisiveness outside the organization, along with subsequent losses of status, funding, or access to policymakers (Johnston, 2005).

Intelligence analysis teams also may differ in other ways from the types of groups that are prevalent in psychological research. Most of the psychological studies reviewed in this report used 3- or 4-person

groups, whereas intelligence analysis teams may be substantially larger. Although not a focus of this review, group size can affect processes and outcomes such as overconfidence, group cohesion, deindividuation, satisfaction, and productivity (Mullen & Copper, 1994; Mullen et al., 1991; Valacich, Dennis, & Nunamaker, 1992; Zarnoth & Sniezek, 1997). In addition, a number of these studies rely on groups working over relatively short periods of time. Studies that have used repeated trials or longitudinal designs show that experience or time makes a difference for group processes and outcomes (e.g., Greitemeyer et al., 2006; Hollingshead, McGrath, & O'Connor, 1993; Wilson, Straus, & McEvily, 2006). The experience of members of real teams, both with each other and with the task, as well as a high level of engagement or commitment to the task, may produce different results.

In sum, research is needed to determine the extent to which common process losses occur in intelligence teams and the conditions that reduce or exacerbate these problems. To determine a starting point for such research, ideally one would consider the magnitude and reliability of the research findings. Magnitude is conveyed by statistical effect sizes and by meta-analyses. However, effect sizes are rarely reported in psychological studies (Fidler, Thomason, Cumming, & Leeman, 2004), and we are aware of few meta-analyses on process losses.[15] Reliability is conveyed by the replicability of research findings. The process losses discussed here were selected because they are well-replicated, well-understood, and relevant to analysis. Among the processes we have reviewed, those focusing on purely group effects, such as production blocking, the common knowledge effect, group polarization, and pressures toward uniformity, have received the greatest attention in the research literature, with many studies demonstrating each. Group amplifications of individual-level phenomena (see Sunstein, 2006), including confirmation bias and overconfidence, have extremely rich research

[15] Meta-analysis provides information about the importance of a phenomenon by combining the results of many studies to identify common trends. Effect size is a common metric used in meta-analysis. We are aware of only two meta-analyses on process losses; the aforementioned studies by Mullen et al. (1991) on production blocking in brainstorming and by Isenberg (1986), who showed the magnitude of group polarization.

traditions in the study of individual decision making, but are relative newcomers to group-level studies, and hence have less of a group-level track record.

In addition to assessing the incidence of process losses, we propose a number of research questions regarding how inputs to the group affect interaction and outcomes in intelligence analysis, including:

- What is the effect of diversity in members' knowledge and skills on information identification, knowledge sharing, and opinion change in the group?
- How do characteristics of individuals in the group, such as longer tenure, higher status, or affiliation, affect changes in members' judgments?
- What is the effect of group size on processes and outcomes in intelligence analysis teams?
- What is the effect of providing trained facilitators on group processes and outcomes in intelligence?
- Does level of classification or compartmentation affect analysts' appraisal of the validity or importance of the information? Does information source contribute to systematic biases in group judgment?
- Does pressure to avoid failure enhance or inhibit collection, sharing, and use of divergent information?
- How does group pressure to arrive at a conclusion or judgment – especially one with consensus – affect how evidence is evaluated and used?
- To what extent are the types of interventions reviewed in this report appropriate in light of the structure and culture of intelligence analyst teams?

Several different methods can be used in a program of research to examine process losses and gains, the conditions under which they are more or less likely to occur, their effects on judgments, and strategies to mitigate negative processes and foster positive ones in intelligence analysis groups:

- Perhaps the gold standard is to use controlled studies that create different conditions or interventions, such as

tradecraft techniques, and examine their effects on the content of discussions, changes in members' pre-discussion and post-discussion preferences or judgments, and members' attitudes toward the process. By using simulated tasks, effects of group processes on accuracy and overconfidence also can be assessed;

- Observations of real groups can be conducted to assess a variety of interaction processes;
- Field studies/surveys can examine outcomes such as opinion change, confidence, and member satisfaction as well as the influence of other variables, such as characteristics of members, tasks, and group structure, on these outcomes. Field studies also can be used to examine the impact of interventions, such different tradecraft techniques, on group processes and analytical outcomes;
- Interviews and focus groups with analysts can identify key individual, group, and organizational variables that affect group analytical processes and outcomes.

Each of these methods has strengths and weaknesses in terms of practicality, internal validity, and external validity.[16] The strongest approach is to use a combination of different methods and measures in a program of research. Similar or complementary findings from studies using multiple methods and measures can establish convergent validity, or triangulation of results, thereby increasing confidence in the validity of research findings. Multiple methods and measures also can serve to identify the boundary conditions for these phenomena.

This report discusses some of the most robust and well-understand processes in analytical teams. At the same time, this review scratches only the surface of the vast research on group dynamics. Other topics relevant to group analysis and decision making that merit future consideration or more in-depth assessment include: (1) minority influence; (2) transactive memory systems; (3) shared mental models; (4)

[16] For example, studying overconfidence requires information about accuracy, or a "right answer". This is not practical in field studies of group judgments about real events, as information about accuracy typically is not available. In contrast, overconfidence can be assessed in controlled experiments or experimental simulations.

judge-advisor systems; (5) group decision support systems and virtual collaboration; (6) stress and group performance, including emergency responding; (7) group composition, including changes in membership and ingroups/outgroups; (8) group facilitation; (9) leadership; (10) social networks; and (11) faulty epistemologies.[17]

Many experts argue for the need for groups to conduct intelligence analysis, but systematic studies of teams in this context are rare. Thus, the topic of group intelligence analysis is fertile ground for research, and a program of research on group dynamics in intelligence teams has the potential to make a significant impact on improving analytical processes and outcomes in the Intelligence Community.

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[17] Examples of faulty epistemologies in intelligence analysis include authority and habit-of-thought (Bruce, 2008).

APPENDIX A. ANNOTATED BIBLIOGRAPHY

General Reviews

Hackman, J. R. (1992). Group influences on individuals in organizations. In M. D. Dunnette & L. M. Hough (Eds.), *Handbook of industrial and organizational psychology* (Vol. 3, pp. 1455-1525). Palo Alto: Consulting Psychologists Press.

Hinsz, V. B., Tindale, R. S., & Vollrath, D. A. (1997). The emerging conceptualization of groups as information processors. *Psychological Bulletin, 121*(1), 43-64.

Kerr, N. L. & Tindale, R. S. (2004). Group performance and decision making. *Annual Review of Psychology*, *55*, 623-655.

McGrath, J. E. (1984). *Groups: Interaction and performance*. Englewood Cliffs: Prentice-Hall, Inc.

Sunstein, C. R. (2006). *Infotopia: How many minds produce knowledge*. New York: Oxford University Press.

Surowiecki, J. (2004). *The wisdom of crowds: Why the many are smarter than the few and how collective wisdom shapes business, economies, societies, and nations*. New York: Doubleday.

Tetlock, P. E. (2005). *Expert political judgment - how good is it? How can we know?* Princeton: Princeton University Press.

Groups in Intelligence Analysis

Hackman, J. R., & O'Connor, M. (2004). *What makes for a great analytic team? Individual vs. team approaches to intelligence analysis.* Washington, DC: Intelligence Science Board, Office of the Director of Central Intelligence.

This paper begins with the thesis that intelligence analysis involves both cognitive and social processes. The authors argue that most intelligence analysis occurs either in "coacting groups" (whereby individuals mostly operate independently and the final product is an aggregation of their individual efforts) or "interdependent work teams" (whereby team members work together closely and the final product is the result of a group effort). Analyzing survey, interview, and observational data from 64 groups across six agencies within the Intelligence Community, the authors compared the effectiveness of these two types of groups. In comparison to coacting groups, interdependent work teams were more likely to operate as a real team, have a compelling purpose, have a structure that facilitated team work, and have access to

competent team coaching (often peer coaching rather than coaching from a leader). Thus, interdependent work teams were more likely to exhibit characteristics of effective teams. However, designing and managing these groups well can be difficult, and they are not appropriate for all types of tasks. The authors discuss different types of work teams and the tasks for which each might be appropriate. They emphasize that coacting groups are appropriate for certain tasks, such as those in which the work can be divided up among team members and there is little need for team members to work together closely.

Woolley, A. W., Gerbasi, M., Chabris, C. F., Kosslyn, S. M., & Hackman, J. R. (2007). *What does it take to figure out what is going on? How team composition and work strategy jointly shape analytic effectiveness*. Cambridge, MA: Department of Psychology, Harvard University.

Intelligence analysts typically must generate judgments based on large amounts of incomplete and potentially unreliable data. Moreover, intelligence analysis frequently occurs in teams; thus, the collection and use of information is influenced by social processes. In this study, the authors examine how cognitive abilities and collaborative planning interventions jointly affect analytical processes and outcomes. They conducted an experiment in which 4-person groups of students and city residents attempted to solve a simulated terrorist plot. Groups were provided with evidence including degraded security camera photos of potential suspects, surveillance video footage, email messages exchanged among potential suspects, and reconnaissance photos and building plans. Groups were composed either to have high task-relevant cognitive abilities (in verbal recall and face recognition) or average cognitive ability on the basis of pre-tests. In addition, one half of the groups were trained to use collaborative planning for their discussions (e.g., discuss who would be responsible for different types of evidence and how they would integrate the evidence). Results show an interaction between the cognitive and collaboration interventions, such that high ability groups that used collaborative planning outperformed all other groups. An interesting result was that the high ability groups without the collaborative planning intervention performed substantially worse than the average ability groups with or without planning. The authors speculate that the high ability/no planning groups performed poorly because members failed to recognize the expertise in the group. Moreover, they argue that these conditions characterize the way that real analytic teams are used, i.e., they are composed of individuals who have specialized expertise, but the groups are left to their own devices regarding how to collaborate.

Additional references on Groups in Intelligence Analysis

Hackman, J. R., & Woolley, A. W. (in press). Creating and leading analytic teams. In R. L. Rees & J. W. Harris (Eds.), A handbook of the psychology of intelligence analysis: The human factor. Burlington, MA: Centra.

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Johnston, R. (2005). *Analytic culture in the U.S. Intelligence Community: An ethnographic study*. Washington, DC: Government Printing Office.

Brainstorming

Choi, H.-S., & Thompson, L. (2005). Old wine in a new bottle: Impact of membership change on group creativity. *Organizational Behavior and Human Decision Processes, 98*, 121-132.

In a departure from the research paradigm comparing nominal and interacting groups, Choi and Thompson (2005) investigated the effects of changes in membership on creative processes in interacting groups. Their hypothesis, that membership changes would enhance creativity, was based on previous research demonstrating that changes in composition increase diversity in a group's knowledge base and serve as a stimulating event that brings about social change. In a study of 3-person teams, they found that groups that experienced a change in membership generated more unique ideas and more diverse ideas when compared with groups that experienced no change in membership. In addition, they showed that the productivity of the newcomers accounted for the positive impact on group creativity and stimulated increased creativity of the "oldtimers", i.e., the members that remained in the groups. The authors caution that their results are probably not applicable to all group situations, and that more research is needed to understand the conditions under which changing group membership improves group functioning. Their results suggest, however, that changing group membership (especially by adding people with different skills or talents) can prevent groups from becoming "stale" and encourage the kind of debate that often does not occur in homogeneous groups.

Diehl, M., & Stroebe, W. (1987). Productivity loss in brainstorming groups: Toward the solution of a riddle. *Journal of Personality and Social Psychology, 53*, 497-509.

The authors review the literature to date on possible explanations for the robust finding that interacting brainstorming groups are less productive than are nominal groups, i.e., an equivalent number of people working alone whose non-redundant ideas are pooled. Researchers have proposed three explanations for this productivity loss: evaluation apprehension; free riding; and production blocking. Evaluation apprehension refers to the notion that group members feel inhibited from contributing ideas because they fear criticism from others. Free riding is a motivational loss that occurs when group members believe they can rely on other members to do the work. Production blocking refers to a constraint on group members' ability to mention ideas because they must wait for their turn to speak. When they have a chance to speak, group

members have forgotten some of their ideas, or they may be too distracted to think of ideas while listening to others talk. Through a series of experiments involving high school and university students, the authors tested each of these explanations on the number and quality of ideas generated by 4-person groups and participants working alone. They found that the effects of evaluation apprehension and free riding on performance were minimal, whereas the effect of production blocking was substantial. The authors suggest that it might be more effective for group members to generate ideas individually and then meet as a group to discuss and evaluate the ideas.

Paulus, P. B., & Yang, H. C. (2000). Idea generation in groups: A basis for creativity in organizations. *Organizational Behavior and Human Decision Processes, 82*(1), 76-87.

This study examines the extent to which "brainwriting", a technique for brainstorming, overcomes productivity losses in interactive brainstorming groups. Previous research has demonstrated that interacting groups are less productive than are nominal groups, or an equivalent number of people working alone whose non-redundant ideas are pooled. Paulus and Yang speculated that if group members paid more attention to the ideas expressed by other members, and if each group member had time to reflect on the discussion after a group meeting, then groups might be more productive. To test these predictions, the authors conducted an experiment in which 4-person groups of university students were asked to think of ideas of possible uses for a paper clip. Two sets of groups used a group-writing or "brainwriting" technique, whereby individuals write down their ideas on slips of paper and exchange them in a round-robin fashion. For one of these two sets of groups, participants were also asked to examine all of the ideas and were told that they would be asked to recall as many ideas as possible (the "memory group"). The third set of groups involved nominal groups, i.e., participants who worked alone but whose ideas were combined with those of three other participants. All groups were given 15 minutes for the task, were then asked to recall as many ideas as they could (in writing), and were subsequently given an additional 15 minutes to think of more ideas. The authors discovered that groups using the group-writing technique (without memory instructions) generated more ideas in Session 1 than memory groups and nominal groups. Furthermore, both sets of groups using the group-writing technique produced more ideas than the nominal groups during the second 15-minute session. The authors conclude that the results point to ways that organizations can improve the productivity of groups.

Additional References on Brainstorming

Kramer, T. J., Fleming, G. P., & Mannis, S. M. (2001). Improving face-to-face brainstorming through modeling and facilitation. *Small Group Research, 32*(5), 533-557.

Nijstad, B. A., Stroebe, W., & Lodewijkx, H. F. M. (2003). Production blocking and idea generation: Does blocking interfere with cognitive processes? *Journal of Experimental Social Psychology, 39*, 531-548.

Paulus, P. B., Dzindolet, M. T., Poletes, G., & Camacho, L. M. (1993). Perception of performance in group brainstorming: The illusion of group productivity. *Personality and Social Psychology Bulletin*, *19*, 78-89.

Common Knowledge Effect

Greitemeyer, T., Schulz-Hardt, S., Brodbeck, F. C., & Frey, D. (2006). Information sampling and group decision making: The effects of an advocacy decision procedure and task experience. *Journal of Experimental Psychology: Applied 12*(1), 31-42.

Research shows that small group discussions are typically dominated by the exchange of shared information (i.e., information that all group members bring to the table), with little unshared information (i.e., information held only by one group member) being discussed or deemed to be persuasive. The researchers examined two factors that could mitigate this tendency. The first factor was a method of contrived dissent in which group members serve as advocates for specific decision alternatives, including alternatives that may be supported only by unshared information. The second factor was the groups' level of experience addressing similar tasks. To determine whether these factors decrease the dominance of shared information in group deliberations, they conducted an experiment involving 3-person groups of university students. Some groups were instructed to use the advocacy procedure, whereas the other groups had unstructured discussions. In groups using the advocacy procedure, each group member had to spend time advocating for each of four decision alternatives. The authors found that the advocacy procedure reduced (but did not eliminate) the advantage of shared information during group discussions, and that groups using this procedure discussed more unshared information as they gained experience (moved from one task to another). Groups with unstructured deliberations saw no reduction in the dominance of shared information, even as they gained experience. Despite the greater discussion of unshared information in groups using the advocacy procedure, the quality of their decisions was no better than that of groups having unstructured discussions. In addition, the quality of these groups' decisions improved little as they gained experience. The authors suggest that advocacy procedures such as the one tested in this study require more refinement in order to improve group decisions.

Stasser, G., & Titus, W. (1985). Pooling of unshared information in group decision making: Biased information sampling during discussion. *Journal of Personality and Social Psychology, 48*(6), 1467-1478.

Groups consisting of individuals who bring unique or different sets of information to the table can potentially reach well-informed decisions. Sound decision making should occur as members share their unique expertise during group discussion, thereby increasing the total amount of information available for informing a collective decision. However, research indicates that such groups often fail to make well-informed decisions. The authors tested a "biased sampling model of group discussion," which seeks to explain why this is so by emphasizing the importance of pre-discussion individual preferences and commonly shared information (i.e., information that all group members bring to the table). The authors conducted an experiment in which university students were given varying amounts of information about candidates for student body president, and then formed groups to reach consensus about which candidate was the best choice. Group decisions were, in fact, highly influenced by commonly shared information and by group members' pre-discussion preferences. Information held by only some group members was often not shared (or deemed to be less persuasive) during discussion, and therefore had less influence on the group decision. The authors argue that unstructured group discussion for the purpose of reaching a consensus often fails to produce careful consideration of all the information available to the group.

Stewart, D. D., & Stasser, G. (1995). Expert role assignment and information sampling during collective recall and decision making. *Journal of Personality and Social Psychology, 69*, 619-628.

Research indicates that groups tend to rely much more on shared information (i.e., information that all group members bring to the table) than unshared information (information held only by one group member) when making a decision. As a result, groups often make poor decisions because they fail to discuss or consider all relevant information. A possible reason for this problem is that individuals may be unaware that other group members have access to specialized information that is relevant to the task. The authors sought to determine whether assigning each group member to be an "expert" in certain information domains (i.e., provide exclusive access to that particular domain) would improve group decision making and the ability of the group to recall task-relevant information. Three-person groups of university students worked on the student body president task (see Stasser & Titus, 1985) under a variety of conditions, including whether expertise was assigned or not. The researchers found that when group members were each given an expert role, the group was much more likely to both recall unshared information and use it to inform decisions. Unshared information was more likely to be discussed during deliberations and was considered to be persuasive because of the known "expertise" of the members providing it. Nonetheless, groups were still somewhat more likely to rely on shared information than unshared

information, especially when asked to recall information that had been discussed.

Additional References For Common Knowledge Effect

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Group Polarization

Brauer, M., Judd, C. M., & Gliner, M. D. (1995). The effects of repeated expressions on attitude polarization during group discussions. *Journal of Personality and Social Psychology, 68*(6), 1014-1029.

This study examines the extent to which characteristics of group discussions influence group polarization. Polarization occurs when group interaction produces a group position or decision that is more extreme (toward risk or caution) than the pre-discussion attitudes of the group members. The authors sought to determine the extent to which this phenomenon is driven by how often group members repeat their viewpoint on a given topic, and by how often they hear the viewpoints of other group members. To estimate the impact of these factors, the authors conducted two studies involving 3-person or 4-person groups of college students. In both studies, members were assigned to group based on having similar attitudes on five political issues. In the first study, the authors manipulated how often each member presented his or her own viewpoint and how often they heard the viewpoints of others. In the second study, group members were either told to incorporate others' viewpoints into their own arguments or were told to refrain from doing so. Based on both studies, the authors determined that repeated attitude expression is partially responsible for group polarization and that the number of different people who present the same viewpoint seems to have a greater effect on polarization than does the number of times the viewpoint is mentioned. The authors also found that polarization was especially pronounced when group members incorporated each others' viewpoints into their own arguments.

Isenberg, D. J. (1986). Group polarization: A critical review and meta-analysis. *Journal of Personality and Social Psychology, 50*(6), 1141-1151.

Research shows that following group interaction, a group of modestly risk-seeking individuals will became much more risk-seeking, and a group of mildly risk-averse individuals will typically yield a highly risk-averse decision. The tendency for group members to exhibit more extreme attitudes and decisions following group interaction is called *group polarization*. The author reviews the literature on the two primary explanations for group polarization: social comparison processes and persuasive argumentation processes. Social comparison involves group members calibrating their own expressed attitudes or beliefs based on the attitudes and beliefs they hear other group members expressing. Group members want to be perceived favorably by the other members; therefore, they tend to shift their attitudes in the direction of other members' positions. Persuasive argumentation suggests that group members base their attitudes or decision preferences on the number and degree of persuasiveness of arguments made by other group members. A review of the empirical literature finds that both explanations partially account for group polarization, but that the impact of persuasive argumentation is much greater. The author also reports the statistical effect sizes of social comparison and persuasive argumentation found in each of twenty-one studies. This analysis confirms the general literature review conclusion that both sets of processes are important in explaining group polarization, but that persuasive argumentation is more important (has a larger average effect size). In addition, the author discusses the ways in which these two processes might interact and identifies factors that might make one process more likely to emerge than the other.

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Confirmation Bias

Schulz-Hardt, S., Frey, D., Luthgens, C., & Moscovici, S. (2000). Biased information search in group decision making. *Journal of Personality and Social Psychology, 78*(4), 655-669.

Research indicates that when faced with a decision, individuals typically favor information that supports rather than conflicts with their initial preferences or judgments. The authors sought to determine whether this tendency is exhibited when groups (as opposed to individuals) make decisions. In particular, they assessed whether groups confirmed or changed a preliminary group decision when asked to

search for new information. Three experiments were conducted, two involving groups of high school and college students and one involving groups of managers from banks and industrial companies. Groups were asked to solve a hypothetical business investment or economic policy problem. The authors found that the groups showed the same tendencies exhibited by individuals. Homogeneous groups (whose members all individually indicated the same preference prior to the group meeting) and moderately heterogeneous groups (those with a small number of people with a different preference) sought information that confirmed the initial preference of all or most group members. This tendency was weakened among groups with more balanced pre-discussion preferences. These groups were more likely to search for information about different alternatives after making a preliminary decision. The researchers also determined that the decisions reached were truly group decisions, and not simply an aggregation of individual preferences. Furthermore, in comparison to heterogeneous groups, homogeneous groups were generally more committed to their preliminary decisions and more confident that they had chosen the best alternative.

Schulz-Hardt, S., Jochims, M., & Frey, D. (2002). Productive conflict in group decision making: Genuine and contrived dissent as strategies to counteract biased information seeking. *Organizational Behavior and Human Decision Processes, 88*, 563-586.

Several studies indicate that groups tend to conduct biased searches for information when making decisions. Not only does this tendency reflect the group members' individual preferences prior to group discussion, it typically produces group biases that are stronger than those that would prevail if members worked alone. In other words, group discussion intensifies the biases of individuals. This is particularly the case for homogeneous groups, i.e., whose members each have the same preferences prior to group deliberations. In this study, the authors test whether this phenomenon is mitigated by two different kinds of dissension within the group: (1) genuine dissent, whereby groups contain minority members who truly disagree with the majorities' preferences (i.e., heterogeneous groups); and (2) contrived dissent, in which a group member is assigned to play the role of "devil's advocate" by challenging the preferred alternative and offering counterarguments. The authors conducted an experiment involving 3-person groups of adult decision-makers from private companies and government agencies. Groups were composed to be either homogeneous or heterogeneous in pre-discussion preferences. In addition, the researchers randomly assigned someone to be devil's advocate in half of the groups. The authors found that genuine dissent was more effective than contrived dissent in encouraging groups to conduct a more balanced (as opposed to biased) information search. Group confidence in the accuracy of preliminary decisions was found to have a mediating effect; heterogeneous groups tended to have less confidence in their decision and consequently searched for more balanced information than did homogeneous groups.

Skov, R. B., & Sherman, S. J. (1986). Information-gathering processes: Diagnosticity, hypothesis-confirmatory strategies, and perceived hypothesis confirmation. *Journal of Experimental Social Psychology, 22*, 93-121.

This study investigates what types of information people naturally seek when testing a hypothesis. The authors presented college undergraduates with hypothetical situations and asked them to determine whether individuals in the scenarios belonged in one of two groups (e.g., Group 1 or Group 2). Participants were allowed to ask yes or no questions about the presence of eight specific characteristics that were associated with each group (e.g., Characteristic A is present 90% of the time in Group 1 but only 50% of the time in Group 2). The eight characteristics varied in the likelihoods associated with each group. When seeking evidence to investigate a hypothesis such as "This individual belongs in Group 1," participants tended to first seek out truly diagnostic information (e.g., those characteristics that differed greatly in likelihoods across groups). Controlling for diagnosticity, however, participants preferred information where a "yes" response supported their hypothesis (e.g., where the likelihood was greater in the hypothesized state). There was also a tendency for participants to seek information that could be interpreted as either strongly confirming the favored hypothesis (e.g., strong yes) or only weakly disconfirming it (e.g., weak no). The overall result of these three tendencies was that information search favored hypothesis-confirming evidence over hypothesis-disconfirming evidence.

Overconfidence

Sniezek, J. A., & Henry, R. A. (1989). Accuracy and confidence in group judgment. *Organizational Behavior & Human Decision Processes, 43*, 1-28.

This study examines accuracy and confidence in individual and group judgments. The authors identify and describe several weighting schemes that can be used to describe and evaluate the processes by which group members move from discussion of individual preferences to a group-level judgment. They conducted an experiment to assess how well these weighting schemes characterize such processes and to compare the accuracy and confidence of group and individual judgments on a given task. Participants in the experiment consisted of university students who worked in 3-person groups or worked individually. Both groups and individuals were asked to rank order and estimate the frequency of various causes of death in the U.S. population as well as to give an estimate of how confident they were in each estimate. Participants provided a range (a 99% confidence interval) for each estimate (i.e., the lowest and highest numbers of people who die from each cause based on a population of 230 million people). The researchers found that group judgments were more accurate than mean or median individual judgments and that groups tended to be more confident in their estimates than were individuals. Moreover, the study documented *process gains*, in

that 30% of groups were *more* accurate than the *most* accurate individual in the group. Two factors explained superior group accuracy. First, the more disagreement that occurred in groups, the more accurate they were. Disagreement had a greater impact on process gains than did the competence of individual members of the group. Second, groups were more accurate when they made out-of-range judgments (in the form of intervals) that fell outside of the range of individual members' judgments (i.e., judgments that were more extreme than the most extreme individuals in the group). This study was the first to document out-of-range group judgments.

Zarnoth, P, & Sniezek, J. A. (1997). The social influence of confidence in group decision making. *Journal of Experimental Social Psychology, 33*, 345-366.

The authors explore the effect of individual group member confidence and type of task on group judgments and confidence. Research indicates that group members exhibiting higher levels of confidence tend to have greater influence over group decisions, especially if the task is "intellective". Tasks can be rated on a continuum between "intellective" (tasks with a demonstrably correct solution) and "judgmental" (tasks for which answers are based on opinion). The authors conducted an experiment involving groups of university students who completed a set of 24 multiple-choice questions and rated how confident they were in each of their responses. Participants worked alone on the first trial; in the second trial, they either worked alone again or in 2-person or 5-person groups. The authors found that confidence increased with group size on all tasks, but accuracy increased accordingly only on intellective tasks. For judgmental tasks, confidence increased with group size, but performance did not. Hence, there was greater *over*confidence in larger groups on judgmental tasks. Furthermore, results showed that both accuracy and confidence can exert forms of social influence on groups. The authors found that highly knowledgeable or accurate individuals had greater influence on group outcomes in intellective tasks than in judgmental tasks. The influence of individuals' confidence on group outcomes, on the other hand, was constant across tasks.

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Pressures toward Uniformity and Groupthink

Esser, J. K. (1998). Alive and well after 25 years: A review of groupthink research. *Organizational Behavior and Human Decision Processes, 73*, 2-3.

In 1971, Irving Janis introduced the theory of "groupthink," which seeks to explain how small decision-making groups make very poor decisions despite ample evidence in favor of alternatives. The author reviews the theoretical and empirical research concerning groupthink that has been published since the theory was first developed. He summarizes both case studies and laboratory studies and compares the findings of both types of research. The full body of case study and laboratory research provides partial support for the groupthink theory, but several elements of the theory have received either little or no attention by researchers. The available evidence suggests that one of the key theoretical antecedents of groupthink, a high level of group cohesiveness, is not strongly associated with the phenomenon. However, studies have confirmed structural and procedural antecedents identified by the theory, such as a high degree of insulation from outsiders or a group leader biased toward a particular alternative. The author argues that the research is weakest in defining and examining the symptoms of groupthink. Much more research is needed to fully understand the prevalence and applicability of groupthink theory.

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Escalation of Commitment

Bazerman, M. H., Giuliano, T., & Appelman, A. (1984). Escalation of commitment in individual and group decision making. *Organizational Behavior & Human Performance, 33*(2), 141-152.

This study focuses on the problem of escalation of commitment, which occurs when individuals or groups persist in pursuing a project or course of action even in the face of significant evidence that the plan is failing. The authors summarize research that identifies this phenomenon among individual decision makers and note that very little research to date had examined whether it occurs among groups. Existing studies suggested that escalation mainly occurs when the same person is responsible for both the initial and successive decisions to invest in an endeavor. To test this hypothesis, the researchers conducted an experiment in which 4-person groups were asked to assume the role of a hypothetical company's management team (in the case of individuals, the company's financial vice-president) and make a decision about whether to continue investing money in a struggling research division. Some groups (and individuals) were told that they were responsible for the initial decision to invest in the division, whereas others were told that a previous team or person had made the decision. The results suggest that escalation of commitment is more likely to occur among groups and individuals responsible for both initial and successive decisions than among those who were not responsible for the initial decision. Such "high responsibility" groups and individuals reported more commitment to the initial decision, and were more likely to see the two decisions as being related, to have more confidence in their second decision, and to believe that their second decision would reverse the fortunes of the initially poor investment. The authors also found evidence that escalation in both groups and individuals may result from cognitive dissonance, whereby decision makers choose to invest again in a failing endeavor in an attempt to justify the initial decision or otherwise reverse the fortunes of the endeavor.

Staw, B. M., & Ross, R. (1989). Understanding behavior in escalation situations. *Science, 246*(4927), 216-220.

The authors discuss the phenomenon of escalation of commitment, which occurs when individuals, groups, or organizations persist in pursuing a course of action even in the face of significant evidence that the plan is failing. They describe some of the key empirical evidence about the likely causes of escalation of commitment. Specifically, they identify causes that are project-specific, psychological, social, and organizational. The authors argue that most studies have examined

psychological determinants of escalation of commitment whereas few have looked at social or organizational factors. In addition, the authors raise the possibility that the impact of different factors may vary over the life of a project. They present a conceptual model that stresses the influence of project-specific and psychological factors on the decision to continue a project despite negative results in the early stages of the endeavor, with social and organizational factors influencing such decisions during later stages. This article highlights the need for researchers and practitioners to consider the varying influences that these different factors could have on decisions to persist with (or end) a project.

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