

STINFO COPY

AFRL-HE-WP-JA-2007-0002



**Improving Analysis: Dealing
with Information Processing
Errors**

R. Scott Rodgers

**Warfighter Interface Division
Cognitive Systems Branch**

November 2006

Interim Report for October 2003 to November 2006

20070423138

**Approved for public release;
distribution is unlimited.**

**Air Force Research Laboratory
Human Effectiveness Directorate
Warfighter Interface Division
Cognitive Systems Branch
Wright-Patterson AFB OH 45433-7604**

NOTICE

Using Government drawings, specifications, or other data included in this document for any purpose other than Government procurement does not in any way obligate the U.S. Government. The fact that the Government formulated or supplied the drawings, specifications, or other data does not license the holder or any other person or corporation; or convey any rights or permission to manufacture, use, or sell any patented invention that may relate to them.

This report was cleared for public release by the Air Force Research Laboratory Wright Site (AFRL/WS) Public Affairs Office (PAO) and is releasable to the National Technical Information Service (NTIS). It will be available to the general public, including foreign nationals.

National Technical Information Service
5285 Port Royal Road, Springfield VA 22161

Federal Government agencies and their contractors registered with Defense Technical Information Center should direct requests for copies of this report to:

Defense Technical Information Center
8725 John J. Kingman Rd., STE 0944, Ft Belvoir VA 22060-6218

TECHNICAL REVIEW AND APPROVAL

AFRL-HE-WP-JA-2007-0002

THIS TECHNICAL REPORT HAS BEEN REVIEWED AND IS APPROVED FOR PUBLICATION.

FOR THE DIRECTOR

//signed//

DANIEL G GODDARD
Chief, Warfighter Interface Division
Air Force Research Laboratory

This report is published in the interest of scientific and technical information exchange and its publication does not constitute the Government's approval or disapproval of its ideas or findings.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) November 2006		2. REPORT TYPE Journal Article		3. DATES COVERED (From - To) October 2003 - November 2006	
4. TITLE AND SUBTITLE Improving Analysis: Dealing with Information Processing Errors				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER 62202F	
				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER 7184D199	
6. AUTHOR(S) R. Scott Rodgers				8. PERFORMING ORGANIZATION REPORT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S) AFRL/HECS	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Materiel Command Air Force Research Laboratory Human Effectiveness Directorate Warfighter Interface Division Cognitive Systems Branch Wright-Patterson AFB OH 45433-7604				11. SPONSOR/MONITOR'S REPORT NUMBER(S) AFRL-HE-WP-JA-2007-0002	
				12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.	
13. SUPPLEMENTARY NOTES Originally published in <i>International Journal of Intelligence and CounterIntelligence</i> , Volume 19, Number 4, pp. 622-641, Winter 2006					
14. ABSTRACT Intelligence analysts and mental health clinicians have some aspects of their respective crafts in common. In many cases both have to make predictions about future behavior. Findings from the clinical literature were used to make the point that humans, in general, are not particularly skilled at combining various pieces of information in order to make predictions, and by extension, intelligence analysts suffer the same fate. Understanding the problems involved in information processing can help us develop methods and tools to assist in mitigating three broad cognitive errors: (a) the tendency to see patterns where none exist, (b) the tendency to seek confirmatory evidence, and (c) the use of preconceived biases.					
15. SUBJECT TERMS Decision Making Aids, Information Restriction and Selection, Information Aggregation, Information Processing, Clinical Judgment, Intelligence Analyst					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT UNCLASSIFIED	b. ABSTRACT UNCLASSIFIED	c. THIS PAGE UNCLASSIFIED			R. Scott Rodgers
			SAR	22	19b. TELEPHONE NUMBER (include area code)

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

THIS PAGE LEFT INTENTIONALLY BLANK

R. SCOTT RODGERS

Improving Analysis: Dealing with Information Processing Errors

Though seemingly odd at first glance, intelligence professionals and mental health clinicians have aspects of their respective crafts in common. Both have the unenviable task of attempting to establish methods for the reliable and valid classification and understanding of individuals and groups of individuals. Both are called upon to predict future behaviors and actions. As mental health professionals, clinicians are called upon to help make decisions, such as diagnoses, treatment selection, outcome assessment and recidivism, risk assessment, child custody, admissions into programs, and hiring selection. Intelligence analysts, on the other hand, are called upon to predict intentions and motivations of international actors, future actions such as troop movements, and likely adversary responses based on friendly actions.

Assessments and information obtained from various other sources provide the foundation for analysts' and clinicians' judgments. Both must sort information and decide overall conclusions and implications. As has been demonstrated in a variety of professional arenas, humans are not particularly skilled at combining various pieces of information. Attention needs to be placed on understanding how and why clinicians and analysts do not do well when making predictions. Two possible reasons may

Dr. R. Scott Rodgers is a Lt. Colonel in the United States Air Force and, at the time of writing, was Director of the Joint Military Intelligence College's Information Operations Program at Bolling Air Force Base, Washington, D.C. Col. Rodgers is a past Deputy Commander of the U.S. Central Command Air Forces Information Warfare Flight at Shaw Air Force Base in South Carolina, where he was previously Chief of Information Warfare Plans. Prior to entering the Air Force in 1992, Dr. Rodgers was a licensed clinical psychologist working in private practice and for various governmental agencies and educational institutions.

account for the relative inability to generate valid predictions: the basic problems associated with the fallible process of human information processing and the specific nature of the endeavor or subject of interest.¹

BASIC PROBLEMS OF INFORMATION PROCESSING

Information can be extremely ambiguous, consisting of impressions of how individuals present themselves. Each new contact or individual presents a wealth of information of varying quality. Evaluating this wealth of fuzzy information places people into very fuzzy sets.² Clearly, humans cannot assess all that is being presented. They need to reduce or simplify the information presented. The question becomes what information should be attended to in decisionmaking and how should this information be used? Hopefully, training has shown what information is most salient or worthy of attention in deliberations. After shrinking the perceptual field to a manageable size, information is then examined and decisions are made about the individual or group in question. In this simplified view, decisionmaking involves two different steps: information restriction and selection, and information aggregation or processing.

Both steps may fall prey to what Richards Heuer describes in his seminal work, *Psychology of Intelligence Analysis*, as mental models. Mental models are patterns of expectation and experience that form a mind-set which predisposes analysts to think in certain ways. Newly acquired information is evaluated and processed through the existing mental model, rather than used to reassess the premises of the model itself. While mental models are necessary and unavoidable due to the wealth of information impinging upon people's senses, the disadvantage is that they can color perception to the extent that important information may be dismissed, distorted, or ignored. Intelligence analysts, in an effort to improve estimation and prediction, must start with a clear understanding of the human mind and how it processes information.³

INFORMATION RESTRICTION AND SELECTION

Although humans restrict information in a variety of ways, the focus here is on three specific forms that affect human information processing: (a) the tendency to see patterns where none exist, (b) the tendency to seek confirmatory evidence, and (c) the use of preconceived biases.

Psychologist Thomas Gilovich summarized a wealth of research on humans' perceptions of relations and causes in everyday life, and how they are very prone to impute order to ambiguous information. People tend to strive for predictability in their world. Gilovich has argued that all humans are predisposed to look for and see order in the relations among events,

but that this process is not without flaws.⁴ He cites several examples of the *clustering illusion* to support this claim. When presented with random sequences (either points on a map or sequences of shots made in a basketball game by different players), people tend to focus on clusters of points, and infer a relationship even though the actual process is random. A common example of this inference of cause is the *gambler's fallacy*. This occurs where the probability of a particular event is over-evaluated, given independent prior events (e.g., estimating the presence of heads on the next coin toss because the previous four tosses resulted in tails).

Heuer has also described a simplified rule of thumb commonly used in probability estimates, known as the availability rule. People use the availability rule whenever they estimate frequency or probability, based on how easily they can recall or imagine instances of whatever they are trying to estimate. Although the availability rule works well, the ability to recall instances of an event is influenced by how recently the event occurred, whether there was personal involvement in the event, and whether the details associated with the event were more vivid and memorable. For example, Central Intelligence Agency (CIA) officers acquainted with the mole Aldrich Ames would likely perceive a greater risk of insider betrayal than officers who did not know anyone involved in spying for the opposition.⁵

Yet, many events of concern to intelligence analysts when predicting future behavior are so unique that past history does not seem relevant to the evaluation (i.e., terrorists using airplanes as a weapon). In thinking of such events, analysts often construct scenarios. In these instances, the plausibility of the scenario acts as a clue to likelihood of the event. If no reasonable scenario comes easily to mind, the event is evaluated as highly unlikely. If a scenario comes easily to mind, the event in question appears probable.⁶

In addition to probability inaccuracies, humans are prone to self-confirmation in cases where equivocal information exists or, in other words, "we perceive what we expect to perceive."⁷ A wealth of research has demonstrated the human tendency to search out and attend only to evidence that confirms one's ideas, beliefs, or hypotheses.⁸ The problem with the confirmatory tendency is that only information supportive of one's beliefs is attended to, even in the face of extremely disconfirming information. Information that could provide corrective feedback that one's beliefs are in error is rarely evaluated. This process of searching for confirmation can lead to some very inaccurate conclusions, and may lead to an increased, perhaps unjustified, confidence in one's conclusions.

Intelligence analysts may also be prone to several additional types of errors when evaluating evidence, such as vividness, unsubstantiated consistency, and uncertain accuracy. Regarding vividness, information that is dramatic,

concrete, or personal can have a significant impact on thinking. For example, a single, vivid case may outweigh a much larger body of statistical evidence or conclusions reached by abstract reasoning. Unsubstantiated consistency can also be deceptive if the information on which it is based is highly correlated, redundant, or comes from a small or biased sample. If an analyst has only a small amount of information and cannot determine representativeness, then confidence in judgments, based on that evidence, must be low regardless of consistency. Likewise, uncertain accuracy can impact analytical conclusions when the caveat concerning source reliability does not attenuate the substance of the information. Pertinent information from a suspect source must be evaluated for reliability.⁹

Related to the errors associated with evaluating evidence is the tendency to reify one's preconceptions. Medical literature has many examples of how clinicians make errors in their clinical decisionmaking that are related to beliefs regarding specific cues. The tendency is to over-pathologize clients,¹⁰ especially when the cues of social class, race, and sex are present.¹¹

Social psychological research on how individuals assess the causality of behavior has also shown a dichotomy between internal and external determinants of human actions. A fundamental error made in judging the cause of behavior is to overestimate the role of internal factors, and to underestimate situational factors. Research has shown that people are more inclined to infer that some behavior was determined by personal qualities, or disposition, rather than external circumstances. Intelligence analysts are familiar with this dichotomy when they assess international actors. Since situational information is often incomplete in the assessment process, the tendency is to assume that an individual's predisposition will determine future action.¹²

Another error in determining behavior specific to analytical judgments is mirror imaging—assuming (consciously or otherwise) that the other side is likely to act in a certain way because that is how the United States would act. But the goal should be to see the options faced by foreign leaders as they themselves see them. Failure to understand that others perceive their national interests differently from the way Americans do has been a consistent source of estimative error in U.S. intelligence analysis.¹³

Both clinicians and analysts need to be aware of the limitations of their information processing abilities because inaccurate decisions regarding individuals under study can be easily made. Clinicians or analysts find it difficult to claim that they are attending to the appropriate information and, if so doing, that it is evaluated in a manner free from inaccurate, preconceived biases. These biases could be related to the resulting poor predictions. As psychologist Paul Meehl has noted, clinicians are not especially skilled at selecting the best information to which to attend.¹⁴ The same applies to intelligence analysts.

SPECIFIC NATURE OF THE ENDEAVOR

Once analysts believe they have quality or accurate information, their next task is to combine the information and to establish data relationships. Evidence—data that is relevant—must be weighted, and judgments made as to which alternative conclusions are supported by the evidence.¹⁵ The relative validity of information is often overlooked. For clinicians (particularly psychologists), usage of standardized assessment devices helps obviate some of the issues related to information selection and restriction.¹⁶ For intelligence analysts, formal quantitative processes, such as Bayesian Analysis, do exist, but seem to be rarely used. In most cases, the weighting of evidence for analysts is a qualitative judgment.¹⁷ The process of making judgments and forming conclusions based on clinical experience and findings can be seen as similar to the process many intelligence analysts engage in when they reach their judgments.

INFORMATION AGGREGATION

Years ago, Meehl penned what he calls his “disturbing little book,” comparing clinical versus actuarial prediction. In his review of the existing literature, he documented the relative superiority of actuarial methods (i.e., those methods using population base rates and/or regression techniques) over clinical methods in clinical decisionmaking.¹⁸ But he held out hope for clinical decisionmaking with respect to situations that require unique combinations of data and the formulation of original hypotheses.¹⁹ Meehl subsequently retracted much of these hopes for the clinician.²⁰ An extensive review of the literature has demonstrated that time and time again, actuarial methods of clinical prediction surpass clinical methods. In almost all cases, optimal weighting by using regression methods results in superior prediction compared to clinicians’ judgments.²¹

In addition, even simple summing of predictors (as opposed to using more sophisticated regression equations) outperformed the expert clinicians. If the optimal weighting (i.e., regressions) of information was not adopted, but instead a strategy of simply adding up the information was used, this procedure still yielded predictions unmatched in accuracy by the expert clinicians.²²

In a similar vein, Robert Clark notes in his book, *Intelligence Analysis: Estimation and Prediction*, that success in prediction for intelligence analysts comes through a proven prediction methodology, and a multidisciplinary understanding of the problem under investigation. However, he adds the disclaimer that intelligence analysts must recognize that, no matter how good the prediction methodology or how well it is applied, they are likely to be wrong. As such, the value of the prediction

model lies in the assessment of the forces (organizational, economic, etc.) which are shaping the event. The essential element in force analysis is for the analyst to determine which existing forces are changing, in what direction, and how rapidly. If the forces are correct, analysts have served the policymakers, who will likely make their own predictions.²³

As Ephraim Kam highlights in his book *Surprise Attack: The Victim's Perspective*, the most severe error, and the most relevant to surprise attack, is the assumption that a trend will continue in a straight line. A successful prediction should be able to forecast potential sources of change, and the timing of the change. While psychological difficulties of anticipating change are significant, many additional kinds of uncertainty in military and international relations are available. Many events are unique and devoid of precedent. Therefore, prediction based on observed regularities becomes more difficult. The number of variables to be considered in making a prediction is large, and information is often incomplete or misleading. Unlike many fields, reducing this level of uncertainty by means of tests or experiments is extremely difficult, if not impossible. While methods such as generating alternate scenarios do exist, they cannot produce the clear-cut predictions required.²⁴

Early critics of these conclusions regarding actuarial methods noted that the research failed to consider (a) the experience level of clinicians (expert clinicians may be much better in predicting than are general clinicians, and certainly than graduate student clinicians); (b) clinician confidence (clinicians may be more confident in some predications than others); (c) that the situation is too artificial for the results to apply to clinical assessment in the real world; and (d) the lack of generalization of regression weights obtained in one study (the optimal weighting for one sample may not at all match that for another sample).²⁵ Subsequent research has focused on addressing these concerns within the literature.

The Impact of Expertise

In reviewing a wealth of studies, psychologists David Faust, Robyn Dawes, and Paul Meehl concluded that expertise has little effect on the results. In conditions where clinicians can choose information and collect it in their preferred manner, expert clinicians still performed no better, and typically worse, than actuarial methods. Clearly, expert clinicians did at times outperform straight statistical models, but little consistency was evident. Expert clinicians evidenced little agreement among themselves in the predictions made, and even for individual expert clinicians, little consistency in prediction accuracy could be demonstrated from one case to the next.²⁶

Intelligence professionals emphasize that the expert perceives his or her own judgmental process as considerably more complex as is in fact the

case. Experts overestimate the importance of factors that have only a minor impact on their judgments, and underestimate the extent to which their decisions are based on a few major variables. Mental models are simpler than they think. The intelligence analyst, like the clinician, is typically unaware of what variables should have the greatest influence, as well as which variables actually have the greatest influence.²⁷

The Role of Confidence

Similar results were obtained when clinician confidence in prediction was taken into account. Indeed, many studies have found that expert clinicians often are no more accurate than less expert clinicians, but that they do have greater confidence in their predictions.²⁸ Psychologist Lawrence Goldberg concluded that, in general, no relation can be determined between confidence in the accuracy of one's prediction and its actual accuracy. Confidence is related to accuracy only when the assessment is based on validated procedures.²⁹ Few areas of research in the field of psychology have yielded results as unequivocal as these.³⁰ But this body of literature has been viewed as having a negligible impact on both practitioners and the field.³¹

In the area of intelligence, Ephraim Kam noted that overconfidence is a factor in surprise attack, among both analysts and decisionmakers. The implications for overconfidence can be viewed on both the conceptual level and the operational level. Conceptually, if an analyst is confident that war is unlikely, signals and indicators to the contrary will not be easily recognized. The higher the degree of confidence, the more slowly discrepant information is acknowledged. There is also less willingness to accept alternate hypotheses about enemy intentions. Operationally, the more confidence a nation has that no attack is likely, the less willing it is to take precautions and countermeasures against such a possibility.³²

Goldberg noted that the superiority of actuarial aggregation is related to five issues.³³ First, clinicians do not do well because they ignore the different validities of the predictors. Usage of sound, actuarially based data with uniformly high validity should obviate this problem. Second, combining variables if they have different metrics is difficult (e.g., how does a clinician intuitively combine scores from two variables, one with scores ranging from 0 to 100 and another with scores from 1 to 5?). As an example of obviating this issue, psychological test data provides information that is normed and scored in a common standardized metric (e.g., a z score. A z score is a statistical measure that quantifies the distance, measured in standard deviations; a data point is from the mean of a data set). Third, clinicians typically are not consistent in their application of predictions made from data; they apply inconsistent weights

to the predictors. For example, a clinician may weight one predictor scale highly for one case and in the next case a different scale is weighted highly. Clearly, applying a consistent manner of combining the data would improve prediction. Robyn Dawes has demonstrated that even the simple averaging of information or scales is superior to an inconsistent clinician combination of information.³⁴ Fourth, clinicians are insensitive to different degrees of redundancy in information. If added information is sought to improve a clinical decision, instruments with little overlap to the current measures should be used. Only by adding nonredundant information will the incremental validity—a prediction above and beyond that already obtained—improve. Finally, clinicians are relatively insensitive to regression effects, and thus need to take these into account when interpreting psychological test information.

Clinicians are not alone in their relative inability to outperform actuarial prediction. Identical results have been yielded in a variety of professional domains such as medical diagnosis,³⁵ predicting bank failures³⁶ and stock market fluctuations, internship matching,³⁷ and predicting a student's success in graduate school.³⁸

HEURISTICS IN CLINICAL JUDGMENT³⁹

Amos Tversky and Daniel Kahneman presented three heuristics, i.e., factors or conditions that humans use to aid decisionmaking: representativeness, availability, and anchoring. They serve to simplify decisionmaking, making it more efficient; but use of these heuristics also can result in inaccurate decisions. The application of these heuristics has been summarized widely in clinical literature as they pertain to both general human decisionmaking⁴⁰ and clinical decisionmaking.⁴¹

The use of heuristics is also relevant to intelligence analysis. Analysts regularly assess probabilities with respect to the outcome of events, enemy capabilities and intentions, the meaning of warning indicators, and the credibility of sources. Evaluation is complicated by numerous bits of information of differing reliability which are related to several potential outcomes of varying probability.⁴²

Representativeness

Representativeness refers to the extent to which something matches relevant categories. A frequent example in clinical practice is the comparison of a specific client with diagnostic categories. The clinician observes client behavior, then assesses the extent to which that behavior fits different diagnostic types. If the behavior or symptoms are seen as similar or representative of a particular diagnostic category, that diagnosis is typically made. In the intelligence field, as Ephraim Kam has observed,

“this heuristic enables one to estimate the likelihood of one state of affairs, given the knowledge of another state of affairs, by judging the similarity between the two.”⁴³ The problem with this decisionmaking heuristic is that other relevant information is often ignored. Three common problems with representativeness are: (a) insensitivity to prior probabilities; (b) sample size; and (c) predictability.

(a) *Insensitivity to prior probabilities* refers to the common failure to take account of base rates in assessing representativeness. Base rates help determine the prior odds or prior probabilities of something occurring.⁴⁴ An example of insensitivity to base rates is the number of diagnoses of multiple personalities made by some clinicians. The actual number of individuals with this diagnosis is extremely rare in the population, yet some clinicians have claimed upwards of ten such clients in their caseload. Besides the obvious exaggeration of symptoms necessary to make such a diagnosis, this assessment ignores the very rare probability of occurrence (based on base rate data). The clinician sensitive to base rates would very closely scrutinize any such low base-rate diagnosis.

Similarly, in assessing a situation, an intelligence analyst may have two kinds of evidence—specifics about the event being examined, and numerical data summarizing information about many similar cases. The numerical information is the base rate or prior probability. For example, an enemy aircraft makes a nonfatal strafing attack. Both Cambodian and Vietnamese jets are known to operate in the area. The base rate is 85 percent for Vietnamese aircraft and 15 percent for Cambodian. But, a U.S. pilot, with an 80 percent accuracy rating, identified the aircraft as Cambodian. The probability that the fighter was Cambodian is often based on the pilot’s report. But the greater likelihood is that the plane was Vietnamese due to the base rate information, despite the pilot’s identification.⁴⁵

(b) *Insensitivity to sample size* refers to the frequent equating of information generated from large and small samples. Obviously, comparing an individual instance to a category generated from a large sample is superior to comparing it to a category generated from a small sample, but this is frequently ignored. Humans manifest this insensitivity in two ways: by over-generalizing from their own limited experience, and by over-generalizing from limited observation. Clinicians build their clinical/observational experience from a small sample of the individuals they have personally interviewed (or studied), yet they frequently err in valuing their own sample as much as some larger sample. The favoring of the limited personal sample, while ignoring the information generated from larger samples, demonstrates this insensitivity to sample size. The other manifestation of this insensitivity is over-generalizing from a limited sample. Clinicians and analysts frequently make decisions from very limited bits of information, and may be prone to ignore input from

other sources that have much more information developed over a longer time.

(c) *Insensitivity to predictability* is similar to insensitivity to base rate, in that no account is taken of the probability of events. Where insensitivity to prior probabilities refers to the ignoring of base rate information, insensitivity to predictability refers to ignoring the differential probabilities of future behavior. Some behaviors and events are much more likely to occur than others. Insensitivity to predictability refers to the common pattern of viewing all predictions as equally likely, or underestimating the relative differences in predictability. Predicting a highly probable event (e.g., what the individual or group will be doing tomorrow) is sometimes viewed as equal in predictability as is an improbable event (e.g., what the individual or group will be doing next year). Being able to accurately predict tomorrow may lead to the common (but inaccurate) conclusion that one can predict next year as well.

A related concept to insensitivity of predictability is the common misunderstanding regarding regression to the mean. Less probable states are followed by more probable states. The most probable future event after an extreme event is one that is less extreme. Predicting that any extremely depressed client will not feel as depressed in the next session is much more likely than that the client will become more depressed.

The problems associated with the representativeness heuristic have important implications for intelligence analysis. Analysts may neglect base rate data even if it is available. Analysts often receive limited warning indicators from small portions of enemy behavior. Unique events or extreme indicators may be overemphasized. A single piece of information may cause a false alarm even when most of the earlier indicators do not suggest a threat. Analysts are prone to believe that small samples are as good as large. Consequently, analysts can become overconfident of conclusions coming from a small body of evidence, neglecting the possibility that this evidence is not representative.⁴⁶

Availability

The second heuristic used by human information processors, as discussed by Amos Tversky and Daniel Kahneman, is that of availability, which refers to the incomplete nature of our memory search for information. To facilitate the speed of memory search, people focus on only the most salient aspects, and frequently ignore other aspects that may also be relevant. Those aspects that are more easily brought to mind are viewed as thus more salient. Availability thus refers to memory access, which is affected by such things as exposure, mood, imaginability, and category vividness.

The bias of exposure is one especially relevant to clinicians. Clinicians use their past and current clients as comparisons, thus the quality of any decision

rests upon the completeness of this sample and the clinician's ability to access it completely. Peter Cohen and Jacob Cohen demonstrated that clinical samples are extremely biased and unrepresentative. The clinical caseload very quickly gets filled with a relatively few clients who tend to be fairly pathological. Given a familiarity with them, these individuals are most easily accessed as a comparison group. Because of the ease of retrievability, these few clients then serve as an inappropriate basis of clinical comparison for decisionmaking. Cohen and Cohen called this natural tendency to inappropriately make decisions based on this very flawed sample the "clinician's illusion."⁴⁷

An individual's access to memory is also affected by his/her mood. The literature on state-dependent learning and recall provides examples of this mood availability heuristic.⁴⁸ Similar to clients who are able to access only negative life experiences when depressed, clinicians suffer from the same retrievability flaw.⁴⁹ For example, a clinician who is feeling angry with a client is more likely to access past clients to whom he/she had similar reactions. This access to past clients can be helpful, but conversely the clinician would be less likely to remember other clients toward whom he/she was not angry, and thus perhaps miss important comparisons.

Biases of imaginability refer to the tendency to retrieve information that is plausible without regard to its probability. People regularly construct a series of possible behaviors or plans based, to a large extent, on their ability to imagine their occurring. By imagining a particular course of events, the likelihood is that they will plan accordingly, regardless of the probability of these events transpiring. Imaginability becomes a flawed indicator of probability of occurrence. Being able to imagine that a client could commit suicide greatly increases a clinician's assessment that it would occur even though it may be extremely unlikely. Because clinicians incorrectly inflate the probability of events due to their imaginability, they often take a very conservative approach toward prevention, even in the face of highly unlikely events.

Finally, the availability heuristic of category vividness also serves people well as information processors but can inflict bias in their decisionmaking. Humans tend to retrieve those categories that are most vivid. Aspects that are most memorable in their extremeness and characteristics are the most easily retrieved. Information that is less exciting or remarkable tends to be the last retrieved. With respect to clinical decisionmaking, this aspect of availability ensures that the past clients most likely to be retrieved for comparison are those most disturbed, troubling, or conversely, most successful. The norm is much less frequently accessed because it is less vivid. Also, the tendency is to be better able to access information that is more abstract than specific. Clinicians, for example, are more likely to remember that a client has relationship problems but may be unable to

provide the specifics of the difficulties. So with respect to the availability heuristic, they are most prone to retrieve information that is vivid (often defined as extreme), abstract (having few specifics to substantiate the concept), based on their own flawed sample, and similar to their current mood.

The Intelligence Relationship. Both Richards Heuer and Ephraim Kam explore aspects of the availability rules as they may apply to intelligence analysts. Heuer, a former CIA analyst, has addressed the error of the vividness criterion, stating that a single vivid case may negate a much larger group of indicators. Kam points to the vital role of experience as a determinant of perceived risk. If experiences are biased, perceptions are also likely to be inaccurate. But, Heuer states that analysts may be less influenced than others by the availability heuristic. Intelligence analysts generally evaluate all available information and do not typically make quick and easy references.⁵⁰

Anchoring

The final major heuristic noted by Tversky and Kahneman is that of anchoring, which refers to the tendency to let initial information and impressions determine subsequent decisionmaking. Even when presented with very different information, humans seldom shift their decisions much from their initial starting point, or anchor. For example, if a clinician receives early information from the client, or other sources, that the diagnosis of borderline personality disorder may be appropriate, less pathological diagnoses may never be examined. Clinicians, too, tend to make decisions rapidly, and maintain these decisions over time.⁵¹ Providing more information to clinicians does not help alter incorrect clinical decisions⁵² or lead to better decisions, although it often does lead to the false impression that the better decision has been made.⁵³

The implications of anchoring impressions to intelligence analysis are clear. Periodically, analysts must update estimates, either because of a changing situation or because of important new information. A natural starting point for such an adjustment is the initial definition of the situation or the previous estimate on that subject. But the anchoring heuristic suggests that analysts may not sufficiently change their estimates. As Kam has stated, "Their judgment is affected by the initial anchor, and their review of estimates may lag behind their receipt of incoming information and perception of changing situations."⁵⁴

The heuristics of representativeness, availability, and anchoring are important aids in human decisionmaking in that they allow for the efficient processing of information. But each heuristic carries with it a bias that can affect the quality of the decisions made. Both analysts and

clinicians can rely too much on memory and their own idiosyncratic weighting of information. Actuarial models do not rely on memory, and can be combined in a variety of straightforward manners, even by just averaging the different scales.⁵⁵

TRAINING AND EXPERIENCE AS REMEDIES TO POOR JUDGMENT?

Perhaps a major reason for the failure of clinicians and intelligence analysts to learn from their experience is the hindsight bias—the tendency to falsely believe that they are able to accurately predict an event after the event has transpired.⁵⁶ A common sports page term applied to this bias is “Monday morning quarterbacking,” wherein the wisdom of certain game plays or strategies that occurred the previous day can be criticized, with the claim of certainty that the critic would have done otherwise had he/she but had the chance. This bias has been documented repeatedly, and may help account for the continued failure to use additional information.⁵⁷ This hindsight bias creates what personality psychologist H. J. Einhorn calls an “illusion of learning.”⁵⁸

Given that humans as processors of information are quite fallible, what is to be done? Should all attempts at decisionmaking be abandoned in favor of statistical models? Clearly, statistical models have more predictive accuracy than clinical or analytical judgment.⁵⁹ The response to this question is a qualified no. Clinicians and analysts do have the ability to observe and select relevant information.

Comprehending the nature of information processing has significant implications for intelligence analysis, however. The circumstances under which accurate perception is the most difficult are usually the circumstances under which intelligence analysis is conducted—highly ambiguous situations due to limited information; bits and pieces of information which must be processed incrementally; and pressure for early judgments and conclusions. Richards Heuer concludes: “That intelligence analysts perform as well as they do is testimony to their generally sound judgment, training and dedication in performing a dauntingly difficult task.”⁶⁰

The problems outlined here have implications for the management as well as conduct of intelligence analysis. Given the difficulties inherent in the human processing of complex information, a prudent management system should: (a) encourage products that clearly outline their assumptions and chains of inference and that specify the degree of source unreliability; (b) support analyses that periodically review key problems from the ground up, in order to avoid pitfalls of the incremental approach; (c) emphasize procedures that elaborate alternative hypotheses. The ideal is to generate a full set of hypotheses, systematically evaluate them individually, and identify the one that is the best fit for all the data. And (d), educate

consumers about the limitations, as well as capabilities, of intelligence in order to define a realistic set of expectations.⁶¹

DECISIONMAKING AIDS

Given the limitations in information processing, several recommendations are offered.⁶²

1. *Adopt a scientific approach to information evaluation and hypothesis testing.* This includes not confusing the ability to explain with the ability to predict. Analysts should focus on making explicit predictions, then assess the extent to which these predictions are borne out. This process of making predictions, and assessing their outcomes, forces analysts to be explicit about assumptions and helps mitigate the “hindsight” bias.⁶³
2. *Get quality information.* Robyn M. Dawes has noted that clinicians typically get poor feedback information. Even if appropriate hypothesis testing was conducted, the quality of information obtained has provided little corrective feedback.⁶⁴ For example, rarely do clinicians obtain information on what has transpired with their clients after termination of service. Frequently, the only cases where feedback is obtained are those that have not succeeded and the patients return for treatment. Attempts should be made to obtain reliable and valid information following termination to evaluate the accuracy of any predictions. Also, care should be taken in using the intelligence customer’s acceptance of intelligence products as accurate or good feedback. In psychology this is commonly called the *P. T. Barnum effect*—the tendency for people to accept very general or vague characterizations of themselves or events and take them to be accurate.
3. *Think Bayesian.* Thomas Bayes, a Presbyterian minister and British mathematician (1702–1761), urged that probabilities be revised when more is learned about an event. For analysts, this means being aware of base rates, as they are related to the probability of occurrence of different behaviors, and the probability of predictability of different, future behaviors. Thinking Bayesian requires attention to the full range of individuals, both with and without the characteristics of focus. The ability to think Bayesian requires knowledge of simple Bayesian probability rules, but it also requires extensive knowledge of population probabilities.⁶⁵ The development of appropriate databases could help provide some of the information on base rates and help determine the predictability of some behaviors.
4. *Consider alternative hypotheses and engage in disconfirming hypothesis testing.* As noted, humans tend to seek confirming evidence, but this strategy is not beneficial for accuracy of decisionmaking. The best

solution is to specify disconfirming evidence, then seek out this information.

All human beings make various errors of attribution and inference in their information processing. By extension analysts will tend to make the same errors. But, validated, objective measures and actuarial processes provide an avenue to improve the accuracy of decisions. Yet care must still be taken in their development, validation, selection, and interpretation. To continue to ignore the findings discussed here and to not develop the databases and processes necessary to mitigate information processing errors means that both clinicians and analysts will forever be considered poor predictors of future actions.

REFERENCES

- ¹ I have adapted the ideas and findings of the chapter cited below relative to the processes of intelligence analysis. Sole credit is given to Terence J. Tracey and James Rounds for their interpretations and findings as they pertain to clinical work and psychological test interpretation. The citations relating to clinicians given in this paper are those cited in the Tracey and Rounds article: Terence J. Tracey and James Rounds, "Inference and Attribution Errors in Test Interpretation," Chapter 5 in Rodney K. Lichtenberg and James W. Goodyear, (eds.), *Scientist-practitioner perspectives on test interpretation* (Boston: Allyn and Bacon, 1998), pp. 113–131.
I also thank Major Jenise L. Kohnke, Ph.D., an intelligence officer in the Air Force Reserves, for her yeoman work on the intelligence aspects of this article. Without her, this article would not exist in any meaningful way for the Intelligence Community.
- ² Nathan Cantor, Edward Smith, Richard French, and Juan Mezzich, "Psychiatric diagnosis as prototype categorization," *Journal of Abnormal Psychology*, No. 89, 1980, pp. 181–193, cited in Tracey and Rounds, p. 114.
- ³ Richards J. Heuer, *Psychology of Intelligence Analysis*, (Washington, DC: Central Intelligence Agency: Center for the Study of Intelligence, 1999), pp. 8–11.
- ⁴ Thomas Gilovich, *How We Know What Isn't So: The Fallibility of Human Reason in Everyday Life* (New York: Free Press, 1991), cited in Tracey and Rounds, p. 114.
- ⁵ Richards J. Heuer, *Psychology of Intelligence Analysis*, p. 147.
- ⁶ *Ibid.*, p. 149.
- ⁷ Daniel Granberg and Edward Brent, "When Prophecy Bends: The Preference-expectation link in U.S. Presidential Elections, 1952–1980," *Journal of Personality and Social Psychology*, No. 45, 1983, pp. 477–491; Donald O. Sears and Robert E. Whitley, "Political persuasion," in Ithiel deSola Pool, Wilbur Schramm, Fredrick W. Frey, Nicholas Maccoby, and Edward B. Parker (eds.), *Handbook of Communication* (Chicago: Rand-McNally, 1973), pp. 253–289; cited in Tracey and Rounds, p. 115; Richards J. Heuer, *Psychology of Intelligence Analysis*, p. 8.

- ⁸ Anthony G. Greenwald, Anthony R. Pratkanis, Michael R. Leippe, and Michael H. Baumgardner, "Under what conditions does theory obstruct research progress?" *Psychological Review*, No. 93, 1986, pp. 216–229; Richard E. Nisbett and Lois Ross, *Human inference: Strategies and shortcomings of social judgment* (New York: Prentice-Hall, 1980); M. Snyder and B. Campbell, "Testing hypotheses about other people: The role of the hypothesis," *Personality and Social Psychology Bulletin*, No. 6, 1980, pp. 421–426, cited in Tracey and Rounds, p. 115.
- ⁹ Richards J. Heuer, *Psychology of Intelligence Analysis*, pp. 116–124.
- ¹⁰ Ellen J. Langer and Robert P. Abelson, "A patient by any other name: Clinical group differences in labeling bias," *Journal of Consulting and Clinical Psychology*, No. 42, 1974, pp. 4–9; David L. Rosehan, "On being sane in insane places," *Science*, No. 179, 1973, pp. 250–258; Maury K. Temerlin, "Suggestion effects in psychiatric diagnosis," *Journal of Nervous and Mental Disease*, No. 147, 1968, pp. 349–353, cited in Tracey and Rounds, p. 116.
- ¹¹ Charles V. Abromowitz and Paul R. Dokecki, "The politics of clinical judgment: Early empirical returns," *Psychological Bulletin*, No. 84, 1977, pp. 460–476; Steve R. Lopez, "Patient variable biases in clinical judgment: Conceptual overview and methodological considerations," *Psychological Bulletin*, No. 106, 1989, pp. 184–203; Inge K. Broverman, Diane M. Broverman, Frances E. Clarkson, Patricia S. Rosenkrantz, and Sara R. Vogel, "Sex-role stereotypes and clinical judgments of mental health," *Journal of Consulting and Clinical Psychology*, No. 34, 1970, pp. 1–7, cited in Tracey and Rounds, p. 116.
- ¹² Richards J. Heuer, *Psychology of Intelligence Analysis*, pp. 136–138.
- ¹³ *Ibid.*
- ¹⁴ Paul E. Meehl, "Why I do not attend case conferences," in Paul E. Meehl, *Psychodiagnosis: Selected papers* (Minneapolis: University of Minnesota Press, 1973), pp. 225–302, cited in Tracey and Rounds, p. 116.
- ¹⁵ Robert M. Clark, *Intelligence Analysis: Estimation and Prediction* (Baltimore: American Literary Press, 1996).
- ¹⁶ William G. Dahlstrom, "Tests: Small samples, large consequences," *American Psychologist*, No. 48, 1993, pp. 393–399, cited in Tracey and Rounds, p. 116.
- ¹⁷ Robert M. Clark, *Intelligence Analysis: Estimation and Prediction*.
- ¹⁸ Paul E. Meehl, *Clinical versus statistical prediction: A theoretical analysis and a review of the evidence* (Minneapolis: University of Minnesota Press, 1954), cited in Tracey and Rounds, p. 116.
- ¹⁹ Paul E. Meehl, "When shall we use our heads instead of the formula?," *Journal of Consulting and Clinical Psychology*, No. 4, 1957, pp. 268–273, cited in Tracey and Rounds, p. 116.
- ²⁰ Paul E. Meehl, "Causes and effects of my disturbing little book," *Journal of Personality Assessment*, No. 50, 1986, pp. 370–375, cited in Tracey and Rounds, p. 117.
- ²¹ Robyn M. Dawes, Daniel Faust, and Paul E. Meehl, "Clinical and actuarial judgment," *Science*, No. 243, 1989, pp. 1668–1674; J. Sawyer, "Measurement

- and prediction, clinical and statistical,” *Psychological Bulletin*, No. 66, 1966, pp. 178–200; James Wiggins, “Clinical and statistical prediction: Where are we and where do we go from here?,” *Clinical Psychology Review*, No. 1, 1981, pp. 3–18, cited in Tracey and Rounds, p. 117.
- ²² Robyn M. Dawes, “The robust beauty of improper linear models in decision making,” *American Psychologist*, No. 34, 1979, pp. 571–582, cited in Tracey and Rounds, p. 118.
- ²³ Robert M. Clark, *Intelligence Analysis: Estimation and Prediction*, p. 163.
- ²⁴ Ephraim Kam, *Surprise Attack: The Victim’s perspective* (Cambridge, MA: Harvard University Press, 1988), pp. 116–117.
- ²⁵ Robert R. Holt, “Clinical and statistical prediction: A reformulation and some new data,” *Journal of Abnormal and Social Psychology*, No. 56, 1958, pp. 1–12; Joseph Zubin, “Clinical versus actuarial prediction: A pseudo-problem,” in *Proceedings, 1955 invitational conference on testing problems* (Princeton, NJ: Educational Testing Service, 1956), pp. 107–128, cited in Tracey and Rounds, p. 118.
- ²⁶ Daniel Faust, “What if we had really listened? Present reflections on altered pasts,” in Dante Cicchetti and William M. Grove (eds.), *Thinking clearly about psychology: Vol. 1, Matters of public interest* (Minneapolis: University of Minnesota Press, 1991), pp. 185–216; Robyn M. Dawes, Daniel Faust, and Paul E. Meehl, “Clinical and actuarial judgment,” pp. 1668–1674, cited in Tracey and Rounds, p. 117.
- ²⁷ Richards J. Heuer, *Psychology of Intelligence Analysis*, pp. 55–59.
- ²⁸ Myrna L. Friedlander and Susan D. Phillips, “Preventing anchoring errors in clinical judgment,” *Journal of Consulting and Clinical Psychology*, No. 52, 1984, pp. 366–371; Myrna L. Friedlander and Sara J. Stockton, “Anchoring and publicity effects in clinical judgment,” *Journal of Clinical Psychology*, No. 39, 1983, pp. 637–643; Stuart Oskamp, “Overconfidence in case-study judgments,” in Daniel Kahneman, Paul Slovic, and Amos Tversky (eds.), *Judgment under uncertainty: Heuristics and biases* (New York: Cambridge University Press, 1982), pp. 287–293; Donald L. Rock, John D. Bransford, Stephen A. Maisto, and Leslie Morey, “The study of clinical judgment: An ecological approach,” *Clinical Psychology Review*, No. 7, 1987, pp. 645–661, cited in Tracey and Rounds, p. 117.
- ²⁹ Lewis R. Goldberg, “Some informal explorations and ruminations about graphology,” in Baruch Nevo (ed.), *Scientific aspects of graphology* (Springfield, IL: Charles C. Thomas, 1986), pp. 281–293; Paul E. Meehl, “Causes and effects of my disturbing little book,” pp. 370–375, cited in Tracey and Rounds, p. 117.
- ³⁰ Paul E. Meehl, “Causes and effects of my disturbing little book,” pp. 370–375, cited in Tracey and Rounds, p. 117.
- ³¹ Robyn M. Dawes, *Rational Choice in an Uncertain World* (San Diego: Harcourt, Brace, Jovanovich, 1988), p. 195, cited in Tracey and Rounds, p. 118.
- ³² Ephraim Kam, *Surprise Attack*, pp. 112–114.

- ³³ Lewis R. Goldberg, "Human mind versus regression equation: Five contrasts," in Dante Cicchetti and William M. Grove (eds.), *Thinking clearly about psychology; Vol. 1: Matters of public interest*, pp. 173–184, cited in Tracey and Rounds, p. 123.
- ³⁴ Robyn M. Dawes, "The robust beauty of improper linear models in decision making," pp. 571–582, cited in Tracey and Rounds, p. 123.
- ³⁵ Hillel J. Einhorn, "Expert measurement and mechanical combination," *Organizational Behavior and Human Performance*, No. 13, 1979, pp. 171–192, cited in Tracey and Rounds, p. 118.
- ³⁶ Roger Libby, "Man versus model of man: Some conflicting evidence," *Organizational Behavior and Human Performance*, No. 16, 1976, pp. 1–12, cited in Tracey and Rounds, p. 118.
- ³⁷ Eugene J. Johnson, "Expertise and decision under uncertainty: Performance and process," in Michelene T. H. Chi, Robert Glaser, and Marshall J. Farr (eds.), *The nature of expertise* (Hillsdale, NJ: Erlbaum, 1988), pp. 209–228, cited in Tracey and Rounds, p. 118.
- ³⁸ Robyn M. Dawes, "The robust beauty of improper linear models in decision making," pp. 571–582, cited in Tracey and Rounds, p. 118.
- ³⁹ The material in this entire section is taken from Amos Tversky and Daniel Kahneman, "Judgment under uncertainty: Heuristics and biases," *Science*, No. 185, 1974, pp. 1124–1131, cited in Tracey and Rounds, pp. 119–123. Citations from additional references are given as appropriate.
- ⁴⁰ Robyn M. Dawes, *Rational Choice in an Uncertain World*; Amos Tversky and Daniel Kahneman, "The framing of decisions and the psychology of choice," *Science*, No. 21, 1981, pp. 453–458, cited in Tracey and Rounds, p. 119.
- ⁴¹ Robyn M. Dawes, *House of Cards: Psychology and Psychiatry Built on Myth* (New York: Free Press, 1994); Terence J. Tracey, "Counseling research as an applied science," in Charles E. Watkins and Lois S. Schneider (eds.), *Research in counseling* (Hillsdale, NJ: Erlbaum, 1991), pp. 1–31, cited in Tracey and Rounds, p. 119.
- ⁴² Ephraim Kam, *Surprise Attack*, p. 107.
- ⁴³ *Ibid.*, p. 108.
- ⁴⁴ *Ibid.*, p. 109.
- ⁴⁵ Richards J. Heuer, *Psychology of Intelligence Analysis*, pp. 157–160.
- ⁴⁶ Ephraim Kam, *Surprise Attack*, p. 110.
- ⁴⁷ Peter Cohen and Jacob Cohen, "The clinician's illusion," *Archives of General Psychiatry*, No. 41, 1984, pp. 1178–1182, cited in Tracey and Rounds, p. 121.
- ⁴⁸ Gordon Bower, "Mood and memory," *American Psychologist*, No. 36, 1981, pp. 129–148; Stephen G. Gilligan and Gordon H. Bower, "Cognitive consequences of emotional arousal," in Charles Izard, Jerome Kagan, and Robert Zajonc (eds.), *Emotions, Cognition, and Behavior* (New York: Cambridge University Press, 1984), pp. 547–588, cited in Tracey and Rounds, p. 121.
- ⁴⁹ Frank Dumont, "Inferential heuristics in clinical problem formulation: Selective review of their strengths and weaknesses," *Professional Psychology*:

- Research and Practice*, No. 24, 1993, pp. 196–205, cited in Tracey and Rounds, p. 121.
- ⁵⁰ Ephraim Kam, *Surprise Attack*; Richards J. Heuer, *Psychology of Intelligence Analysis*.
- ⁵¹ Edward G. Gauron and James K. Dickinson, “Diagnostic decision-making in psychiatry 2: Diagnostic styles,” *Archives of General Psychiatry*, No. 14, 1966, pp. 233–237; Paul E. Meehl, “The cognitive activity of the clinician,” *American Psychologist*, No. 15, 1960, pp. 19–27; Marcel Rubin and Fredrick C. Shontz, “Diagnostic prototypes and diagnostic processes of clinical psychologists,” *Journal of Consulting Psychology*, No. 24, 1960, pp. 234–239, cited in Tracey and Rounds, p. 123.
- ⁵² Paul R. Clavelle and Allen D. Turner, “Clinical decision-making among professionals and paraprofessionals,” *Journal of Clinical Psychology*, No. 33, 1980, pp. 133–152, cited in Tracey and Rounds, p. 123.
- ⁵³ Stuart Oskamp, “Overconfidence in case-study judgments,” in Daniel Kahneman, Paul Slovic, and Amos Tversky (eds.), *Judgment under uncertainty: Heuristics and biases*, pp. 287–293, cited in Tracey and Rounds, p. 123.
- ⁵⁴ Ephraim Kam, *Surprise Attack*, p. 112.
- ⁵⁵ Robyn M. Dawes, “The robust beauty of improper linear models in decision making,” pp. 571–582, cited in Tracey and Rounds, p. 123.
- ⁵⁶ Daniel Wedding and Daniel Faust, “Clinical judgment and decision making in neuropsychology,” *Archives of Clinical Neuropsychology*, No. 4, 1989, pp. 233–265, cited in Tracey and Rounds, p. 124.
- ⁵⁷ Harold R. Arkes, Daniel Faust, Thomas J. Guilmette, and Kenneth Hart, “Eliminating the hindsight bias,” *Journal of Applied Psychology*, No. 73, 1988, pp. 305–307; Baruch Fischhoff, “Hindsight = foresight: The effect of outcome knowledge on judgment under uncertainty,” *Journal of Experimental Psychology: Human Perception and Performance*, No. 1, 1975, pp. 288–299, cited in Tracey and Rounds, p. 125.
- ⁵⁸ Hillel J. Einhorn, “Accepting error to make less error,” *Journal of Personality Assessment*, No. 50, 1986, pp. 387–395, cited in Tracey and Rounds, p. 125.
- ⁵⁹ Linda D. Eyde, David M. Kowel, and Francis J. Fishburne, “The validity of computer-based test interpretations of the MMPI,” in Thomas B. Gutkin and Steven L. Wise (eds.), *Buros-Nebraska Symposium on Measurement and Testing: The computer and the decision-making process*, Vol. 4 (Hillsdale, NJ: Erlbaum, 1991), pp. 75–124, cited in Tracey and Rounds, p. 125.
- ⁶⁰ Richards J. Heuer, *Psychology of Intelligence Analysis*, pp. 14–16.
- ⁶¹ *Ibid.*
- ⁶² Harold R. Arkes, “Impediments to accurate clinical judgment and possible ways to minimize their impact,” *Journal of Consulting and Clinical Psychology*, No. 49, 1981, pp. 323–330; Frank Dumont, “Inferential heuristics in clinical problem formulation: Selective review of their strengths and weaknesses,” pp. 196–205; Peter Salovey and David C. Turk, “Clinical judgment and decision-making,” in C. Rick Snyder and Donelson R. Forsyth (eds.), *Handbook of social and clinical*

psychology: The health perspective (New York: Pergamon, 1991), pp. 416–437; Michael Wierzbicki, *Issues in Clinical Psychology: Subjective versus objective approaches* (Boston: Allyn and Bacon, 1993), cited in Tracey and Rounds, p. 125.

⁶³ Terence J. Tracey, “Counseling research as an applied science,” in Charles E. Watkins and Lois S. Schneider (eds.), *Research in counseling*, pp. 1–31, cited in Tracey and Rounds, p. 125.

⁶⁴ Robyn M. Dawes, *House of Cards: Psychology and Psychiatry Built on Myth*, cited in Tracey and Rounds, p. 125.

⁶⁵ Robyn M. Dawes, “Probabilistic versus causal thinking,” in Dante Cicchetti and William M. Grove (eds.), *Thinking clearly about psychology: Vol. 1, Matters of public interest*, pp. 185–216, cited in Tracey and Rounds, p. 126.