THE NATURE OF INFORMATION AND OVERCONFIDENCE ON VENTURE CAPITALISTS' DECISION MAKING

ANDREW L. ZACHARAKIS
Babson College, Babson Park, Massachusetts

DEAN A. SHEPHERD
University of Colorado, Boulder, Colorado

EXECUTIVE SUMMARY

Venture capitalists (VCs) are considered experts in identifying high potential new ventures—gazelles. Thus, the VC decision process has received tremendous attention within the entrepreneurship literature. Yet, most studies on VC decision-making focus on which decision criteria are central to selecting gazelles. Although informative, the majority of these studies has neglected cognitive differences in how VCs make decisions. This is surprising considering the influence cognitive differences are likely to have on the exploitation of an opportunity as well as its influence on likely success. The current study investigates whether VCs are overconfident, as well as the factors surrounding the decision that lead to overconfidence.

Overconfidence describes the tendency to overestimate the likely occurrence of a set of events. Overconfident people make probability judgments that are more extreme than they should, given the evidence and their knowledge. In the case of the new venture investment decision, overconfident VCs may overestimate the likelihood that a funded company will succeed.

The results of the current study indicate that VCs are indeed overconfident (96% of the 51 participating VCs exhibited significant overconfidence) and that overconfidence negatively affects VC decision accuracy (the correlation between overconfidence and accuracy was 0.70). The level of overconfidence depended upon the amount of information, the type of information, and whether the VC strongly believes the venture will succeed or fail.

As more information becomes available, people tend to believe they will make better decisions; they

Address correspondence to Andrew L. Zacharakis, Babson College, Arthur M. Blank Center for Entrepreneurship, Babson Park, MA, 02457; (781) 239-4497; E-mail: Zacharakis@Babson.edu

This research was funded in part by the Center for Entrepreneurial Leadership Inc. and the Ewing Marion Kauffman Foundation. The contents of this publication are solely the responsibility of the authors.

The authors would like to acknowledge the insightful comments of Robert Baron and two anonymous reviewers on earlier drafts.

Journal of Business Venturing **16**, 311–332

655 Avenue of the Americas, New York, NY 10010
0883-9026/01/$–see front matter
PII S0883-9026(99)00052-X

are making a "more informed decision." More information ideally should enable the VCs to assess any potential pitfalls. However, additional information makes the decision more complex. Information factors may contradict and relate to other information in unexpected ways. Even if more information is available, people usually don't analyze all of it (even though they believe they do). Thus, more information creates greater confidence, but it also leads to lower decision accuracy.

The type of information that is available also impacts overconfidence and decision accuracy. VCs are intuitive decision makers. When people are familiar with a decision and the structure of the information surrounding that decision, they resort to automatic information processing. On the other hand, if information surrounding the decision is structured in an unfamiliar way, people need to decipher what each piece of information means and how that impacts their overall accuracy. In the case of expert VCs, that means they must deviate from their intuitive style. It seems that forcing them outside their "comfort zone" has a negative effect on their confidence and has an even greater effect (negative) on their accuracy.

There is evidence of an "availability bias" in VC decision-making; VCs rely on how well the current decision matches past successful or failed investments. VCs are overconfident in their prediction of venture success when they predict a very high level of success. VCs are also overconfident in their prediction of venture failure when they predict a very low likelihood of success. This high level of overconfidence in success predictions (or failure predictions) may encourage the VC to limit information search and fund a lower potential investment (or prematurely reject a stronger potential investment).

Although overconfidence in itself does not necessarily lead to a wrong decision, the bias is likely to inhibit learning and improving the decision process. Overconfident VCs may not fully consider all relevant information, nor search for additional information to improve their decision. Moreover, the natural tendency for people to recall past successes rather than failures may mean that VCs will make the same mistakes again. VCs can take simple steps to reduce the effect of overconfidence, including counterfactual thinking (i.e., imaging scenarios where current assumptions might not hold), formally recording how past decisions were made at the time of the decision (versus trying to recall how that decision was made from memory), and using actuarial decision aids that decompose decisions into core components. Reducing overconfidence may lead to stronger decisions. It is hoped that this study illustrates the power of cognitive theories for understanding VC decision-making.

INTRODUCTION

Venture capitalist (VC) decision-making has received much attention in the entrepreneurship literature, yet most of this research has neglected potential biases that might hinder effective decision-making. The majority of research has listed the decision criteria VCs report they use when assessing new venture performance (Wells 1974; Poindexter 1976; Tyebjee and Bruno 1984; MacMillan, Seigel, and Subba Narasimha 1985; MacMillan, Zeman, and Subba Narasimha 1987; Robinson 1987). Although informative, the majority of these studies has neglected cognitive differences in how VCs make decisions. This is surprising considering the influence cognitive differences are likely to have on the exploitation of an opportunity as well as its influence on likely success (Venkatraman 1997). Furthermore, there is substantial evidence from the judgment/decision-making literature that suggests cognitive differences are important and affect decision quality. Heeding Venkatraman's (1997) call, the current study uses concepts highlighted in cognitive science to investigate VC decision-making.

One of the most fruitful areas of inquiry within the judgment/decision-making literature has been the study of biases. Biases *cause decision-makers to process information incorrectly, which may lead to inaccurate decisions and judgments* (Tversky and Kahneman 1974). Kahneman and Tversky (1982: 494) propose three related reasons for the importance of investigating decision-makers' systematic errors and inferential biases: (1) Exploring intellectual limitations may suggest ways to improve decision quality; (2)

errors and biases often reveal the psychological processes that govern judgment and inference; and (3) mistakes and fallacies help the mapping of human intuitions by indicating which principles of statistics or logic are nonintuitive.

It must be noted that biases are unlikely to be universally evident—presence, magnitude, and even the consequences of a bias likely depend on the decision task. Biases and heuristics can lead to efficient and effective decision-making under uncertain and complex environmental conditions (Pitz and Sachs 1984; Tversky and Kahneman 1974), especially when decisions need to be made quickly (Payne, Bettman, and Johnson 1988). However, biases can lead to errors (Kahneman, Slovic, and Tversky 1982; Nisbett and Ross 1980). Baron (1998) proposes that making decisions in highly uncertain environments places a strain on information processing capabilities (Gilbert, McNulty, Giuliano, and Benson 1992), involves high levels of emotion (Oaksford, Morris, and Williams 1996). It can also involve extreme time constraints (Wyer and Srull 1994), which probably leads to greater susceptibility of cognitive errors.

Such a decision environment is consistent with a VC's task of assessing new venture success—a VC's investment decision occurs in the rapid, high speed new venture environment. For example, VCs evaluate hundreds of data points during venture screening and due diligence which can lead to information overload (Zacharakis and Meyer 2000). Moreover, much of the surrounding information is ambiguous and uncertain in nature. The above suggests that due to the nature of the VC task, they are highly susceptible to cognitive biases.

While the cognition literature provides evidence of a number of biases and heuristics in decision-making, this study investigates the overconfidence bias because it is common, pervasive and of great practical importance (Griffen and Vary 1996). According to Griffin and Varey (1996), there are two types of overconfidence. First, **optimistic overconfidence** is *the tendency to overestimate the likelihood that one's favored outcome will occur.* Second, **overestimation of one's own knowledge** is *overconfidence in the validity of the judgment even when there is no personally favored hypothesis or outcome.* Both types of overconfidence may cloud a VC's judgment and lead to a poor decision. Overconfident VCs may be more likely to commit funds to inappropriate new ventures, be less likely to seek additional information that may help them make a better investment decision and be less motivated to seek personal improvement.

The VCs' ability to accurately interpret information influences the potential upside (or downside) of any investment. If decision-makers are overconfident, however, they may limit their information search (Cooper, Folta, and Woo 1995; Harvey, 1994; Mahajan, 1992), "commit resources without pausing to consider additional information" (Mahajan, 1992: 329), and/or lose sight of the extent of their meta-knowledge (an understanding of the limits of one's own knowledge). Therefore, VCs who are overconfident in their own decision process may rely on their existing knowledge instead of seeking additional information. Thus, overconfidence may be problematic because it impedes the VC's ability to accurately perceive potential opportunities and pitfalls. The more opportunities and pitfalls a VC can foresee in the early life of a venture, the greater the chance that the funded venture will generate high returns because the VC can implement needed changes or reject the investment proposal altogether. Generally, overconfidence has a negative effect on decision quality.

Therefore, it is important to apply the theories of biases and heuristics to reveal the psychological processes (specifically those relating to overconfidence) that govern VCs in their assessments of new venture success. This increased understanding of VCs' cognition may provide important insights into improving decision quality. This study investigates the following research questions: *Are VCs overconfident? Does overconfidence influence decision accuracy? Under what circumstances would we expect VCs to exhibit greater levels of overconfidence?*

The study proceeds as follows: First the judgment/decision-making literature is reviewed and applied to the nature of the venture capital investment decision and hypotheses generated around the above research questions. Second, data-collection is discussed including a description of the sample and survey instrument used. Third, conjoint analysis and analysis of variance are used to determine if the hypothesized factors do increase overconfidence. Fourth, the results are reviewed and discussed in terms of the judgment/decision-making theory and our understanding of VCs' decision-making. Finally, the implications of this study for future research and for VCs and entrepreneurs are discussed.

NATURE OF THE INVESTMENT DECISION

To assess the viability of an investment proposal, VCs typically seek and compile information. During the screening stage of the evaluation process, VCs study the entrepreneur's business plan, which represents a compilation of information. If the proposal is worthwhile, VCs gather and analyze more information in subsequent evaluation stages (Tyebjee and Bruno 1984) before making the final investment decision. Most studies into VCs' decision-making have investigated the information that VCs report they use when assessing new venture performance (Wells 1974; Poindexter 1976; Tyebjee and Bruno 1984; MacMillan, et al. 1985; MacMillan, et al. 1987; Robinson 1987). The purpose of such studies is to tap into the expertise VCs appear to have in selecting those new ventures that are going to be "home runs"—highly profitable investments.

Cognitive science suggests that researchers need to investigate more than just the information content to understand the judgment being made. Researchers also need to understand how that information is used to form a judgment. Biases, and in this case the overconfidence bias, affect how information is obtained and compiled in order to make a judgment. As discussed above, the VC task is one that requires decisions be made in a highly uncertain environment, placing a strain on information processing capabilities and involving high levels of emotion and extreme time constraints. Baron (1998) proposes that for such tasks we can expect a greater susceptibility to cognitive errors. Moreover, Busenitz and Barney (1997) found that entrepreneurs are more prone to biases, including overconfidence, than managers in large organizations. Is overconfidence problematic for VCs as well?

Kunze (1990) argues that if VCs fully analyzed every potential investment, they would never fund any ventures. In essence, the more a VC analyzes a potential investment, the more reasons (s)he will find for the venture to ultimately fail; paralysis by analysis sets in. Moreover, as the number of VC firms and the size of their funds has increased, VCs feel added pressure to make larger investments more quickly so that they can leverage the return on their fund (Kunze 1990). Kunze (1990) implies that VCs face considerable time pressures and often have insufficient time to complete a full analysis of each investment opportunity.

These time pressures described by Kunze (1990) might be the reason for Ginger More's recent description of VCs as more like money managers than company builders (More 1999) (Ginger More is a founder of the Oak Partners venture capital firm). If

VCs view themselves more as money managers than venture builders, they are more likely to be overconfident in their decision ability to choose the "right" investment rather than be optimistically overconfident in their ability to actively influence the outcome of their decision (over and above the resources invested). Furthermore, as discussed in the introduction, overconfidence may hinder VC decision-making because it impacts how VCs gather and use information. This discussion leads to the following hypotheses:

Hypothesis 1A: VCs are overconfident.

Hypothesis 1B: Overconfidence adversely affects decision accuracy.

The remaining hypotheses will explore contextual factors that we propose affect the level of overconfidence. Overconfidence is operationalized as the person's confidence level minus the accuracy of her/his decision (Mahajan 1992). Contextual factors influence the decision environment thereby impacting a person's confidence level. Moreover, contextual factors may make it more or less difficult to derive a correct answer; contextual factors impact accuracy. Therefore, contextual factors may influence overconfidence (i.e., the context differentially affects confidence and accuracy).

We propose that the nature of the information being used to make a prediction about future success differentially affects the level of confidence and accuracy and therefore affects overconfidence. The nature of information refers to the amount of information, the form (framing) of information, the VC's historical information (experiences), and the vividness of the information to the VC. Each is now addressed and hypotheses developed.

Amount of Information

Confidence increases as the amount of relevant information increases (Oskamp 1982; Elstein and Bordage 1988). Decision-makers believe that more information improves the accuracy of their decision, but accuracy does not significantly change (Castellan 1977) and may even decrease (Arkes 1981). For example, Oskamp (1982) had 32 subjects (8 psychologists, 18 graduate students and 6 undergraduates) evaluate a scenario of an individual seeking counseling. As more information became available, the participants became significantly more confident (p = .001) across all expert levels (Oskamp 1982). However, accuracy in determining the correct prognosis did not significantly, nor consistently, improve with more information. Zacharakis and Meyer (2000) found that VCs' decision accuracy actually decreased when they had more information to assess venture potential. Why would decision accuracy decrease?

One plausible explanation is that decision-makers utilize fewer cues than they think they do (Brehmer and Brehmer 1988; Stewart 1988) ignoring the additional information or in some cases using it inappropriately. Zacharakis and Meyer (2000) suggest that the decrease in accuracy might be a function of cognitive overload. Because there is more information to evaluate, VCs are drawn to the more salient information factors and may ignore other factors that are more pertinent to the decision. Therefore, more information does not lead to improved decision accuracy, just increased confidence. Since confidence increases and accuracy decreases, overconfidence increases. The above discussion leads to hypothesis two:

Hypothesis 2A: VCs with access to more information are more confident in their decision than those with access to less information.

Hypothesis 2B: VCs with access to more information are less accurate in their decision.

Hypothesis 2C: VCs with access to more information are more overconfident.

Framing of Information

People possess a multitude of mental models (Medin and Ross 1996; Rumelhart and Ortnoy 1977), which can be called into action depending upon the situation. Thus, when the VC perceives a somewhat familiar situation that requires action, an appropriate mental model is summoned from long-term memory. In unfamiliar situations, the VC uses a particular evaluation strategy (a mental model of how to approach new situations) to formulate the information into a mental model, which is then manipulated to make a decision. We propose that a VC's perception of familiarity is, in part, determined by how the investment proposal is framed. If the investment is framed in terms of criteria VCs believe are important predictors of performance then this situation will seem more familiar than the same new venture proposal framed in terms of criteria that are unfamiliar yet are as predictive (or more predictive) as the familiar criteria. We propose VCs are more confident with decisions based on information framed in a familiar way than information framed in an unfamiliar way.

Social Judgment Theory (SJT) (Brunswik 1956) from cognitive psychology provides a framework for understanding how different types of information impact the decision process. SJT suggests that people make decisions using *cognitive* information factors or cues. Cognitive cues are decision criteria that expert VCs deem as best discriminating between success and failure. In other words, cognitive cues are those information factors that VCs say they use to make a decision. Cognitive cues are how VCs "frame" a decision. A multitude of studies have identified a variety of important cognitive cues (Wells 1974; Poindexter 1976; Tyebjee and Bruno 1984; MacMillan et al. 1985, 1987; Robinson 1987). Cognitive cues, however, may not be optimal in distinguishing between outcomes.

Task cues, on the other hand, are statistically derived as those information factors that best distinguish between possible outcomes. These cues are not necessarily in the form with which the decision-maker is familiar or comfortable. Task cues would be outside the VC's typical "frame." Roure and Keeley (1990), for example, derived task cues for 38 high-tech ventures from the Silicon Valley. The cues are completeness of team, product superiority, and time to product development and buyer concentration. These task cues are proxies for information that VCs deem important, but not in a format in which VCs are necessarily familiar. For instance, team completeness is a measure of how many five top management roles are filled at first funding (Roure and Keeley 1990). VCs, on the other hand, like to examine individual characteristics of the entrepreneurial team (i.e., familiarity with market, past start-up experience, etc.). Thus, VCs may not find the parsimonious task cues complete or intuitively appealing. Therefore, using task information may decrease VC confidence in her/his decision and have a detrimental effect on decision accuracy. For example, VCs using cognitive cues were able to more accurately predict success or failure of the new venture than those VCs that were required to use task cues—VCs using task cues were half as accurate (Zacharakis and Meyer 2000).

We argue above that VCs are experts in making new venture investment decisions and they start with a high base level of confidence. We propose that even if the form (frame) of the information changes and makes a decision much more difficult, VCs' confidence is "sticky" and they will make insufficient adjustments in their confidence level to changes in decision accuracy. From a theoretical perspective, this "sticky" confidence level could be a function of an anchoring and adjustment bias.[1] For instance, VCs' confidence level for familiar information would represent an anchor for confidence, and when the form of the information changes decreasing accuracy there will be an insufficient downward adjustment in confidence to compensate for the decrease in accuracy. In other words, "if a person's beliefs are positive, biases that favor conservatism generally will maintain positive illusions" (Taylor and Brown, 1988: 202). Therefore, VCs using task cues will be more overconfident. Hence:

> *Hypothesis 3A:* VCs presented with task cues are less confident in their decisions than VCs presented with cognitive cues.
>
> *Hypothesis 3B:* VCs presented with task cues are less accurate in their decisions than VCs presented with cognitive cues.
>
> *Hypothesis 3C:* VCs presented with task cues are more overconfident in their decisions than VCs presented with cognitive cues.

Personal Historical Information

Human behavior is a function of past decisions (Nelson and Winter 1982). Hence, outcomes of past decisions will influence the interpretation of information surrounding new decisions. Experience, according to Hambrick and Mason (1984), affect one's decision-making. For example, Trumbo, Adams, Milner, and Schipper (1962) found experienced judges to be more confident, but not necessarily more accurate. As VCs gain experience, they become more secure in their ability and eventually rely on an intuitive decision-making process—a "gut" feeling as to whether a venture will succeed or fail (Khan 1987; MacMillan et al. 1987). Such intuitive decision-making may lead to a false sense of security in that VCs believe they are fully evaluating all available information. Therefore, we propose that while accuracy may increase with experience, confidence increases at a greater rate, and therefore experienced VCs will demonstrate more overconfidence than their less experienced counterparts. Hence:

> *Hypothesis 4A:* The more experienced the VC, the more confident (s)he will be.
>
> *Hypothesis 4B:* The more experienced the VC, the more accurate (s)he will be.
>
> *Hypothesis 4C:* The more experienced the VC, the more overconfident (s)he will be.

Vividness of Information

The decision-maker's past experience influences his perception of future events. Those situations that occur frequently are more salient and more available or easily recalled to bear on current decisions (Tversky and Kahneman 1973; Bazerman 1994). This avail-

[1] Slovic and Lichtenstein (1971) suggest that: (a) an arbitrarily chosen reference point (anchor) will significantly influence value estimates and (b) value estimates will be insufficiently adjusted away from the reference point toward the true value of the object of estimation. This finding appears robust across a number of contexts (Hogarth 1988; Northcraft and Neale 1987).

ability heuristic often serves decision-makers well because those events that occur more frequently in our mind are often those that also occur more frequently in reality. However, this is not always the case. Factors other than the objective frequency of an event also affect the availability of information and these irrelevant influences may inappropriately affect VC judgment. For example, a VC's recall of information is likely to be affected by past events that are more vivid and evoke emotion. This might explain the tendency of decision-makers to recall past successes rather than past failures (Dawes 1988; Dawes, Faust, and Meehl 1989); a VC's successes may be more vivid and evoke more emotion than failures, especially "home runs." A "home run" that provides astronomical returns and makes a portfolio successful is likely to be highly vivid in the VC's mind. VC's may view current prospects in terms of how well this investment matches certain attributes of those past glories.

Tversky and Kahneman (1973) propose that the assessment of frequency or probability of an event is less likely to be affected by events that are unemotional in nature, difficult to imagine, and/or vague. New ventures with marginal performance (i.e., the floating dead) may not evoke as much emotion or be as easily recalled because those that are either big winners or big losers. We know that successes and failures are less common than average performance.

Griffin and Tversky (1992) propose that extremes of available evidence are likely to be assessed with higher confidence (holding all other things equal). Tversky and Kahneman (1974) suggest this leads to overestimating unlikely events. We propose that the implications for VC decision-making is that they will be more confident with success predictions than failure predictions. Success predictions will have certain attributes that match past "home runs". However, VCs will be more confident with success or failure predictions than predictions of average performance. Just as "home runs" are vivid, spectacular failures may also be easily recalled. Thus, VCs may be more confident in failure predictions than moderate performance predictions because these firms exhibit attributes that VCs recall from past failures. Moderate predictions may have one or two attributes congruent with a "home run" or dramatic failures, but other attributes may not match well with the VC's mental model of success or failure, thereby making the venture ambiguous.

Although confidence in success and failure predictions will be more vivid than moderate predictions, we propose that success predictions will be more vivid than failure predictions. People tend to attribute success to their own actions, but failure to uncontrollable external events (Bettman and Weitz 1983). In fact, Zacharakis, Meyer, and DeCastro (1999) find that VCs attribute *failed* ventures to uncontrollable external factors (versus poor management). Thus, they rationalize that failure was beyond their (and the entrepreneur's) control. On the other hand, Zacharakis et al. (1999) find that VCs attribute *success* to internal factors. Thus, success predictions are likely to be more vivid than failure predictions.

Accuracy should improve substantially with predictions at the extreme (i.e., success or failure versus an assessment of moderate performance). Ventures at the extreme better match past successes or failures; thus, VCs are using more appropriate mental models for making those decisions. We propose that while confidence will increase with the vividness of the information, accuracy increases at a greater rate. Therefore, VCs will demonstrate less overconfidence when making decisions involving vivid information, i.e., overconfidence is greater for failure (rather than success), for moderate (rather than success), and for moderate (rather than failure). Hence:

Hypothesis 5A: VCs are more confident in success predictions than failure predictions.

Hypothesis 5B: VCs are more accurate in success predictions than failure predictions.

Hypothesis 5C: VCs are less overconfident in success predictions than failure predictions.

Hypothesis 6A: VCs are more confident in success predictions than they are in moderate performance predictions.

Hypothesis 6B: VCs are more accurate with success predictions than they are with moderate performance predictions.

Hypothesis 6C: VCs are less overconfident in success predictions than they are in moderate performance predictions.

Hypothesis 7A: VCs are more confident in failure predictions than they are in moderate performance predictions.

Hypothesis 7B: VCs are more accurate with failure predictions than they are with moderate performance predictions.

Hypothesis 7C: VCs are less overconfident in failure predictions than they are in moderate performance predictions.

In sum, due to the nature of a VC's task, they will be overconfident in their assessments of venture potential and this overconfidence will adversely affect decision accuracy. However, we hypothesize that the level of overconfidence depends on the amount of information, the framing of information, historical personal information (experience) and the vividness of information. Specifically, VCs with greater access to information, presented with unfamiliar task cues, and who have considerable experience will be more overconfident than those with less information, presented familiar cognitive cues and have less experience. Furthermore, we hypothesize that the vividness of the information (i.e., success, failure and moderate performance predictions) will also affect the level of overconfidence—VCs are more overconfident in failure predictions than success predictions, as well as more overconfident in moderate performance predictions than in success and failure predictions. The research method to empirically test the hypothesized relationships is now described.

METHOD

A policy capturing experiment, a real-time method common in cognitive psychology, was used on 53 VCs to examine their investment decision process. Two of the 53 participants were removed (one because the PC crashed during the exercise and the other because he did not wish to continue past the first few decisions). The participating VCs were from two entrepreneurial hotbeds, Denver/Boulder and the Silicon Valley. Appendix A details the sample demographics.

Each of the participants made 50 investment decisions using from four to eight information factors depending upon treatment (see Table 1). The cognitive cues in Treatments 1 and 2 were derived from previous post hoc research (Wells 1974; Poindexter 1976; Tyebjee and Bruno 1984; MacMillan et al. 1985; MacMillan et al. 1987; Robinson 1987). Cue frequency across studies and reported importance within each study were the criteria for including a particular cue in the experiment. Additionally, cues that were highly correlated with other cues were removed (Lewis, Patton, and Green

TABLE 1 Experiment Treatment Variables

Base Cognitive Cues (Treatment 1)	Additional Cognitive Cues (Treatment 2)	Task Cues (Treatment 3)
1. Market familiarity—average number of years of experience in market/industry for team 2. Leadership ability—average number of years of management experience for team 3. Proprietary protection—level of protection provided because product/service or process to deliver product/service is unique and difficult to imitate 4. Market size–market revenues for most current year 5. Market growth—percentage over last several years	Same five cues as base cognitive cues treatment plus: 6. Relevant track record—number of past start-up experiences for team 7. Competitors—number of direct competitors 8. Competitor strength–five-point scale from high strength (large relative market share) to low (numerous small market share competitors)	1. Completeness of team—percentage of key positions which were filled at the time of the first major (over $300,000) outside funding. 2. Product superiority—how product compares with existing products 3. Time to development—number of months from initiation of development to the initial sale as forecast in business plan 4. Buyers concentration—measures the number of potential customers in the target market during the first two years of sales

1988) retaining the cue that was deemed most important in the literature. A consulting expert VC also verified that the retained cue was valid and important. Although the list is not exhaustive, it is more probable that the identified cues in this study include unimportant factors rather than exclude important factors, because experts typically identify far more cues than they actually use (Stewart 1988).

Treatment 1 (the Base Cognitive Cues Treatment) presented five information cues commonly cited in past VC decision-making studies. Treatment 2 (Additional Cognitive Cues Treatment) explored the effect of added information; it used the original five cues plus three others. Treatment 3 (Task Cues Treatment) investigated how the VCs reacted to information cues that supposedly best distinguish between ultimate success and failure. Unlike the previous two treatments, Treatment 3 cues were those statistically derived (by Roure and Keeley 1990). As such, these cues were not in a form with which the VC was familiar. VCs were sent letters asking them to participate. Once they agreed, they were randomly assigned to one of the three treatments.

Decision scenarios were created once the pertinent cues had been identified. Cooperative VCs outside the sample of the study (primarily VCs based in Chicago and the East Coast) provided actual investment decision scenarios. A stipulation for using the actual cases was that the entrepreneur, venture, and any associated firms or individuals remain unidentified. Such a provision does not impede this study in any way. In fact, identifying the venture or entrepreneur might bias the participant's decisions. For example, personal knowledge of an entrepreneur's reputation might lead the subjects to judge that case without fully evaluating other supplied information. Products also are not identified, because many of the actual ventures included products identified with unique firms. Moreover, identifying the product might also narrow the available sample size. A VC may be hesitant to make a decision about a biotechnology firm if (s)he specializes in computer disk storage. Although a proposed venture may not fit a particular VC firm's investment criteria, VCs within those firms often screen such ventures and, if they have potential, refer them to a more suitable VC. For the same reasons, financial cues are not included in this experiment. Different VCs use different hurdle rates. Since this experiment focuses on the screening stage it is appropriate to minimize any preset biases regarding unique firm investment criteria (i.e., industry, etc.).

Value ranges given to each cue allow it to be compared across scenarios (Stewart 1988). Concrete values are used (e.g., market size) for cue values when possible, but purely representative distributions are appropriate for subjective cues (Stewart 1988). A uniform coding system for subjective information factors allows consistent coding across the business plans used in building the experiment. For instance, the subjective information factors within the Cognitive Cue Treatments were rated on a five-point scale. For example, the proprietary product cue value rated from 1 (lowest protection) to 5 (highest protection). Likewise, competitor strength was also rated on a five-point scale. Within the Task Cue Treatment, Roure and Keeley's (1990) subjective rating scale was used.

The lead researcher pulled information factors from the business plans of the actual cases. To ensure inter-judge reliability, a colleague unfamiliar with the business plans or their outcomes also coded all appropriate cues. The lead researcher provided the second coder with the entire list and description of the information factors of interest. Overall inter-judge reliability equates to 87.5%. Berelson (1952) reports that inter-judge reliability typically ranges from 66 to 95%. As such, the coding is deemed reliable.

A technique to further decrease multicolinearity while maintaining strong external validity is to combine actual and statistically derived cases. A random case generator from Policy PC software package (Stewart 1991) creates a manageable number of statistically derived cases. MANOVA (Multivariate Analysis of Variance) verifies that the statistical cases are from the same population as the actual cases. The independent variables (decision cues used in the three treatments) have equal variance between real and generated cases, and the multivariate means are equivalent. Furthermore, a consulting expert VC identified those cases that were not feasible (i.e., combination of cue values that rarely occurs in reality). Unfeasible scenarios were dropped from the sample of potential candidates.

The investment decisions were presented on a notebook computer brought directly to the VC's office. VCs were assigned to the three treatments with 20 VCs completing Treatment 1, 17 completing Treatment 2, and 14 completing Treatment 3.

After the VCs viewed each decision case, they gauged how likely the potential venture was to succeed on a seven-point scale—7 equated to very likely to succeed and 1 equated to very unlikely to succeed. Next, the participants recorded their confidence in their success assessment using another seven-point scale. The confidence scale was anchored by high confidence (the venture exhibits all of the characteristics of a resounding success/failure) and low confidence (no more confident the venture will succeed or fail than in predicting a head or a tails in a coin flip). In sum, the confidence level that the VC records should equate with the expected outcome of the venture. The VC clicks 7 if (s)he is certain that the venture will either succeed or fail. If, on the other hand, the information is so ambiguous that the VC cannot accurately gauge whether the venture will succeed or fail, (s)he clicks 1. A pre-experiment questionnaire requested both personal and firm characteristics including years of experience in the venture capital industry.

To assess the base level of overconfidence, the predictive ability (accuracy) for each VC was calculated as the proportion of correct VC responses (i.e., a comparison of the predicted performance with actual performance). Because the exercise included 25 actual funded ventures that had achieved some outcome (i.e., venture harvested with some return or failed providing no return on investment), we can compare participating VC predictions with the venture's actual outcome. Coding of the VC response to success or failure was conducted as follows: 5 to 7 (success probability is high), 4 (VC is unsure or doesn't know), 1 to 3 (failure probability is high). Likert responses of 4 were not included in the analysis. When measuring actual outcomes, a venture was considered a success if it had a return on investment of 15% or greater (Dean and Giglierano 1990). The venture was coded a failure if its return was less than 15%[2]. The number of correct predictions out of the total number of possible ventures was the accuracy rate. Although lots of things can influence a venture's ultimate success after funding (i.e., changes in market conditions, management decisions, VC involvement, etc.), Roure and Keeley (1990) assert that the initial investment decision is highly correlated with venture outcome. In other words, ultimate venture success is predictable from characteristics of the new venture at prefunding, such as the quality of the entrepreneurial team, the nature of opportunity, and potential market growth.

Confidence, accuracy and overconfidence were only measured using the 25 cases derived from actual ventures, not the 25 statistically generated cases. The appropriateness of a VC's confidence (overconfidence, under-confidence, or perfect calibration) is determined by comparing the "confidence in the accuracy of a prediction" with the "accuracy of prediction" (Mahajan 1992). An individual is overconfident when their confidence is significantly higher than their accuracy rate. Under-confidence represents a confidence level below one's accuracy.

To analyze the data, an overconfidence index was calculated. It represents a ratio of confidence over accuracy. Confidence is measured as a mean of confidence ratings for that person and converted to a percentage (i.e., from a scale out of 7 to a scale out of 100). Accuracy was measured as the percentage of accurate predictions for each person. Therefore, we had an overconfidence index for each VC. If the overconfidence index was one then the person was appropriately calibrated, i.e., their confidence is appropriate for their level of accuracy. An index below one indicated under-confidence, and an index was above one represented overconfidence.

For hypotheses 2, 3, and 5 ANOVA (Analysis of Variance) was used to determine if the differences hypothesized were significant. Hypothesis 3 used only VCs that used cognitive cues. To test Hypotheses 6 and 7, the following were calculated: (a) confidence level, (b) accuracy level, and (c) overconfidence index for each person for all three levels of success predictions—success, failure, and moderate performance predictions. Again ANOVA was used to determine if the differences were significant. Hypothesis 4, like hypothesis 1B, used regression analysis.

To compare confidence in success predictions with confidence in failure predictions, each individual's mean confidence for predictions of success (scores of 5, 6, or 7 on the seven-point scale) was matched with that individual's confidence in their failure predictions (scores of 1, 2, or 3 on the seven-point scale).

RESULTS

The mean overconfidence index across all VCs was 2.91 with a standard deviation of 2.42—on average, VCs are overconfident. Figure 1 demonstrates that 96% of the partici-

[2] It should be noted that no actual outcomes were very close to the 15% cut-off. The nearest success venture had a ROI (Return on Investment) of 31% and the nearest failure venture had an ROI of 6%. Most ventures were much further away than these two.

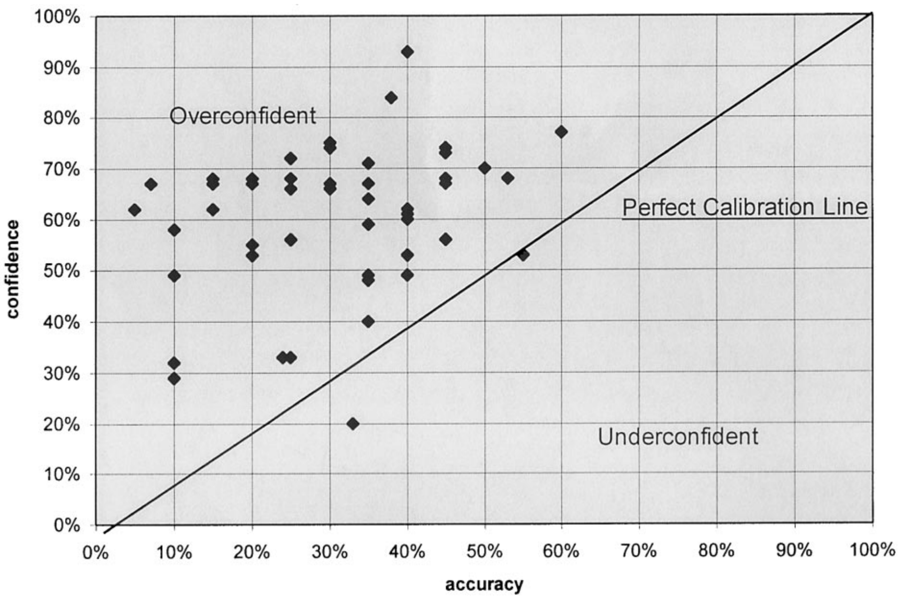

FIGURE 1 Scatterplot of confidence against accuracy.

pating VCs have a confidence level that is greater than their accuracy rate, i.e., VCs' confidence in their predictions are above the diagonal line (the diagonal line represents perfect calibration—the appropriate level of confidence). ANOVA indicates that VCs' confidence is significantly higher than their accuracy ($p = 0.0001$). This provides support for Hypothesis 1A—VCs are overconfident.

So what if VCs are overconfident? We have argued using theory that overconfidence could have a detrimental effect on accuracy. We used regression analysis to analyze the effect of overconfidence (using the overconfidence index) on accuracy (percentage of predictions that were accurate). If everyone were perfectly calibrated, then the overconfidence index would explain none of the variance in accuracy.

The results for hypothesis 1B and hypotheses 2–7 are presented in Table 2. Table 2 demonstrates that the level of overconfidence significantly predicted accuracy ($p = 0.000$). An R^2 of 0.496 indicates that almost half of the variance in accuracy amongst VCs can be explained by their differences in overconfidence. The regression coefficient was negative indicating that the higher the VC's overconfidence, the lower the decision accuracy. The correlation between overconfidence and accuracy is -0.704. This provides support for hypothesis 1B.

The majority of hypotheses were supported (see Table 2). The amount of information and type of information (cognitive cue or task cue) affected VC decision-making as expected. However, Hypothesis 2A, which suggested that more information would increase VC confidence, is not supported (although in the expected direction). Nonetheless, more information had a significantly negative impact on accuracy ($p = 0.020$). Thus, more information leads to higher overconfidence ($p = 0.027$). The type of information also impacts confidence, accuracy and overconfidence, although Hypothesis 3A, which suggests task cues lead to decreased confidence, received only marginal support ($p = 0.087$).

Hypotheses 4A, 4B, and 4C, which suggest that experienced VCs are more confi-

TABLE 2 Results

Hypothesis (Using Regression Analysis)	B	R^2	F	Significance of F	Support
H1B: Overconfidence adversely affects accuracy.	−13.153	0.496	46.182	0.000	Supported
H4A: The more experienced the VC, the more confident (s)he will be.	8.982	0.012	0.575	0.452	Not supported
H4B: The more experienced the VC, the more accurate (s)he will be.	9.482	0.015	0.744	0.393	Not supported
H4C: The more experienced the VC, the more overconfident (s)he will be.	−0.916	0.047	2.304	0.136	Not supported

Hypothesis (Using ANOVA)	Mean 1	Mean 2	R^2	P Value	Support
H2A: VCs with access to more information are more confident in their decision.	0.685	0.663	0.009	0.579	No support
H2B: VCs with access to more information are less accurate in their decision.	0.283	0.375	0.142	0.020	Supported
H2C: VCs with access to more information are more overconfident.	2.600	1.880	0.132	0.027	Supported
H3A: VCs presented task cues are less confident in their decisions.	0.673	0.602	0.060	0.087	Marginal support
H3B: VCs presented task cues are less accurate in their decisions.	0.332	0.167	0.278	0.000	Supported
H3C: VCs presented task cues are more overconfident in their decisions.	2.211	3.426	0.196	0.002	Supported
H5A: VCs are more confident in success predictions than failure predictions.	0.709	0.648	0.040	0.048	Supported
H5B: VCs are more accurate in success predictions than failure predictions.	0.572	0.226	0.476	0.000	Supported
H5C: VCs are less overconfident in success predictions than failure predictions.	1.313	4.181	0.288	0.000	Supported
H6A: VCs are more confident in success predictions than they are in moderate performance predictions.	0.709	0.588	0.205	0.000	Supported
H6B: VCs are more accurate with success predictions than they are with moderate performance predictions.	0.572	0.017	0.764	0.000	Supported
H6C: VCs are less overconfident in success predictions than they are in moderate performance predictions.	1.313	10.000	0.993	0.000	Supported
H7A: VCs are more confident in failure predictions than they are in moderate performance predictions.	0.648	0.588	0.043	0.039	Supported
H7B: VCs are more accurate with failure predictions than they are with moderate performance predictions.	0.226	0.017	0.427	0.000	Supported
H7C: VCs are less overconfident in failure predictions than they are in moderate performance predictions.	4.181	10.000	0.638	0.000	Supported

dent, more accurate, and less overconfident than less experienced VCs, are not supported (see Table 2). Regression analysis using years of VC experience as the independent variable indicates that experience is not significantly correlated with confidence, accuracy, or overconfidence.

Hypotheses 5, 6, and 7, which address the vividness of information used in the decision, are all supported (see Table 2). VCs are more confident in success predictions than failure (Hypothesis 5A) and moderate predictions (Hypothesis 6A). Likewise, VCs are more confident in failure predictions than moderate predictions (Hypothesis 7A). VCs are more accurate with success predictions than failure (Hypothesis 5B) and moderate predictions (Hypothesis 6B). VCs are also more accurate with failure predictions than moderate predictions (Hypothesis 7B). Moreover, VCs are most overconfident in moderate predictions, followed by failure predictions and least for success predictions providing support for Hypotheses 5C, 6C, and 7C.

DISCUSSION

This study used theory from the judgment/decision-making literature to investigate the factors that affect the presence and/or magnitude of overconfidence bias for VCs assessing likely new venture success. Consistent with this literature, the current study found VCs were overconfident. Furthermore, the level of overconfidence did vary depending on the amount of information provided and how that information was framed. Such consistency provided the opportunity to use theory to help us understand which factors affect VC overconfidence and why. For example, VCs' overconfidence is higher (a) for task cues (unfamiliar cues) than for cognitive cues (familiar cues), (b) for failure predictions than for success predictions, and (c) for moderate performance predictions than for success and failure predictions.

The findings that suggest VCs are more overconfident with decisions utilizing unfamiliar decision cues (as expected) result from their decrease in decision accuracy being greater than the decrease in confidence (an insufficient downward adjustment of confidence to reflect the substantial decrease in accuracy). The fact that VCs are more confident when using cognitive cues is consistent with research that suggests VCs are intuitive decision-makers (Khan 1987; McMillan et al. 1987). When people are familiar with a decision and the structure of the information surrounding that decision, they resort to an automatic information processing style (Koriat, Lichtenstein, and Fischhoff 1980). On the other hand, if information surrounding the decision is structured in an unfamiliar way, people need to decipher what each piece of information means and how that impacts their overall decision (Shiffrin and Schneider 1977). In the case of expert VCs, that means they must deviate from their intuitive style. It seems that forcing them outside their "comfort zone" has a negative affect on their confidence and has an even greater affect (negative) on their accuracy.

While there is evidence to suggest that VCs are susceptible to an availability bias (i.e., making a decision about a current venture on the basis of how it matches past successful or failed funded ventures), VCs are less overconfident with their success predictions than with all other predictions (as hypothesized).

Hypothesis 4, which suggests that greater experience leads to greater overconfidence, was not supported. A possible explanation is that VCs progress up the learning curve rapidly. After a year or so as an associate, the VC may already be confident in their ability. They may also already be intuitive decision-makers.

Practical Implications for VCs

The findings of this study suggest that VCs are overconfident. The practical implications of such overconfidence may be an overreliance on existing knowledge resulting in only a limited information search instead of seeking additional information (Mahajan 1992). This may result in backing ventures that should not have been funded and/or passing on opportunities that should have been grasped. Recognition of the overconfidence bias represents an opportunity for VCs to improve their decision accuracy—they can more carefully scrutinize those "high risk of overconfidence" decisions with the goals of reducing the negative implications associated with the overconfidence bias. We propose a number of techniques that reduce automatic processing, force VCs to more critically analyze key pieces of information, and possibly reduce overconfidence (and potentially other biases). It should be pointed out that through trial and error many VC firms already use one or more of these techniques. We propose that the use of counterfactual thinking, the "humbling effect," and decision aids are potentially the most useful techniques—they are briefly described below.

First, VCs can utilize counterfactual reasoning (Fischhoff and MacGregor 1982; Mahajan 1992; Russo and Schoemaker 1992). Counterfactual reasoning refers to imagining scenarios where the current decision assumptions might not hold. What factors might suggest that the present decision is incorrect? Has all the available information been correctly analyzed? Is there additional information that has yet to be uncovered? Might it suggest a different "story," one of venture failure? Many VC firms have weekly meetings where each VC gives a status report of the ventures that (s)he is considering. Arkes, Christensen, Lai, and Blumer (1987) suggest that this exercise of justifying one's decision in front of a group will force counterfactual information to be addressed. Whether the individual VC develops counterfactual information himself or whether colleagues raise counterfactual scenarios, this questioning of the reasons behind a decision should decrease overconfidence and improve decision quality.

Second, VCs can use the "humbling effect" (Mahajan 1992; Russo and Schoemaker 1992). The humbling effect refers to receiving negative feedback from past decisions. Unfortunately for VCs, the ultimate source of feedback (whether a venture succeeds or fails) typically takes years to come forth. Delayed feedback makes it more difficult for decision-makers to learn from their mistakes (Shanteau 1992). As time passes, decision-makers suffer from post hoc rationalizations and recall biases (Barr, Stimpert, and Huff 1992; Sandberg, Schweiger, and Hofer 1988). One method that VCs can use to increase the effect of feedback is to keep a record (Fischhoff and MacGregor 1982), or "scorecard" of what criteria they considered when initially making the decision. Comparing scorecards of successful and failed ventures is potentially a great learning tool and could reduce overconfidence in future decisions. However, follow-up discussion with the VCs in this study found that only 24% utilize such tools.

Finally, VCs can use actuarial decision aides (Elstein and Bordage 1988). An actuarial model decomposes decisions into component parts and then optimally combines relevant information to derive an answer. Thus, an actuarial model of the VC's decision forces the VC to systematically evaluate each component independently and then combine these independent analyses to obtain an investment decision. Zacharakis and Meyer (2000) found that actuarial decision aids significantly improve decision effectiveness of VCs. Improvement in the investment decision may in part be attributed to a reduction in the VCs' overconfidence. An empirical investigation of the effect that the use of decision aids has on the level of overconfidence would be an important research pursuit.

In sum, VCs, as do all expert decision-makers, need to be aware of the threat of overconfidence and the associated reduction in decision quality. We propose to VCs that overconfidence represents an opportunity for improving decision quality first through awareness that you are likely to be overconfident and, second, through applying some of the above techniques to reduce the negative impact of the bias.

Limitations of Study

This study utilizes policy capturing as its primary technique for empirical analysis. As with any technique there are limitations. Some of these limitations and the means by which they were addressed are now described. One such issue might be that the information within the decision exercise does not perfectly mirror the "real life" decision. Such "paper tests" affect the external validity of many lens model experiments (Brehmer and Brehmer 1988). Nevertheless, policy-capturing experiments are still a valid method for deriving what information decision-makers actually use (Stewart 1993). Brown (1972) finds that under even the most contrived cases, the decisions reflect actual decisions. Moreover, because the VC decision has a large "paper" component in the real world (i.e., much of the VC's information comes from business plans), correlation between the experimental task and the "real world" decision should be higher than most policy capturing studies.

Coded cues might eliminate perceptual elements from the task, pushing it into a more conceptual domain and placing less emphasis on judges' ability to extract cue information (Brehmer and Brehmer 1988). VCs' real decision environment is information rich and often captured in voluminous business plans. For practical purposes, a full executive summary of a business plan could not be presented, and the number of cues needed to be reduced. The cues chosen are justified by numerous VCs' decision-making studies, and discussions with VCs, entrepreneurs, and academics indicate that the instrument has face validity. We propose that this limitation was more likely to increase the chance of rejecting this study's hypotheses. For example, maybe the additional three cues presented in Treatment 2 were not a sufficiently strong manipulation of an increase in information (not sufficiently representative of the information load sometimes facing a VC). Thus, the current design could be considered a conservative test of the impact of information on confidence.

Future Research Opportunities

There are a number of research opportunities that arise from this study. For example, can VCs use the information in this study (namely, VCs are overconfident and that overconfidence negatively affects accuracy) to improve their decision process (i.e., reduce the level of overconfidence or employ people who are less overconfident)? Judgment/decision-making scholars would likely respond in the affirmative, and we have described techniques that may be used to reduce overconfidence. Alternatively, is there greater complexity in the relationship between overconfidence and a VC's performance? Maybe overconfidence is not always dysfunctional. Maybe the relationship between confidence and a VC's performance is not linear but an inverted U shape where the optimal level of confidence is not perfect calibration but at some other level of overconfidence.

Busenitz and Barney (1997) propose that optimistic overconfidence is useful for entrepreneurship; otherwise they might not start the business. If entrepreneurs fully evaluated all available information, they might miss the "window of opportunity" or freeze from "paralysis by analysis." Moreover, a more "rational" decision process might increase the perceived risk of a new venture and lead VCs to reject many promising ventures. This discussion leads to the following research question: Is there an optimal level of overconfidence?

Although optimistic overconfidence likely increases the VC's proclivity to fund new ventures and work hard to make sure those funded ventures succeed, reducing the negative effect of overconfidence may increase decision quality without unduly diminishing the VCs faith in funded ventures. In other words, implementing some of the techniques for reducing overconfidence cited earlier should improve decision quality, which in turn should give the VC greater faith in her/his decision and generate some of the positives of optimistic overconfidence without the negative effects of systematic biases. This discussion leads to some intriguing research questions: Do VCs who use techniques that reduce overconfidence make better decisions? Do these VCs reject more venture proposals? Is their commitment as measured by active involvement in funded ventures less than their peers who do not use overconfidence reducing techniques?

CONCLUSION

VCs are commonly recognized as experts in predicting new venture success. However, this paper indicates that VC investment decisions are biased by overconfidence. This overconfidence negatively affects decision accuracy. Overconfidence varies with the amount, form, and vividness of the information used in their decision. Specifically, VC overconfidence increases with more information, unfamiliar framing of information, and also with moderate performance predictions relative to all other more extreme (more vivid) predictions, and with failure predictions relative to extreme success predictions. VC overconfidence will likely lead to a reduced information search, decreased motivation for self-improvement, and the funding of inappropriate ventures. Awareness of overconfidence bias provides a basis for improving the quality of VCs' investment decisions.

REFERENCES

Arkes, H.R. 1981. Impediments to accurate clinical judgment and possible ways to minimize their impact. *Journal of Consulting and Clinical Psychology* 49:323–330.

Arkes, H.R., Christensen, C., Lai, C., and Blumer, C. 1987. Two methods of reducing overconfidence. *Organizational Behavior and Human Decision Processes* 39:133–144.

Baron, R.A. 1998. Cognitive mechanisms in entrepreneurship: Why, and when entrepreneurs think differently than other people. *Journal of Business Venturing* 13:275–294.

Barr, P.S., Stimpert, J.L., and Huff, A.S. 1992. Cognitive change, strategic action, and organizational renewal. *Strategic Management Journal* 13:15–36.

Bazerman, M.H. 1994 *Judgement in Managerial Decision-making.* New York, NY: Wiley.

Bettman, J., and Weitz, B. 1983. Attributions in the boardroom: Causal reasoning in corporate annual reports. *Administrative Science Quarterly* 28:165–183.

Brehmer, A., and Brehmer, B. 1988. What have we learned about human judgment from thirty years of policy capturing. In B. Brehmer and C. Joyce, eds., *Human Judgment: The SJT View*. North Holland: Elsevier.

Brown, T.R. 1972. A comparison of judgmental policy equations obtained from human judges under natural and contrived conditions. *Mathematic Bioscience* 15:205–230.

Brunswik, E. 1956. *Perception and the Representative Design of Experiments.* Berkeley: University of California Press.

Busenitz, L.W., and Barney, J.B. 1997. Differences between entrepreneurs and managers in large organizations: Biases and heuristics in strategic decision-making. *Journal of Business Venturing* 12:9–30.

Castellan, N.J. 1977. Decision-making with multiple probabilistic cues. In N. Castellan, J. Pisoni, and M. Potts, eds., *Cognitive Theory*, volume 2. Hillsdale, NJ: Erlbaum. 117–146.

Cooper, A.C., Folta, T.B., and Woo, C. 1995. Entrepreneurial information search. *Journal of Business Venturing* 10:107–120.

Dawes, R.M. 1988. *Rational Choice in an Uncertain World.* Fort Worth: Harcourt Brace Jovanovich.

Dawes, R.M., Faust, D., and Meehl, P.E. 1989. Clinical versus actuarial judgment. *Science* 243:1668–1674.

Dean, B.V., and Giglierano, J.J. 1990. Multistage financing of technical start-up companies in Silicon Valley. *Journal of Business Venturing* 5:375–389.

Elstein, A.S., and Bordage, G. 1988. Psychology of clinic reasoning. In Dowie and A.S. Elstein, eds., *Professional Judgment*, 109–129.

Fischhoff, B., and MacGregor, D. 1982. Subjective confidence in forecasts. *Journal of Forecasting* 1:155–172.

Gilbert, D., and McNulty, S., Giuliano, T., and Benson, J. 1992. Blurry words and fuzzy deeds: The attribution of obscure behavior. *Journal of Personality and Social Psychology* 62(1):18–25.

Griffin, D.W., and Tversky, A. 1992. The weighting of evidence and the determinants of confidence. *Cognitive Psychology* 24:411–435.

Griffin, D.W., and Varey, C.A. 1996. Towards a consensus on overconfidence. *Organizational Behavior and Human Decision Processes* 65(3):227–231.

Hambrick, D.C., and Mason, P.A. 1984. Upper echelons: The organization as a reflection of its top managers. *Academy of Management Review* 9(2):193–206.

Harvey, N. 1994. Relations between confidence and skilled performance. In G. Wright and R. Ayton, eds., *Subjective Probability.* New York: Wiley, 321–351.

Hogarth, R.M. 1988. *Judgement and Choice.* Chichester, Great Britain: Wiley.

Kahneman, D., and Tversky, A. 1982. The psychology of preferences. *Scientific America* 246:160–173.

Kahneman, D., Slovic, P., and Tversky, A. 1982. *Judgment Under Uncertainty: Heuristics and Biases.* Cambridge: Cambridge University Press.

Khan, A.M. 1987. Assessing venture capital investments with noncompensatory behavioral decision models. *Journal of Business Venturing* 2:193–205.

Koriat, A., Lichtenstein, S., and Fischhoff, B. 1980. Reasons for confidence. *Journal of Experimental Psychology: Human Learning and Memory* 6:107–118.

Kunze, R.J. 1990. *Nothing Ventured: The Perils and Payoffs of the Great American Venture Capital Game.* New York: Harper Business.

Lewis, B.L., Patton, J.M., Green, S.L. 1988. The effects of information choice and information use on analysts; predictions of municipal bond rating changes. *The Accounting Review* 63 (2):270–282.

MacMillan, I.C., Zemann, L., and Subba Narasimha, P.N. 1987. Criteria distinguishing unsuccessful ventures in the venture screening process. *Journal of Business Venturing* 2:123–137.

MacMillan, I.C., Seigel, R., and Subba Narasimha, P.N. 1985. Criteria used by venture capitalist to evaluate new venture proposals. *Journal of Business Venturing* 1:119–128.

Mahajan, J. 1992. The overconfidence effect in marketing management predictions. *Journal of Marketing Research* 29:329–342.

Medin, D.L., and Ross, B.H. 1996. *Cognitive Psychology*, 2nd edition. Fort Worth, TX: Harcourt Brace College Publishers.

Nelson, R.R., and Winter, S.G. 1982. *An Evolutionary Theory of Economic Change.* Cambridge, MA.: Harvard University Press.

Nisbett, R.E., and Ross, L. 1980. *Human Inference.* Englewood Cliffs, NJ: Prentice-Hall.

Northcraft, G.B., and Neale, M. 1987. Experts, Amateurs, and Real Estate: An Anchoring-and-Adjustment Perspective on Property Pricing Decisions. *Organizational Behavior and Human Decision Process* 39 (February): 84–97.

Oaksford, M., Morris, F., and Williams, M. 1996. Mood, reasoning, and centralexecutive processes. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 22(2):476–492.

Oskamp, S. 1982. Overconfidence in case-study judgments. In D. Kahneman, P. Slovic, and A. Tversky, eds., *Judgment Under Uncertainty: Heuristics and Biases.* Cambridge: Cambridge University Press. 287–293.

Payne, J.W., Bettman, J.R., and Johnson, E.J. 1988. Adaptive strategy selection in decision-making. *Journal of Experimental Psychology: Learning Memory and Cognition* 14(3):534–552.

Pitz, G., and Sachs, N. 1984. Judgment and decision: Theory and application. *Annual Review of Psychology* 35:139–163.

Poindexter, E.A. 1976. *The Efficiency of Financial Markets: The Venture Capital Case.* Unpublished doctoral dissertation: New York University, New York.

Robinson, R.B. 1987. Emerging strategies in the venture capital industry. *Journal of Business Venturing*, 2:53–77.

Roure, J.B., and Keeley, R.H. 1990. Predictors of success in new technology based ventures. *Journal of Business Venturing*, 5:201–220.

Rumelhart, D.E., and Ortnoy, A. 1977. The representation of knowledge in memory. In R. Anderson, R. Spiro, and W. Montague, eds., *Schooling and Acquisition of Knowledge.* Hillsdale, NJ: Erlbaum.

Russo, J.E., and Schoemaker, P.J.H. 1992. Managing overconfidence. *Sloan Management Review* Winter: 7–17.

Sandberg, W.R., Schweiger, D.M., and Hofer, C.W. 1988. The use of verbal protocols in determining venture capitalists' decision processes. *Entrepreneurship Theory and Practice* Winter: 8–20.

Shanteau, J. 1992. Competence in experts: The role of task characteristics. *Organizational Behavior and Human Decision Processes* 53:252–266.

Shiffrin, R. M., and Schneider, W. 1977. Controlled and automatic human information processing: Perceptual learning, automatic attending, and a general theory. *Psychological Review* 84:127–190.

Slovic, P., and Lichtenstein, S. 1971. Comparison of bayesian and regression approaches to the study of information procession in judgment. *Organizational Behavior and Human Performance* 6:649–744.

Stewart, T.R., 1993. *Notes on the Validity of Judgment Analysis.* Working paper.

Stewart, T.R. 1991. *Policy PC: Judgment Analysis Software Reference Manual.* Albany: Executive Decision Services.

Stewart, T.R. 1988. Judgment analysis: Procedures. In B. Brehmer and C. Joyce, eds., *Human Judgment: The SJT View.* North Holland: Elsevier.

Taylor, S.E., and Brown, J.D. 1988. Illusion and well-being: A social psychological perspective on mental health. *Psychological Bulletin* 103:193–210.

Trumbo, D., Adams, C., Milner, M., and Schipper, L. 1962. Reliability and accuracy in the introspection of hard red winter wheat. *Cereal Science Today* 7:62–71.

Tversky, A., and Kahneman, D. 1974. Judgment under uncertainty: heuristics and biases. *Science* 185:1124–1131.

Tversky, A., and Kahneman, D. 1973. Availability: A heuristic for judging frequency and probability. *Cognitive Psychology* 5:207–232.

Tyebjee, T.T., and Bruno, A.V. 1984. A model of venture capitalist investment activity. *Management Science* 30(9):1051–1056.

Venkataraman, S. 1997. The distinctive domain of entrepreneurship research: An editor's perspective. In J. Katz, ed., *Advances in Entrepreneurship, Firm Emergence, and Growth*, Volume III. Greenwich, CT: JAI Press. 119–138.

Wells, W.A. 1974. *Venture Capital Decision-making.* Unpublished doctoral dissertation, Carnegie-Mellon University, Pittsburgh.

Wyer, R., and Srull, T. 1994. *Handbook of Social Cognition.* Hillsdale, NJ: Erlbaum.

Zacharakis, A.L., and Meyer, G.D. 2000. The potential of actuarial decision models: Can they improve the venture capital investment decision? *Journal of Business Venturing* 15(4):323–346.

Zacharakis, A.L., Meyer, G.D., and DeCastro, J.O. 1999. Differing perceptions of new venture failure: A matched exploratory study of venture capitalists and entrepreneurs. *Journal of Small Business Management* 37(3):1–14.

APPENDIX A VC Firm Level Demographics

Variable	Description	Range	Mean	Standard Deviation
Stage of Investment	Seed (%)	0–100	21.6	21.214
	Start-up (%)	0–100	35.7	21.926
	Early growth (%)	0–60	22.8	15.324
	Expansion (%)	0–60	18.5	17.809
	Decline (%)	0–40	1.5	6.136
Size of VC Firm	Dollars under investment control (in millions)	1–2000	202.9	316.196
Age of Firm	Years since founding	1–32	14.0	7.890
Number of Associates	FT equivalents actively involved in venture funding decisions	1–35	5.4	5.033
Industry Requirements	Percentage of portfolio in high technology versus low technology	0–100	81.4	24.977
Geographic Focus	State (1) Regional (2) National (3) International (4) None (5)	1–4	2.4	.753
Average Funding per Venture	Dollar amount (in thousands)	50–50,000	3304.6	7031.198
Type of VC Firm	Independent/private, bank affiliated, corporation affiliated, nonaffiliated SBIC (Small Business Investment Corporation)	All independent		
Average Number of Investors per Venture	0, 1–3, 4–5, >5	0–>5	2.5	1.525
	Individual VC Demographics			
Age	Measured in years	29–72	46.5	10.366
Gender		50 males, 3 females		
Education Level	Years of education with a high school graduate = 12; 4-yr college degree = 16, etc., College, Graduate, etc.	14–22	17.8	.977
Education Type (number of VCs with degree in field)	Business	44		
	Engineering	23		
	Liberal Arts	17		
	Science	8		
Tenure with Firm	Number of years with current firm	1–25	8.7	6.104
Other VC Experience	Years	0–19	2.3	4.239
Other Relevant Experience	Number of years working (including years as VC)	5–49	22.5	10.341