THESIS DECLARATION

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Thesis title:

MICROFOUNDATIONS OF ENTREPRENEURIAL DECISION MAKING: COGNITIVE AND AFFECTIVE FACTORS IN THE EVALUATION AND PURSUIT OF NOVEL OPPORTUNITIES

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To my mother and my grandfather

ABSTRACT

My dissertation explores the individual, situational and procedural factors that can foster decision makers' ability to form effective judgments under conditions of strong (Knightian) uncertainty, focusing specifically on strategic and entrepreneurial settings. It considers the process through which individuals evaluate novel opportunities, thus developing a procedural, rather than a substantive, content-based approach. In addition, it aims at mapping both the factors that influence one's evaluation of entrepreneurial projects, as well as one's ability and motivation to actively pursue the selected opportunities. These lines of research are explored within three papers in my dissertation.

The first paper builds on a recent tradition, which argues that even though under conditions of high uncertainty decision makers are boundedly rational and cannot maximize their

outcomes, they can nonetheless optimize the process of their judgments itself, by applying a set of effective, procedurally-correct heuristics. In particular, the study operationalizes some of these heuristics, often portrayed as opposites in traditional literature, and shows that they can actually be complementary, and that joint reliance on them reduces judgment error in the evaluation of start-up projects. The study is based upon interview data from a sample of experienced angel investors, and relies upon verbal protocol analysis and process tracing techniques.

The second paper focuses further on the set of effective strategies, outlined in the first paper, and aims to explore the cognitive factors that can support an individual's ability to apply these strategies in the context of early-stage opportunities' evaluation. Using interview data from angel investors, it shows that having a high level of cognitive structural complexity of one's representation of the problem

space (complexity of the beheld), as well as a high level of complexity of one's representation of self (complexity of the beholder), foster individuals' reliance on effective heuristics in evaluations of novel opportunities. These results have three important implications: a) they indicate specific cognitive processes, which can foster reliance on effective decision making strategies under uncertainty b) map the actual process that decision makers apply in the course of evaluating novel opportunities c) and finally, contribute to research on angel investing by outlining strategies that could help them form better judgments.

Finally, the third paper of my dissertation explores whether reliance on such effective decision making strategies, could also be situationally fostered in individuals. More specifically, it focuses on effectuation or reasoning on resources, and studies whether temporarily activating a counterfactual mindset in participants can increase their ability to apply

effective strategies in subsequent judgments. Previous research has shown conflicting views on counterfactual thinking, arguing that opportunity finders are more likely to rely on it, compared to non-finders, and at same time that entrepreneurs believe they are less likely to engage in counterfactual thoughts compared to others. In two experiments, this work shows that priming individuals with a specific type of counterfactual increases significantly their reliance on effectual logic in a subsequent project evaluation task. This is important as it provides some evidence that effective entrepreneurial logic can be externally fostered and is not necessarily an individual-specific trait.

Overall, the dissertation aims at providing a micro-perspective to the entrepreneurial decision making process, capturing the cognitive and affective factors that may facilitate actors in engaging successfully in the evaluation and pursuit of opportunities under conditions of high uncertainty.

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INTRODUCTION

This work aims to contribute to research on decision making under high uncertainty by exploring individual, situational and procedural factors that can facilitate one's ability to form effective judgments. It is positioned within strategic and entrepreneurial decision making, as in such settings individuals often operate under Knightian uncertainty (Knight, 1921), where neither the possible outcomes of their initiatives, nor their respective probabilities are known. Furthermore, they also commonly report being unaware of the specific process that they apply when forming their judgments (Paul et al., 2007). Under such uncertainty, research within the economic and behavioral decision making traditions tends to predict that individuals become less rational (Simon, 1955; Tirole, 1999), as they cannot resort to maximization approaches, and thus are more likely to rely on cognitive

shortcuts (Tversky & Kahneman, 1974) and simple effort-saving tools (Eisenhardt & Bingham, 2011; Gigerenzer & Goldstein, 1996). Rather than adopting this view of the decision maker, the studies reported in this thesis build upon emerging research, which argues that even though individuals cannot optimize under Knightian uncertainty, they can still optimize in a procedural sense, applying the best decision making process they can with the available knowledge at hand and thus relying on *effective* and *effortful* heuristics under high uncertainty (Felin & Zenger, 2009; Grandori, 1984, 2010; Sarasvathy, 2001; Wiltbank et al., 2009). Within three studies, the following work contributes to this perspective by: a) mapping decision makers' reliance on a set of such effective heuristics under uncertainty and showing that the *complementary* use of these strategies reduces judgment error b) exploring the cognitive factors that foster one's ability to apply these effective heuristics in the evaluation of novel opportunities c) and testing whether

reliance on such effective heuristics can also be situationally induced in individuals (rather than pertaining to entrepreneurs or opportunity-finders per se).

The first paper of this dissertation operationalizes and explores the application of a set of such effective, effortful heuristics in the context of decision making under high uncertainty (Knight, 1921), more specifically in entrepreneurial decision making (Shepherd & McMillan, 2006). As argued earlier, in such settings, decision makers are seen as boundedly rational (Simon, 1955) and resorting to heuristics that are expected to either *bias* their decisions (Baron, 1998; Busenitz & Barney, 1997; Tversky & Kahneman, 1974; Zacharakis & Shepherd, 2001) or to have a positive impact only in terms of cognitive *effort-saving* (Bingham & Haleblian, 2012; Bingham & Eisenhardt, 2011; Gigerenzer & Goldstein, 1996). Emerging studies, however, have highlighted that decision makers can also use heuristics that are *effortful* and *procedurally-correct* (e.g., see Felin &

Zenger, 2009; Grandori, 1984, 2010; McGrath, 1997; Sarasvathy, 2001, 2008) and can thus effectively support individual judgment under high uncertainty. In the first paper, I focus specifically on a set of these heuristics, namely effectuation and expectation (Sarasvathy, 2001; Wiltbank et al., 2009), as well as experience-based pattern-recognition and theoretical causal modelling (Bandura, 1986; Felin & Zenger, 2009) and explore their impact on decision makers' evaluations of start-up projects in the context of informal (angel) investing.

In order to test whether such heuristics are indeed used, and if applied, have a positive impact in terms of forming correct judgments, I interviewed twenty-five experienced angel investors, using a think aloud procedure (Ericsson & Simon, 1984). This procedure tackles the problem of biases and retrospective reporting associated with other methods, and allows one to effectively map the actual strategies that decision makers apply during their evaluations.

Investors were involved in ninety-minute semi-structured interviews during which they selected and evaluated actual business plans of pre-revenue start-up projects. Using verbal protocol analysis, I found that investors did apply the theoretically-selected effective heuristics, and those who applied a larger *set* of these heuristics reported lower error rates in their judgments, thus evidencing their *complementarity*. Therefore, even though some of these effective heuristics are commonly seen as opposites in the literature, the ability of individuals to apply a greater set of them showed an overall positive effect in terms of reducing the likelihood of selecting bad or rejecting good projects (Type I and Type II errors) in this study.

Therefore, this work contributes to decision making theory in general and to decision making in entrepreneurial settings in particular. First of all, it contributes to theory on decision making in entrepreneurial settings by operationalizing a set of effective heuristics for innovation

and providing some evidence on the complementarity in their application, thus overcoming some of the rigid dichotomies around these concepts. This research also contributes to practice since informal investors have received fairly little systematic research attention, as they are difficult to track (Sudek, 2007) and report little self-awareness of the decision strategies (Paul et al., 2007) and processes that they apply (Jose, Roure, & Aernoudt, 2005; Zahra & Wright, 2012).

Even though recent work has increasingly acknowledged the benefits of applying such effective heuristics in the context of high uncertainty, we still know very little as regards what factors support individuals' ability to apply these heuristics in their judgments. Building on the results from the first paper, the second paper of this thesis sets on to explore this question by developing a cognitive structural framework of individuals' ability to rely upon such heuristics when evaluating novel opportunities. In particular, it focuses on the complexity of individuals' mental

representations of their self (complexity of the beholder) and their problem space (complexity of the beheld) (Rafaeli-Mor & Steinberg, 2002; Streufert & Swezey, 1986) and traces how the interaction of these two factors influences decision makers' ability to apply these heuristics. More specifically, it explores how the ability of individuals to structure their problem space, both in terms of the number of factors they consider and the interconnections they build among them, affects their reliance upon effective decision making strategies in the context of uncertainty. In addition, it matches this with their ability to structure their representations of themselves in terms of the different role identities they can enact across contexts and the overlap among these roles, and argues that this further influences their ability to apply effective strategies under uncertainty. Therefore, the second paper aims at exploring *how* and *why* people engage in certain decision processes, rather than *what* they focus on throughout the evaluation. In addition, in contrast to previous research,

which has mostly studied cognitive factors in relation to entrepreneurial *outcomes*, this work focuses on their role for the decision making *process* instead (Gregoire et al., 2011; Shane, 2003). In order to explore the relevance of this cognitive framework for individuals' ability to apply such effective heuristics, I chose angel investing as a high uncertainty setting and interviewed twenty-five angel investors using a project evaluation simulation task and a think aloud procedure.

The results are based upon verbal protocol analysis and process tracing, whereby I find evidence that being characterized with both high cognitive structural complexity of external representations, as well as of one's domain of self, increases one's ability to rely upon effective decision making strategies in the context of early-stage project evaluations. In order to map the complexity of investors' representations of external events, I developed a process tracing technique, based on Streufert and Swezey's work (1987), and adapted it

to the context of business plan evaluations, which is a further contribution of this research. Overall, the results have three important contributions: a) they evidence how specific cognitive factors can foster reliance on effective decision making strategies under high uncertainty b) they provide insight on the specific decision making process that individuals apply c) and finally suggest that effective entrepreneurial judgment could also be trained, thereby opening up the black box of the entrepreneurial decision making process.

The last paper of my dissertation explores, in turn, whether reliance on effective decision making heuristics in the context of early-stage project evaluations could also be situationally fostered in individuals. In particular, I focus on counterfactual thinking (Roese, 1994) and explore how temporarily activating an additive (if only I had) counterfactual mindset, as opposed to a subtractive (if only I had *not*) or no counterfactual mindset, can influence decision

makers' ability to engage in reasoning on resources logic (Sarasvathy, 2001), which has been shown to support decision making under uncertainty. In order to rule out that more experienced subjects or people with more knowledge in a specific sector would be better able to form more counterfactual scenarios, I elicit the counterfactual mindset in response to a task, unrelated to the actual project under evaluation.

Previous work on counterfactual thinking has shown conflicting results, whereby Gaglio (2004) has argued that opportunity finders are more likely to rely on it, compared to non-finders, whereas Baron (1998) has suggested that entrepreneurs believe they are less likely to engage in counterfactual thoughts compared to others. Furthermore, as Galinsky and Kray (2004) have shown, a counterfactual mindset can also be *temporarily* activated, thus influencing decision makers' performance on subsequent tasks. In order to explore the role of counterfactual mindsets on individuals'

ability to apply effectuation logic, two experiments were conducted. The results indicate that, as predicted, situationally inducing additive counterfactual thinking can increase decision makers' reliance on effectuation in a subsequent, unrelated task. This finding is important as it discusses how a specific cognitive process can foster judgment under uncertainty and suggests that reliance on effective entrepreneurial heuristics could also be situationally induced and may not pertain only to the traits of the individual.

In addition, this work also considers the relevance of one's emotions throughout the decision making process. Even though the influence of counterfactual thinking has commonly been considered independent from the emotional states it fosters (Kray, Galinsky, & Wong, 2006), previous research has typically focused on the role of positive versus negative emotions (Seo et al., 2010; Schwarz, 2000). Rather than adopting such a valence perspective, I explore the certainty and uncertainty appraisals of negative valence emotions (see

Lerner & Keltner, 2001; Smith & Ellsworth, 1985) as they are associated with different information processing patterns (Tiedens & Linton, 2001) and find that additive counterfactuals foster certainty, whereas subtractive counterfactuals – uncertainty emotions. Therefore, the results further show an important interplay between cognition and emotion and lay ground for future research, addressing the role of both of these factors for an effective decision making process.

Overall, this research contributes to entrepreneurial decision making by outlining a set of cognitive and affective factors that can effectively foster judgment under uncertainty, and by mapping individuals' decision making process, rather than focusing simply on its content or stages as is common in previous research. In addition, by relying on a sample of real investors and using actual cases within a simulated project evaluation task, this research also contributes to practice since informal investors have received fairly little systematic

research attention (Sudek, 2007). Yet they are responsible for fostering innovation (Van Osnabrugge & Robinson, 2000; Sudek, 2007), by filling the equity gap left by venture capitalists (Berggren & Fili, 2008), thus a greater insight into their judgment process can have important economic implications.

CHAPTER 1.

EFFECTIVE HEURISTICS FOR ENTREPRENEURIAL DECISION MAKING: LESSONS FROM ANGEL INVESTING

ABSTRACT

This research focuses on angel investing in entrepreneurial start-up projects and explores the presence and impact of effective heuristics that facilitate decision makers' ability to form correct judgments under high uncertainty. The study is based upon interviews with real investors who were involved in a simulation task evaluating actual business opportunities. A set of procedurally-correct heuristics for research-intensive decision making and innovation were specified ex-ante on the basis of previous theoretical and empirical work. In addition, hypotheses are developed on the complementarity among

those effective heuristics, where previous literature often consider them as alternative ‘approaches’ (e.g. ‘effectuation’ versus ‘causation’ or ‘theory’-driven versus ‘experience’-based research). Protocol analysis of twenty-five interviews with the investors revealed that those heuristics were indeed applied and their use, especially in combination, led to lower error rates in the evaluation of the start-up projects. Implications for the theory and practice of entrepreneurial and strategic decision making are outlined.

INTRODUCTION

The question and the phenomenon of how to achieve *effective* judgment under conditions of uncertainty, despite its importance especially in entrepreneurial and strategic decision making contexts, has remained relatively underexplored. According to the established perspectives in the literature, under such conditions, decision makers are seen as boundedly rational (Simon, 1955) and resorting to heuristics that are likely to either bias their decisions (Tversky & Kahneman, 1974) or to have a positive impact only in terms of cognitive effort-saving (Bingham & Eisenhardt, 2011; Bingham & Haleblian, 2012; Gigerenzer & Goldstein, 1996). These approaches are rooted in behavioral decision making and the bounded rationality tradition, where individuals' reliance on heuristics is seen mainly as a substitute for more in-depth analysis. Such a conceptualization of heuristics largely dominates the entrepreneurship literature, demonstrating that

entrepreneurs often suffer from overconfidence and escalation of commitment, as well as representativeness and availability biases (Baron, 1998; Busenitz & Barney, 1997; Busenitz & Lau, 1996; Holcomb, Ireland, Holmes Jr, & Hitt, 2009; Zacharakis & Shepherd, 2001). Furthermore with reference to early stage financing, Shepherd and colleagues (2003) show that investors also tend to opt for intuitive, automatic information processing, therefore often overfitting and overgeneralizing the world.

The current work suggests that there is a conspicuous gap in the above outlined frameworks. In particular, they neglect the presence of a third possible type of decision procedures, which while being *heuristic* are also *rational* (Grandori, 2010) and *effective* (Felin & Zenger, 2009; Grandori, 1984, 2010; McGrath, 1997; Sarasvathy, 2001, 2008). In other terms, it is conceived possible that decision makers follow methods for formulating and testing hypotheses on correct actions, rather than calculating optimal

or satisfactory solutions; and they are considered to do so in a *procedurally* and *logically* correct way (much in the same way as scientists can proceed in a rational way under uncertainty by using correct methods). The set of heuristics included within this tradition include: 'modelling' problems as cause-effect hypotheses on possible performance (Bandura, 1986), rather than as 'gaps' with respect to a given type/level of performance to be reached; crafting 'robust' and 'multipurposed' alternatives, and using multiple criteria for evaluation, rather than just looking for acceptable ones against few and given parameters (Grandori, 2010); letting resources search for uses and means search for ends, rather than only the traditional reverse (Sarasvathy, 2001, 2008); considering search stopping rules based on the reliability and validity of the problem model and the marginal contribution to knowledge of further research, and not only the marginal cost of search (Browne & Pitts, 2004); generating hypotheses by using theory and not only experience (Felin & Zenger,

2009); gathering information in a wide, systematic and hypotheses driven way (Fiet, 2002), and testing hypotheses according to procedures that have the same logical structure as those applied in scientific discovery (Grandori, 1984; Liedtka, 2000; Popper, 1989).

Research in entrepreneurship has focused largely on a subset of these strategies so far, in particular effectuation (versus causation) and theoretical (versus experience-based) search. These strategies have either been portrayed as opposites or have been explored somewhat in parallel or disconnected from each other. In this paper, these oppositions and disconnections are bridged, suggesting and empirically testing that, it is the ability to apply these heuristics jointly within the decision making process, that supports best one's judgment under high uncertainty. In doing so, we set to explore the relevance and application of these heuristics in the practice of entrepreneurship, by developing an empirical study on the evaluation process of entrepreneurial start-up

projects. The setting is selected especially because of the high level of uncertainty involved, where it becomes particularly important to proceed rationally with limited and fallible knowledge of the world, and to reduce judgment errors, especially the core types of errors possibly plaguing the discovery processes, namely rejecting good projects/hypotheses or accepting bad ones (Type I and Type II errors). The focus of the empirical study is specifically on the procedures that investors apply during the screening and evaluation stages of pre-revenue businesses, for which there is neither sufficient financial information available, nor significant indications in terms of the prior track record and experience of the venture founders (Sudek, 2007).

Core hypotheses include the expectation that deductive calculative optimization procedures will be rarely if at all applicable and used. However, rather than expecting that the decision makers will then resort to some fast and frugal thinking or biasing heuristics, we predict that they can and

would rely instead on a repertory of procedurally-correct hypothesis-testing heuristics. Furthermore, we expect that, contrary to the way they are typically modelled in the literature, decision makers would be able to effectively rely on all of these strategies and the complementarity in their application will reduce the judgment error. Overall, the aim is to provide evidence that rational discovery is possible and indeed practiced, and to decrease the dichotomized focus through which most of these heuristics have been exposed in the literature so far. These rational heuristics are conceived as exemplary patterns of thinking one is able to apply under the specified conditions of uncertainty, and not necessarily as 'the average' or most frequent behaviours diffused among a generic decision makers' population. Therefore, the study is also conducted with knowledgeable, expert decision makers, who are more likely to have discovered better heuristics (albeit often with low awareness about them) (Simon, 1976), rather than with novice or student samples. In particular, we

involved experienced angel investors in an evaluation simulation of start-up projects.

Results from the study show that, within the simulation, decision makers using the specified *effective* and *effortful* heuristics demonstrated a lower tendency to commit Type I and Type II errors, which were estimated on their convergence with the evaluations of the same projects by independent investors during actual pitches: a type of inter-rater reliability and criterion validity measure of 'errors'. This procedure can be justified on various grounds. First, prior research has suggested that over time in any given decision area, decision makers learn which procedures are better and which are worse and tend to converge on better performing procedures (e.g. Gavetti & Rivkin 2007; Henderson, Orsenigo & Pisano, 1999; Suchman, 1994). Second, this research design allows us to check the validity of the decisions within the simulated setting with respect to real life decision making. Third, we have a procedural measure of acceptance / rejection

judgments, whereas a substantive measure, based on actual success of projects may be improper since it could also just measure chance and the effect of exogenous variables (rather than the quality of the decision making process).

The rest of the paper is organized as follows. First, an overview of the set of heuristics, theoretically considered as logically sound and procedurally correct under conditions of high uncertainty, is provided. Then, the relevance of these selected heuristics is observed in the empirical study, which explores the complementarity of their application. Lastly, results are outlined and their implications for effective judgment under uncertainty are discussed.

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RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

Effective Heuristics

As outlined earlier, the majority of research on heuristics in human information processing has been characterized by two features: a) being largely focused on the *negative* and biasing implications that these procedures have on people's perceptions, attitudes and decision making (Kahneman, Slovic, & Tversky, 1982; Tversky & Kahneman, 1974) and b) if their *positive* aspects are considered, attention has been limited to efficiency and quickness (Eisenhardt & Bingham, 2011; Gigerenzer & Goldstein, 1996). The underlying proposition and prediction in those approaches is that with an increase in the complexity and uncertainty of a problem, the information processing approach tends to become less maximizing, farsighted, and systematic (Payne, 1976).

However, studies and scholars in other areas of social science - to a large extent non mainstream in their own fields, such as Bandura (1986), Campbell (1960) and Shackle (1979) – also did not fully subscribe to the idea that the higher the uncertainty, the weaker the form of thought that decision makers *can* apply (albeit they frequently *might* do so in closed problems). In fact, how can we explain the considerable amount of innovation and discovery we observe, if 'behavioral decision making' and 'bounded rationality' were the entire story?

Alternative and better decision processes have in fact been discussed in studies on the cognitive processes in discovery-intensive activities such as science, design, technical innovation, and entrepreneurship. Among those, some can be considered particularly important for entrepreneurial decision making. Some of the examples in the literature include effectuation versus causation (Sarasvathy, 2001) and theory-driven versus experience-based decision making (Felin &

Zenger, 2009). It has been documented that innovation and discovery largely rely on ‘disciplined’ (Drucker, 1985), systematic (Fiet, 2002) information gathering, looking far and considering structural phenomena, rather than searching locally and being trapped by case-based easily available information. Second, it has been observed that theoretical and causal modeling is key to developing innovative hypotheses in business as in science and life alike (Bandura 1986; Felin & Zenger, 2009; Grandori, 1984; Magnani, 2000; Popper 1989) and that experience is not enough.

Third, it has been shown that these causal models can start from sought effects and make hypotheses on possible causes, or start from causes and make hypotheses on possible effects (Henderson et al., 1999; Saravasthy, 2001; Thagart & Croft, 1999). Nonetheless, even in those studies that consider new types of heuristics, it is often implied that using the ‘new’, ‘high performing’ heuristics come as an ‘alternative’ to using the ‘older’, supposedly inferior heuristics.

Some of the examples in the literature include effectuation versus causation (Sarasvathy, 2001), theory-driven versus experience-based decision making (Felin and Zenger, 2009) and compensatory versus non-compensatory approaches to multi-criteria decision making (Payne, 1976). Differently from the traditional contingency view of the use of these heuristics, whereby the decision strategy becomes 'less rational' and 'less analytic' in the face of uncertainty, we develop a different 'contingent' proposition: in order to deal with uncertainty, it is better to enlarge the set of effective heuristics applied, rather than to simply have to choose among them[1]. Therefore, in the next sections, we define the selected heuristics and present a study, which fleshes out this idea further, building upon the notion that all of these

[1] The use of multiple heuristics for improving decision making performance has been rarely addressed. An exception is the work by Bingham and Eisenhardt (2011) and Bingham, Eisenhardt and Furr (2007). However, in those analyses, even when the qualifier 'rational' and 'effective' is applied to heuristics, it is still used to refer to empirically 'successful' (as inferred from outcomes), and heuristics are seen as field-specific rules of thumb, learned by experience.

effective heuristics will be observed in the decision makers' evaluation process, and their joint application will have positive consequences for the quality of their decision making processes.

In addition to specifying the expected procedurally correct heuristics, a method for assessing the quality of the decision processes stemming from their use should be devised. In complex and innovative decisions, it's quality that matters, much more than decision efficiency, process costs, and effort saving. Hence, the wise decision maker – as much as the wise judge or scientist - can be reasonably supposed (and advised) to try to minimize decision errors, rather than decision costs. Therefore, in this paper and study, heuristics are classified as good or bad according to their logical and theoretical properties, and their use is treated as an independent variable. Decision performance is conceived as a dependent variable and assessed in terms of reduction of Type I and Type II errors: accepting bad projects and rejecting good

ones – indeed a particularly suitable criterion in the field of new project financing, in which the empirical study is conducted. Nonetheless, it would be difficult, and perhaps improper, to measure those types of errors in terms of the real success of the selected versus rejected projects. In fact, the actual results of current pre-revenue projects may be available some ten years from now; and the rejected projects are subject to a 'partial feedback' issue (if rejected, they are 'lost', and cannot really be tested any longer); and success under uncertainty is by definition a probabilistic phenomenon, which depends on many other factors beyond decision procedures. Hence, we resorted to a *procedural* proxy, also considering that there is an important difference between using good decision procedures (which is the focus of the current study) and getting to good outcomes (something that can hardly be guaranteed by any decision procedure under uncertainty). Therefore, the projects selected in the simulated decision making task will be compared with the choices made

by other, independent expert investors in the field. The projects, which had been actually financed in the real world, are then classified as 'good', while projects that went unfinanced as 'bad'. Inter-rater agreement on project quality by experts is after all one of the few possible ex-ante indicators of projects' goodness, and in fact it is widely used for decisions on funding projects in any uncertain field, including science. In addition, such design provides evidence that the simulated choices and procedures are realistic and not distorted by the specific research setting. One consideration with relying upon other investors' willingness to fund or not the projects as an indicator of the correctness of their decision making is that rather than converging on using a set of good heuristics for the evaluation of projects, both the study's subjects and real life investors are conforming to norms of the field, which may necessarily have any effectiveness properties. Yet, there is empirical research indicating that decision making strategies in a field, if converging, tend to

converge to superior rather inferior procedures (e.g., Henderson et al., 1999). At any rate, to address this, the study also takes into consideration the number of successful exits that decision makers have made and shows that decision makers who apply the theoretically superior heuristics are also the ones to have an above-average number of successful exits in their record.

We concentrate on three 'couples' of heuristics, which have been emphasized and often opposed in the literature.

Compensatory and Non-compensatory strategies

It is widely acknowledged that one have to rely upon multiple criteria in order to dimensionalize desired performance well. Two approaches have been often opposed, and even considered as indicators of a maximizing/rational versus satisficing/behavioral decision making: compensatory versus non-compensatory. Compensatory techniques (establishing trade-offs) are seen as cognitively taxing and

more sophisticated, while non-compensatory techniques as simplifying rules and avoidance of trade-offs across dimensions (Ford et al., 1989). The decision strategies typically classified under the compensatory umbrella include linear or additive difference models, whereas the ones seen as non-compensatory are lexicographic, conjunctive, disjunctive rules, as well as elimination by aspects (for a comprehensive review, see Payne, 1976). Therefore, traditionally it is expected that under conditions of high uncertainty, decision makers would tend to apply mostly non-compensatory approaches, because of the time and cognitive constraints. In multidimensional complex problem solving though, it is doubtful that non compensatory approaches are to be considered in any sense less rational than compensatory approaches. In fact, much sensitive information may be lost in performing trade-offs between qualitatively different criteria for reducing them to a single utility numbered function (Grandori, 2010). Therefore, we expect that in the context of

decision making under uncertainty, a) multi-criteria are used, and b) non-compensatory strategies prevail but lead to effective judgments (at least) no less than compensatory strategies.

Effectuation and Forecasting / Expectation

The notion of effectuation is well-known in the entrepreneurship field. However, it has been associated with many components, both conceptually and in its operationalization, including: who I am, what I know, whom I know, affordable loss, and fabricating rather than finding a market (Sarasvathy, 2008). Among those various meanings and components, the core heuristic of using reversed search rules, namely 'resources/means in search of uses/ends', has been also independently detected in other areas of uncertain decision making, for example technological innovations (Thagart & Croft, 1999) and innovative strategy making (Grandori, 1984).

In all these studies, the 'resource in search of uses' heuristics has not been contrasted with 'causation' intended as not making causal judgments, nor ascribed a special property of control over environments. Rather, the causal judgments are reversed (what effects the cause X may have) and the very multiplicity of those effects reduces risk (rather than increasing control). Therefore, we operationalize 'effectuation' as resources in search of uses. The power of 'resources in search of use heuristic' is not that it avoids causal judgment or it gives more 'control' over the environment, but lies in reasoning 'no matter what the state of world might be' and in exploiting the multiple actions that may stem from the same resource. Hence, we shall consider the formulation of causal hypotheses as an independent dimension, to be rather contrasted with an experience-based, a-theoretical approach, rather than with effectuation itself [2].

[2] A review of the current conceptual and empirical operationalizations of effectuation, and its most recent critique, is available in Perry, Chandler and Markova (2012).

‘Effectuation’, in our strict sense, can be distinguished from trying to express expectations/ forecasts on the consequences of actions under specified scenarios/states of the world (see next paragraph).

The opposition and the debate in the literature on new project financing between ‘betting on the jockey or on the horse’ (Kaplan & Strömberg, 2004) can be read as an example of the two different logics: ‘betting on resources’, which may produce a stream of good, albeit yet unknown projects, hence on ‘resources in search of effects’; or ‘betting on projects’ which are forecasted to be promising. Once the distinction is clarified in such terms, doubts can be casted on whether scenario reasoning and forecasting, to the extent that it is feasible, should be detrimental. In fact, Sarasvathy (2008) herself reports in a survey precisely on angel investors, that whether or not angels relied upon prediction/forecasting did not make a difference for their exit outcomes (see also Wiltbank et al., 2009), while the use of effectuation had a

clear positive impact. Therefore, in our study it is hypothesized that in principle both heuristics can be potentially useful, especially in combination, as they both contribute to a broader, more careful and balanced project analysis. It is left to empirical testing to establish their relative importance and possible interaction effects.

Theoretical modelling and Pattern-Recognition

On the experience versus theory dimension, *experience* has been greatly emphasized as a source of wisdom in all organizational behavior literature (see for instance March & Levinthal, 1993). Nonetheless, it has also been observed that *theoretical knowledge* and the construction of causal models may be useful, if not necessary, to draw hypotheses about new projects and their possible success, where the novelty of ideas and conditions may make past experience unreliable, at least if used in an imitative rather than theoretical and explanatory way (Bandura, 1986; Felin & Zenger, 2009; Grandori, 1984; Magnani, 2000). This should

not amount, though, to deny that ‘experience’, in the sense of accumulated, field-specific and empirically grounded knowledge, is going to be irrelevant in decision making in novel settings. Again, an opposition of theory versus practice would be unsatisfactory for discriminating among effective and ineffective heuristics. Both theory and evidence, deduction and abduction, knowledge based on direct observation and experimentation, and knowledge of general laws regulating phenomena, can contribute to generating and testing hypotheses in business as in science alike. Hence, both the deduction of hypotheses on action from relevant theory, and the abduction of hypotheses on the basis of observation, experimentation and ‘experience’ are considered here as effective heuristics for discovery.

On the basis of the above discussion, we advance the hypotheses that:

H 1: Effective entrepreneurial decision making (lower procedural error rates) is sustained by the use of multiple criteria, explored in both non-compensatory and compensatory ways to the extent that it can be applied.

H2: Effective entrepreneurial decision making (lower procedural error rates) is sustained by the use of effectuation, but also of expectation heuristics to the extent it can be applied.

H3: Effective entrepreneurial decision making (lower procedural error rates) is sustained by the use of theory, but also experience to the extent it can be applied.

Enquiring on these hypotheses will contribute to clarifying the logic and structure of decision making in the field of early stage investing, so far analyzed mainly content-wise (which criteria are applied), rather than process-wise

(which procedures are employed) and through survey-based methods, rather than experimental methods respectively. The following work is therefore innovative both in its focus on the logic rather than the content of entrepreneurial decision-making and for its quasi-experimental, simulation-based method applied with experienced real investors.

RESEARCH SETTING AND METHODS

The context chosen for the present study is early stage investing, and more specifically business angel investing. As argued earlier, it is considered relevant for the purposes of this paper since informal investors typically operate under conditions of heightened uncertainty due to the lack of available information on the venture or track record of the entrepreneurs. Business angels (BAs) are high net worth individuals, who are able to invest their own resources in unquoted businesses with no family connection, in which they

take a stake in the post-investment development process (Mason & Harrison, 2008). Angels tend to invest more opportunistically, do not necessarily estimate internal rates of return (Mason & Rogers, 1997), and are much more involved in the ventures in which they invest, often motivated by personal factors rather than return on investment (Benjamin & Margulis, 2000). Up until recently, there has been a significant difficulty in tracking angel investors as such and evaluating their activity in terms of the amounts invested and their average returns due to the privacy of their profiles (Mason & Harrison, 2002), which represents an important gap in our current understanding of their investments. Recent reports by NESTA (Wiltbank, 2009) based on 158 angel investors showed that 44% of angel investments generate positive returns, with the average overall return being 2.2 times the invested capital (average investment size £42,000). Nine percent of the exits reportedly return more than 10 times the invested capital. The average investment by angel groups

in the UK is reported around £1 billion, whereas it amounts to about $26 billion in the US (Wiltbank, 2009).

Despite their importance for the economy, there is still a lack of available research on the process through which angel investors arrive at their decisions (Riding et al., 2007), which is further echoed in Zahra and Wright's (2012) more general call for a stronger focus on understanding the process dynamics in entrepreneurship research. One of the few studies aimed at capturing the process dynamics applied by investors has shown that they rely on elimination-by-aspects heuristics during the screening stage, however, it does not address the strategies applied past this initial stage (Maxwell et al., 2011). As Mason and Harrison argue, a greater understanding of the specific decision process can significantly improve angels' success rates (2002). Some of the factors that have been studied as relevant in the evaluation process of angel investing include the product (interest/benefits, protectability and innovation); the market (size, customer engagement,

growth potential); the entrepreneur (experience, commitment, trustworthiness); the financial criteria (expectations, capitalization, ROI, liquidity); and the entrepreneurial team (team characteristics, entrepreneur fit, referral source) (see for instance Feeney et al., 1999; Haar et al., 1988; Landstrom, 1998; Mason & Harrison, 2002; Paul et al., 2007; Sudek, 2007; van Osnabrugge, 2000). A detailed overview of these factors, as addressed within each paper, is available in Maxwell and colleagues (2011). The categories relevant to the evaluation of business plans that will be considered in the current paper are built upon some of the previous research outlined above (e.g., Maxwell et al., 2011), as well as upon insights gained from extensive discussions with experienced active angel investors. Overall, the final outline of the main factors selected for the process tracing analysis in this work is provided in Appendix A.

Investors' Sample

In order to guarantee a large enough sample of experienced angel investors, members of the British Business Angels Network (BBAN) were approached with an initial request for the contacts of individual investors or partnering organizations. Envestors, a company engaged with matching entrepreneurs and business angels, agreed to collaborate and facilitated the contact between the research team and individual investors. Sixty experienced investors, registered with Envestors[3], were contacted with an invitation to participate in a one-hour semi-structured interview. Twenty-eight investors responded positively to the invitation and agreed to participate, of which 25 were suitable for analysis as one of the subjects was not comfortable with the 'think aloud' procedure, whereas two others preferred to discuss past investments rather than engage in the task at hand. The

[3] Investors were selected on the basis of their experience, as well as on how active they have been over the past two years in participating in the company's events and in soliciting new projects in which to invest.

collaborating company arranged to have all interviews conducted at their offices, thereby providing a standardized setting for all interviews and controlling for any external influences. In addition, the researchers were invited to attend several investor events where entrepreneurial pitches[4] took place, which allowed them to familiarize themselves well with the actual settings and process and to discuss with attending angels about their impressions of the investment process.

Within the current sample, the average amount invested in pre-revenue or early-stage entrepreneurial projects by the investors amounted to £127,045, with a minimum investment of £10,000 and a maximum investment amount of £650,000 per investor. The total number of projects in which the angels in the present sample had invested was 329 and the total number of successful exits was 61, where the average number of projects, which a single investor had funded, was

[4] The authors are indebted to the host company for their kind collaboration and support throughout the entire duration of this project.

13 (with a minimum for the sample of 4 and a maximum of 50). In terms of their years of angel investing experience, the average was 9 years of active investing, with a minimum of 3 and a maximum of 35. Lastly, the average number of successful exits of the investors was 3, whereby the minimum was 0 and the maximum 13. Within the sample, 19 of the investors reported having previous experience in starting up their own business. All of the investors had advanced degrees and were evenly distributed within the 36 to 45 and 46 to 55 age brackets.

Before proceeding, some of the common limitations associated with having angel investors as a sample should be noted, namely survivor bias, self-selection bias, and the overall difficulty of identifying practising angels per se. Self-selection implies that the analysis may not be representative of the angel investors' population and therefore the results may not generalize to all investors. In line with this, it should then be noted that the study was conducted with practising

angel investors in the United Kingdom, which does not exclude the presence of certain cultural differences with respect to investors' practices in other countries. Nonetheless, this was done in order to ensure that the interviews are conducted in the native language of the investors since verbal protocol analysis may not be reliable if the subjects think aloud in a foreign language. Furthermore, the decision task per se was selected so that it is very similar in format and type to the practices used across various European and American angel networks. Survivor bias, on the other hand, implies that the investors in our sample are only the ones who have been successful or at least still remain in the business, rather than the ones who have failed. Nonetheless, given that the focus of this work is to study the effective heuristics decision makers apply, it was intentionally decided that the interviews will be conducted with investors who have funded at least one project so that they have hands-on experience and understanding of the process. In addition, the sample does involve investors

who have not yet exited successfully from a business and investors with as many as 13 successful exits. Overall, the results and recommendations of this work should be evaluated in light of the above-listed limitations.

Data Gathering Method

One way to capture whether decision makers use such heuristics is to observe how they make decisions and extract the rationale that they apply based on their responses. This is always more reliable than asking for retrospective self-reports on decision processes, but it is all the more so in high uncertainty settings, where decision makers are typically rather unaware of their methods and report relying on 'intuition' instead (Paul, Whittam, & Wyper, 2007).

A suitable technique, which takes into account the problem of biases in retrospective reporting and allows for the observation and interpretation of concurrent behavior, is verbal protocol analysis. When using this technique,

participants are invited to speak out loud everything that comes to their minds when engaging in a task, without being required to provide any justifications for their reasoning to the interviewer (see Ericsson & Simon, 1984; Nisbett & Wilson, 1977). Even though some authors have argued that verbalizing during a task could influence one's decision making, Schweiger (1983) has reported no significant differences between subjects who verbalized and those who did not in terms of their task performance. Furthermore, despite the fact that this is a very labor intensive technique, the richness of the data it produces could certainly offset its main limitations. The methodology has been applied successfully when studying the decision-making of venture capitalists (s.f., Hall & Hofer, 1993; Zacharakis & Meyer, 1995) and it is therefore deemed appropriate for the present research framework, particularly because it reduces the likelihood of self-report biases (Nisbett & Wilson, 1977) and captures as closely as possible the actual decision making of

individuals. Hence, this work will extract decision heuristics relying on verbal protocol analysis, which will be outlined in detail as a method in the next section. In addition, in order to understand better whether investors differ in their ability to apply such heuristics, a process tracing approach will be adopted (Payne, Bettman, & Johnson, 1993).

Stimulus Material

The materials chosen for this study were actual business plans typically produced and distributed to investors by the host company during entrepreneurial pitches. The cases were selected so that they were within different industries to ensure that they capture investors' diverse competences and preferences, such that two of the projects involved the use of a new technology and two were based upon a tangible product. All plans had the same format as developed by the host company (Envestors) and were of comparable length, having a similar amount of information provided per individual category (e.g., market proposition, team, financial details). In

addition, they were selected so that the amount of total financing required was approximately similar for each project and considered with the possibility range of the investors in terms of co-investment (around £250,000). Investors were handed the four plans stacked together and their order was randomized across the different interviews to prevent any primacy or recency effects. As Roure and Keeley (1990) have argued, a lot of the important information about a new project can be extracted from its business plan, which makes it a suitable stimulus material for the purposes of this study.

In addition, the projects were also selected so as to include some, which were actually accepted, and some which were not accepted for financing and development by independent investors (different from the subjects in this sample) during real pitches. In this way a performance criterion for evaluating the quality of the decision process is available: accepting or rejecting projects that have been rated as bad or good by independent investors taking real risk have

been classified as Type I and Type II errors in the current study.

Procedure

Participants were met at Envestors in a dedicated office, where all interviews were conducted individually, and were acquainted with the purpose of the study. They were told that the researchers were interested in understanding better the decision making processes involved in the evaluation of early-stage projects. Afterwards, they were given four actual two-page business plans produced by Envestors[5]. Once participants received the materials, they were asked to imagine that they have just received them as they normally would, either during an event or at their offices, and were

[5] The reason for selecting this format of the proposals is that the majority of business angel networks follow the same setup, namely they pre-screen a set of projects and present these to investors on a single occasion, providing them with the business plans developed by the applying entrepreneurs. Therefore, in order to ensure that the experience is as close as possible to the real decision making situations, the same stimuli and format were adopted during the interviews, ensuring that investors had not seen the selected projects before or received any prior information about them.

invited to share with the researcher how they would usually proceed with evaluating the proposals. More specifically, they were asked to choose the project which would interest them the most and then verbalize their thoughts as they review the selected business plan. Upon the approval of each individual, sessions were tape-recorded and later on transcribed and content-analyzed in order to extract the rationale and map the process that investors followed when screening and evaluating the projects.

Operationalization and Measurement

First of all, we coded whether decision makers relied upon a compensatory or non-compensatory approach in evaluating the projects. Segments of text were classified as instances of a compensatory strategy if investors performed trade-offs among the different factors and as non-compensatory when investors indicated that the projects had to strictly meet a set of predefined criteria, and did not proceed if these were not satisfied.

An example of a compensatory approach is provided below:

'I have backed management teams, where their initial idea hasn't quite worked out yet, but they have seen it, they have adjusted things, they have refocused the company and made a success out of the company that I have invested in' (P1).

In contrast, a non-compensatory approach can be represented with the quote below:

'My key criteria (size, differentiator, management), they all have to be met. I don't compromise here as it is really easy for things to go awry' (P23).

The decision making strategies applied by each investor (compensatory versus non-compensatory) were coded by the main researcher and an independent coder.

Next, in order to code the set of strategies selected for the study, all interview recordings were transcribed and content-analyzed by coding individual sections into thought segments (Ericsson and Simon, 1984), focusing on extracting the different building blocks of the decision making heuristics. In particular, the decision process of each investor was coded by counting all instances or short text segments (see Newell & Simon, 1972), which referred to effectuation, forecasting, theoretical causal modelling and experience-based pattern recognition (as argued earlier, in the present work 'effectuation' is opposed to 'forecasting', rather than 'causation' and thus operationalized as the 'means/resources in search of ends/uses' versus the 'sought results in search of means'). In particular, a numerical code was assigned to each heuristic type based on the number of independent instances where an individual referred to it.

For instance, an example of *theoretical causal modelling* states:

'*Seeing how they react when I ask questions, how similar they have approached problems that I have come across in the past… Just want to get a sense of how they respond to particular situations and then extrapolate how they might respond to an unfamiliar problem in the future based on their current reactions*' (P23).

On the other hand, an investor, relying upon *experience-based* pattern-recognition states:

'Once I have worked out what they do and I am interested, I can put the details together and relate that back to my own experience and get a feel if there are any gaps; (P12).

With respect to *effectuation* logic, an example from the scripts is:

'If the team does not have the skills, they can get non-execs mentoring people who are experienced in the field - this is what smart teams do if they lack experience; You need to

find or develop a structure that gradually fits the profile of the business rather than impose your own; Accountants, lawyers, they are all rule-driven and this is not a rule-driven job.'

On the other hand, reliance on forecasting can be observed in the following statement:

'I do look at the numbers and check if they go 700k, 1400k, etc. I don't look at year 4 and 5. I look at if this business could, within 3 years, do what it predicts, cause then it could be worth it' (P27).

On average, investors used 2.2 instances of effectuation-based logic within their analysis of the business plans (min 0, max 6) and 1.92 forecasting-based segments (min 0, max 7). The total number of instances of effectuation-based logic for all subjects was 51 and the total number of instances of forecasting 46 respectively. Furthermore, investors in the sample used 2.16 instances of pattern-

recognition (min 1, max 4) and 1.87 instances of theoretical causal modelling logic (min 0, max 5). The total number of instances of pattern-recognition was 44 and of theoretical causal modelling 57. Given the specificity of the information being coded, an independent coder, blind to the purpose of the study, was solicited. He reached an agreement with the authors' coding and categorization of instances in 87% of the cases. The disagreements were reviewed again and reclassified upon discussion.

Performance

The four projects selected for this study had been presented during actual 'pitches' and it was possible to establish whether they were funded or not. As already discussed, this independent assessment was used for classifying projects as (more likely to be) 'good' or 'bad' in order to calculate a Type I and Type II 'error rate'. To ensure consistency within the stimulus materials, there was a 'good' and a 'bad' project both within the set of technology-based

plans, and within the set of tangible product plans. The sample in the current study was not exposed to or aware of the business plans or pitches of these companies prior to the study. Overall, we found that 15 investors rejected or selected the projects correctly, whereas 10 exhibited a Type I or Type II error with respect to the independent real assessment yardstick.

A second proxy indicator of performance that was used in this study in order to increase the reliability of the reported results was the number of successful exits of participants and its relation to their ability to apply effective heuristics and choose correctly. Specific details of this are provided in the sections below.

DATA ANALYSIS AND RESULTS

Compensatory and Non-compensatory

Overall, we found that, as expected, the majority of investors (with the exception of 4) did not rely upon a single method in evaluating the projects and relied upon compensatory or non-compensatory strategies throughout their decision making process. Therefore, this supports Hypothesis 1, which stated that contrary to the traditional opposition in the literature, decision makers under uncertainty do rely on a large set of factors and assess projects in both compensatory and non-compensatory manner.

Effectuation and Forecasting/Expectation

The sample was divided into high versus low effectuation and high versus low forecasting groups, based upon the respective average levels of reliance on these heuristics by the investors within the sample. In line with our prediction (H1a), participants' scores on both effectuation and

forecasting indicate that they don't necessarily occur in a mutually exclusive way and can be effectively and concurrently applied by the same person in the same process. As regards effectuation, within a sample of 24[6] investors, 10 were characterized by an above-average level of effectuation, 9 of whom were able to correctly accept/reject the relevant projects. An overview of all frequencies is provided in Table 1, Appendix B.

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place Table 1 about here

As can be observed from this table, if effectuation is high, the error rate is low (1/10) irrespectively of the level of expectation/forecasting. This result is in line with previous

[6] One case was excluded from analysis here as the investor correctly rejected the 'bad' (nonfunded) project, however on the grounds that it simply did not meet his market size criterion rather than because he had employed a more effective analysis.

findings (Sarasvathy, 2008) and corroborates the notion that forecasting is less important than effectuation in avoiding errors. However, this analysis, as well as previous studies, falls short from ascertaining whether the contribution of forecasting heuristics, even though less important, may still be positive, especially if combined with effectuation to sustain the overall depth and breadth of one's search behaviors. Some insight on this question can be gained by looking at high-forecasting processes. In this condition, 7 investors correctly accepted/rejected the relevant project and 6 opted for the wrong project or rejected a good one. The interesting regularity is that ineffective processes were all characterized by a much higher forecasting score, yet the effective ones were characterized by scores closer to the average for the sample. This finding suggests a new hypothesis for future research: it seems possible and indeed plausible that the superior recipe is 'high effectuation and medium forecasting', namely that the complementarity lies

between a high intensity of resources analysis and a moderate investment in formulating forecasts and expectations.

Theoretical Modelling and Pattern-recognition

We also explored in an analogous way whether relying on theory versus experience has an impact on outcomes. We split the sample in high versus low reliance on these strategies based on the respective averages for the sample and found that scoring high on the use of either the theoretical or experiential type was beneficial for formulating correct judgments in line with Hypothesis 2. An overview of all reported frequencies is available in Table 1 in Appendix B.

In order to gain a better understanding of the complementarity between these four heuristics, we computed two new indices, namely heuristic breadth and depth. The *heuristic breadth* index captured individuals' reliance on the different types of heuristics present in the process (namely effectuation and forecasting, theory and experience-based

modelling). The presence of any of these heuristics was attributed a score of 1, thereby making the maximum value for this indicator of breadth equal to 4. In the current sample, the investors had an average breadth of search of 2.58. A *heuristic depth* index was also computed by summing together all text segments that investors had within each of the four categories. For example, if they reported 2 instances of theory-based forecasting, 1 instance of experience-based forecasting, 4 instances of theory-based effectuation and no instances of experience-based effectuation, their total depth of search score amounted to 7.

The sample was then divided into high versus low heuristic breadth and depth groups with respect to the average levels of the two indicators. We found that the rate of correctness in evaluation of the projects was about ¾ in the case of above average breadth and depth (9 out of 12 investors, and 8 out of 11 respectively), which decreased to ½ for the groups scoring below average on the two indicators (6

out of 12, and 7 out of 13 respectively). This supports Hypothesis 2: the joint application of these heuristics, did in fact reduce the likelihood of errors. Therefore, some of the much stressed oppositions in decision making studies do not seem to be very important in highly uncertain, open rather closed problem solving. A figure with the results for the four heuristics types and the breadth and depth indices is provided in Appendix C.

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place Figures 1A & 1B about here

Finally, in order to have another proxy for performance, we checked whether investors who had an above average score on the heuristic breadth index (namely, who were able to apply all four types of heuristics), would also report a greater number of successful exits compared to the rest of the sample. Overall, the number of investors with successful exits in the sample was 18, of which 7 were

characterized by having more exits than the average for the current sample (in this case, greater than 3 exits). Each of these 7 investors was also characterized by high heuristics breadth. Investors with below average number of exits or no exits at all were evenly distributed on this index, such that 8 had high and 9 had low breadth of search and choice. Therefore, we have another indicator that the application of these effective heuristics has paid off in terms of making correct choices in the long run.

DISCUSSION

Overall, the aim of this work has been to explore further the process that decision makers apply when forming decisions under conditions of high uncertainty and the potential strategies, which support it, especially in the context of entrepreneurial judgment. It contributes to an emerging line of research on effective, procedurally-correct heuristics and provides evidence on their application and benefits for the

evaluation of early-stage entrepreneurial projects. It shows that under such conditions of strong, Knightian uncertainty, joint reliance upon *effectuation* and *expectation*, as well as *theoretical modelling* and *experience-based pattern recognition* improves the judgment of angel investors, whereby they tend to commit less Type I and Type II errors during their decision making process. Furthermore, we also find that decision makers do effectively rely on multiple criteria in their judgments, which are integrated in both non-compensatory and compensatory ways.

What is particularly interesting and emerges from the current study with respect to the relevance and application of these heuristics, is that rather than singling a specific heuristic that is more likely to facilitate effective judgments, we provide evidence in favour of the *complementarity* of use of a set of heuristics. Specifically, we show that if a set of these heuristics is actively applied throughout the evaluation process, it reduces effectively the judgment errors of the

individual decision makers, namely the likelihood of committing Type I or Type II errors (rejecting good or accepting bad projects). This is important as it suggests that some of the rigid dichotomies in the literature on decision making may not necessarily have an effective expression in practice (i.e., reliance on either compensatory or non-compensatory techniques, effectual or forecasting logic, experience or theory-driven causal modelling, etc.) (s.f., Payne et al., 1993; Sarasvathy, 2001; Wiltbank et al., 2009). Therefore, the findings can provide insights to decision makers by elucidating the strategies that could facilitate effective judgment under conditions of uncertainty.

In addition to providing a set of relevant decision making strategies, which in the course of being heuristic are also rational, logically-sound and effective, and suggesting that their application can be complementary, this work further contributes to understanding and mapping the *process* that decision makers apply under such conditions of uncertainty.

The available models fall short of understanding and providing a detailed account of the specific *logic* or *patterns of thinking* applied by BAs in the context of highly partial and changing information. Instead, they are either focused on *content* only – i.e. the 'factors' that are or should be taken into account, or represent *stage* models - i.e. the 'phases' that are or should be followed (Paul et al., 2007). Furthermore, current models of the process have been mostly focused on the description of what '*not to do'* (biasing way of reasoning or 'heuristics' to be avoided) (Mitchell et al., 2002; Vermeulen & Curşeu 2010), rather than on prescribing what '*to do'* (effective heuristics to be followed). In line with this, the underlying mechanism through which decisions to invest in innovative projects are taken has largely remained *opaque* in its logic to the decision makers themselves. Therefore, by focusing on understanding the specific decision making process, this research aims at answering the question *how* rather than *what* facilitates decision makers in judging

effectively under conditions of high uncertainty (Gregoire et al., 2011; Zahra & Wright, 2012).

Lastly, by relying on a sample of real investors and using actual cases within a simulated project evaluation task, this research also contributes to practice since informal investors have received fairly little systematic research attention, as they are difficult to track (Sudek, 2007) and report little self-awareness of the decision strategies (Paul et al., 2007) and the processes they apply (Jose, Roure, & Aernoudt, 2005). Yet, it is precisely this group of investors that represents the largest source of external seed funds for innovative start-ups and is responsible for fostering innovation (Van Osnabrugge & Robinson, 2000; Sudek, 2007) and filling the equity gap left by venture capitalists (Avdeitchikova, Landstrom, & Mansson, 2008; Berggren & Fili, 2008; Clarke, 2005), therefore having a better insight into their judgment process can have important economic implications.

CONCLUSION

This paper and study contributes to decision making theory in general and to decision making in entrepreneurial settings in particular. A first contribution has been to overcome some of the rigid, sometimes even naïve, oppositions and dichotomies that have been diffused around those concepts, most of which have in fact been criticised conceptually and face empirical counterevidence. In particular, the much emphasized oppositions between 'compensatory' and 'non-compensatory' strategies, between 'effectuation' and 'forecasting', between 'experiential learning' and 'theoretical modelling', do not seem to capture the important differences in terms of decision quality and the probability of error in uncertain and complex settings. Actually the use of a wide portfolio of all of these heuristics has been hypothesized and found to bring a positive difference to one's decision making performance. Another contribution has been to assess the different role of each

heuristic for the reduction of (Type I and Type II) judgment errors in accepting and rejecting projects. Finally, the paper also contributes to decision making practice in a field, in which investors are often unaware of the logic they use and are even more unaware of which decision procedures should be used, i.e., are to be considered effective.

Hopefully, this study also contributes to opening the road for further research on heuristics for innovation and entrepreneurship, extending the set of heuristics currently explored and investigating the extent to which the effect of the complementarity hypothesis would still hold.

APPENDIX A

A List of Informal Investors' Decision Making Criteria

1. **Product**
    a. Product interest
    b. Benefits, applications, product extensions
    c. Technological Innovativeness, Differentiator
    d. IP and Protectability
    e. Development and technology risks
    f. Clarity of the proposition
2. **Market validation (demand for product)**
    a. Interest by third parties
    b. Customer traction
3. **Route to market**
    a. Distribution partners
    b. Market entry (clarity of business model)
    c. Marketing channels
    d. Projected customer base
4. **Market potential**
    a. Size
    b. Growth
    c. Competitiveness
5. **Team Industry Experience**
    a. Recognized industry expertise
    b. Track record in previous ventures
6. **Team Personal Characteristics**
    a. Managerial capability
    b. Trustworthiness
    c. Ability to work as a team
7. **Financial results**
    a. Realistic forecast
    b. Profitability
    c. Cash flow

8. **Financing**
    a. Projected use of funds
    b. Previous funding
    c. Managers' financial contribution
9. **Deal criteria**
    a. Valuation
    b. Amount required
    c. % of company currently offered
    d. Projected exit
10. **Shareholders**

APPENDIX B

Table 1a. Summary of Investors Frequencies of Correct Versus Incorrect Judgments

Investors scoring ABOVE Average on:	**Correctly accept/reject a project**	**Incorrectly accept/reject a project**	**Correctly accept/reject (%)**	**Incorrectly accept/reject (%)**	**Total (number of people)**
Effectuation	9	1	90	10	10
Forecasting	7	6	62	38	13
Experience-based	6	1	86	14	7
Theoretical Causal Modelling	9	3	75	25	12
Heuristic Breadth	9	3	75	25	12
Heuristic Depth	8	3	73	27	11
Average (number of people)	**7.8**	**2.7**			
Average (% of people)			**75**	**25**	

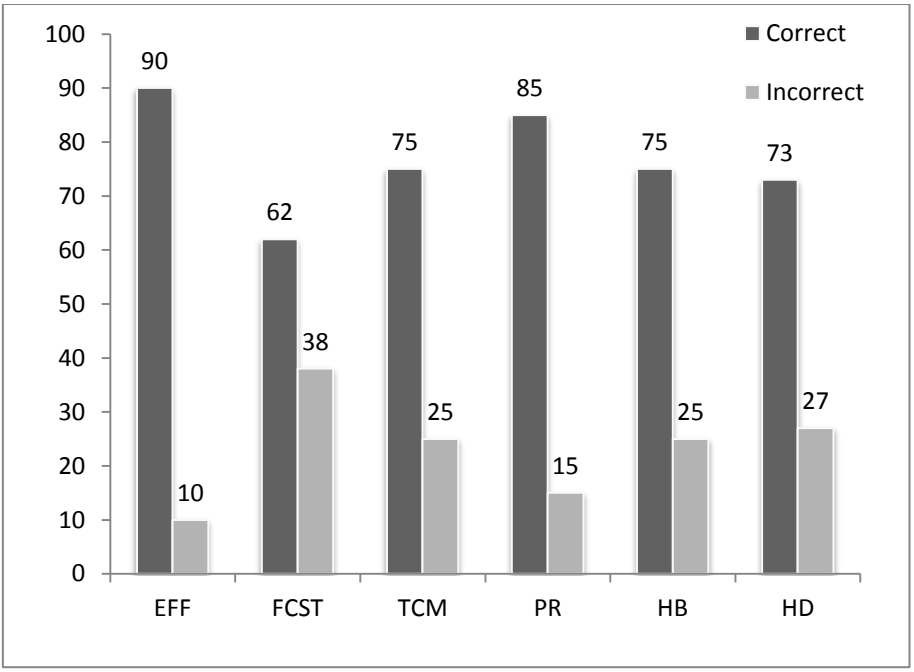
APPENDIX B

Table 1b. Summary of Investors Frequencies of Correct Versus Incorrect Judgments

Investors scoring BELOW Average on:	**Correctly accept/reject a project**	**Incorrectly accept/reject a project**	**Correctly accept/reject (%)**	**Incorrectly accept/reject (%)**	**Total (number of people)**
Effectuation	6	8	43	57	14
Forecasting	7	4	64	36	11
Experience-based	9	8	53	47	17
Theoretical Causal Modelling	6	6	50	50	12
Heuristic Breadth	6	6	50	50	12
Heuristic Depth	7	6	54	46	13
Average (number of people)	**6.7**	**6**			
Average (% of people)			**52**	**48**	

APPENDIX C

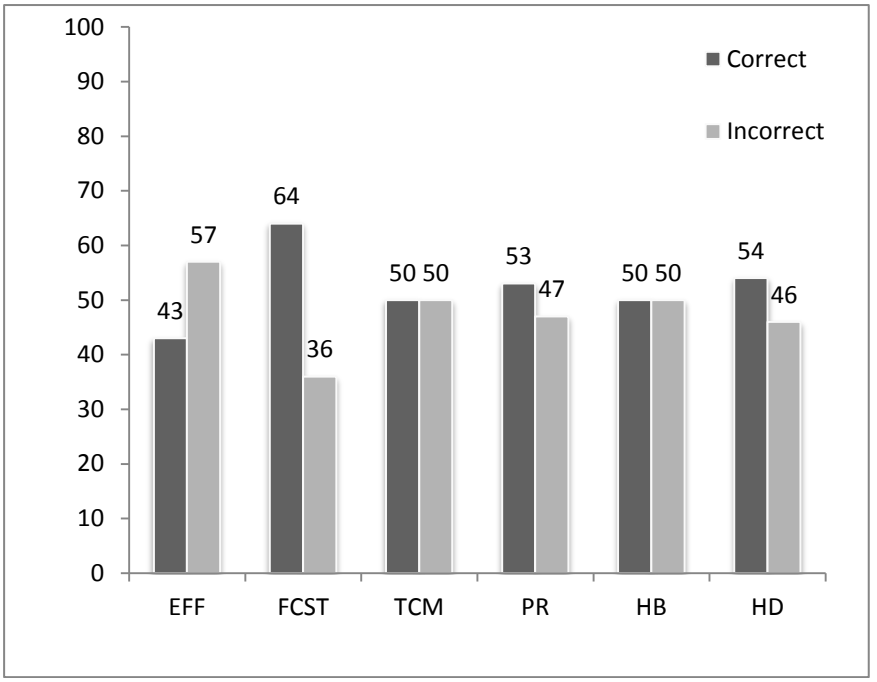
Figure 1 A. Ability to Correctly Accept/Reject Projects



EFF	Effectuation
FCST	Forecasting
TCM	Theoretical-Causal Modelling
PR	Pattern-recognition (experience-based)
HB	Heuristic Breadth
HD	Heuristic Depth

APPENDIX C

Figure 1 B. Ability to Correctly Accept/Reject Projects



EFF	Effectuation
FCST	Forecasting
TCM	Theoretical-Causal Modelling
PR	Pattern-recognition (experience-based)
HB	Heuristic Breadth
HD	Heuristic Depth

CHAPTER 2.

COGNITIVE STRUCTURAL CONFIGURATIONS FOR EFFECTIVE ENTREPRENEURIAL JUDGMENT

ABSTRACT

Past research on decision making under high uncertainty highlights the tendency of boundedly rational individuals to rely on effort-saving strategies based on cognitive shortcuts, fast and frugal heuristics or quick and simple rules in order to make decisions. In contrast with this prevailing view, in this paper I focus on a set of effortful and effective heuristics, which have been shown to positively influence decision makers' judgments in entrepreneurial and strategic contexts. Whilst some of these effortful heuristics are traditionally viewed as opposite to each other, recent work has shown that not only can they be complementary, but that complementarity increases their effectiveness. What remains unclear, however, are the factors that support our ability to

successfully integrate and apply these heuristics within the decision making process. In this paper, I explore these factors through a study of business angels' evaluation of entrepreneurial start-up projects. I adopt a cognitive structural approach, and rely on interview data and verbal protocol analysis to capture individuals' decision making process and to map their ability to structure their mental representations of the problem space and of themselves. I hypothesize that a high level of cognitive complexity of their representations of both their external and self domains will foster individuals' ability to use effective heuristics in their evaluations. My results support these hypotheses, and contribute to our understanding of effective heuristics under high uncertainty and the cognitive structures that allow decision makers to integrate these heuristics and apply them in order to form correct judgments.

INTRODUCTION

Previous research on decision making under high uncertainty has traditionally emphasized that individuals are boundedly rational and therefore likely to resort to cognitive shortcuts, (Tversky & Kahneman, 1974), fast and frugal tools (Gigerenzer & Goldstein, 1996), or simple decision rules (Bingham & Eisenhardt, 2011), which are effort-saving. In contrast to such a cognitive miser (Fiske & Taylor, 1984) view of the decision maker, recent research has suggested that they can also apply a set of *effortful* and *effective* heuristics instead, which can positively influence their judgments. Some of these strategies include effectuation or reasoning on resources (Sarasvathy, 2001, 2008), expectation or forecasting, theoretical causal modelling (Felin & Zenger, 2009; Magnani, 2000) and experience-based pattern recognition (Bandura, 1986; March & Levinthal, 1983). These heuristics have been shown to enhance entrepreneurs'

ability to perceive novel opportunities (Felin & Zenger, 2009) and create new ventures (Sarasvathy, 2008), as well as investors' successful exits from ventures (Wiltbank, Read, Dew, & Sarasvathy, 2009). Albeit often modeled as opposite to each other, or studied in isolation, it has been shown that the joint reliance on these heuristics it not only possible (s.f., Felin & Zenger, 2009), but can also positively influence the decision making process by reducing judgment errors (Cholakova & Grandori, 2012; Felin & Zenger, 2009). Nonetheless, despite the fact that recent research has increasingly emphasized the relevance and benefit of such effective strategies under high uncertainty, we still know very little about the factors that can help decision makers engage in them[7]. In this study, I aim to address this question by

[7] One exception is the work of Haynie and colleagues (2010), who have proposed a conceptual model on the role of metacognitive awareness in explaining when one uses effectual or causal logic under uncertainty. However, they do not provide an operationalization of their model and focus mostly on a switching perspective (either one logic or the other), rather than a synthesis of the alternatives. This work provides a detailed overview of the cognitive factors that are considered relevant for the application of a set of effective strategies (thus not only focusing on

outlining a cognitive-structural approach to the factors that foster one's ability to apply these heuristics effectively and form good judgments. This is important both from a theoretical and a practical perspective. Theoretically, it can provide insight on the configurations of cognitive factors that can help individuals integrate these effective strategies within their decision making process. Even though cognitive characteristics have received a lot of attention in entrepreneurial decision making (see Hodgkinson & Starbuck, 2008), the focus so far has been largely on their role in entrepreneurial *outcomes* (s.f., Shane, 2000, 2003; Shepherd & DeTienne, 2005). Therefore, we still have little understanding of how cognitive factors impact the decision-making *process* itself (Gregoire, Corbett, & McMullen, 2011). From a practice perspective, this work is further important as decision makers under high uncertainty often report little awareness of the exact process that they follow

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effectuation) and explores what supports our ability to apply them, within a complementarity framework.

(Fiet, 1991; Paul et al., 2007) and thus this work signals some factors that can be effectively applied when evaluating novel entrepreneurial opportunities.

In addressing the potential antecedents to the use of such effective strategies, I focus on the role of people's cognitive complexity. In particular, I address the complexity of their representations of *external* events, namely their ability to flexibly structure their problem space, as well as the complexity of their *self* representations, namely their ability to enact a set of independent, non-overlapping identities in the course of their decision making process. This is motivated by the fact that one's ability to apply such strategies should be sustained by keeping more flexible representations of one's problem space, rather than seizing quickly upon a single perspective (Streufert & Swezey, 1986). Furthermore, it should also be supported by having a larger set of role identities (thus being able to see one's self differently across contexts) (Rafaeli-Mor & Steinberg, 2002) and resort to a

wider set of personal resources in applying or enacting the different decision strategies, rather than having a more rigid self-view that may limit action.

I study the role of cognitive structural complexity for individual's ability to apply the set of effective heuristics in the context of angel investing, as it is characterized by high (Knightian) uncertainty. Angel investments represent high net investments in unquoted businesses by private individuals, who have no family connection and take a stake in the post-investment development process of the business (Mason & Harrison, 2008). This setting has already been used to capture decision making under high uncertainty (see Grandori & Cholakova, 2012; Mason & Harrison, 2008; Sarasvathy, 2008; Wiltbank et al., 2009) and is thus considered well-suited for the purposes of the present work. I hypothesize that decision makers who have developed a high level of cognitive structural complexity of their representations of *external* and *self* domains, will be better able to integrate and apply

effective strategies in their judgment process under uncertainty. To test these hypotheses, I conducted interviews with experienced angel investors who were involved in a simulated evaluation of business start-up projects. Based upon verbal protocol analysis and process tracing techniques, I find support for these hypotheses and show that individuals who were characterized by high structural complexity of their representations of the problem space and of their self-representations, had a greater ability to rely upon effective heuristics in their evaluations.

This work aims to make several contributions. First of all, it improves our understanding of the *cognitive* factors that sustain our ability to develop effective strategies in the context of decision making under uncertainty and form better judgments. Furthermore, it contributes to research on *effective* decision making heuristics by opening up the black box of the entrepreneurial *process* (Gregoire, Corbett, & McMullen, 2011; Jose, Roure, & Aernoudt, 2005; Moroz & Hindle, 2012;

Zahra & Wright, 2012). Finally, my observations also have important practical implications in terms of helping investors structure their judgment process better under high uncertainty, as they often report being unaware of the exact reasoning that they apply. In particular, given that angel investors represent the largest source of external seed funds for innovative start-ups, yet more than half of their investments are reported as losses (Wiltbank, 2009), understanding the factors that better support their judgment can have important economic implications.

THEORETICAL BACKGROUND

Effective Heuristics for Entrepreneurial Decision Making

Entrepreneurial decision making is typically characterized by a high level of uncertainty (McMullen & Shepherd, 2006; Shane & Eckhardt, 2003), whereby decisions are taken in situations in which the relevant alternatives,

states of the world, and possible consequences of actions are not ‘given’ or ‘known’ (Knight, 1921). Therefore, it is not possible to calculate probabilities of future events or conceive of these at all, individuals’ preferences are not given or ordered, and there is no indication as to which environmental factors should be attended or not respectively. It is commonly accepted that under such conditions, decision makers are boundedly rational (Simon, 1955) and thus likely to resort to shortcuts (Tversky & Kahneman, 1974), fast and frugal tools (Gigerenzer & Goldstein, 1996) or quick and simple rules (Bingham & Eisenhardt, 2011) in forming their judgments. Rather than following this perspective, the present work adopts an alternative view, according to which individuals can apply effortful and effective heuristics under high uncertainty, which positively influence their decision making (Felin & Zenger, 2009; Grandori, 1984, 2010; McGrath, 1997; Sarasvathy, 2001, 2008). The effortful and effective heuristic strategies on which this work will focus are reasoning on

resources or effectuation (Sarasvathy, 2001) and theoretical causal modeling (Felin & Zenger, 2009; Magnani, 2000), expectation (forecasting) and pattern-recognition (Bandura, 1986) as they have received the most research attention in the literature so far. *Effectuation* consists of looking for the potential effects that a set of means or resources might have, rather than looking for means/alternatives for generating a given effect (Sarasvathy, 2001). The main characteristic of effectuation that this work will focus upon is the idea of betting on the resources, rather than the outcomes, thereby not fixating on a set result and limiting one's self to searching the specific means necessary to achieve it. This work will not address some of the other aspects of effectuation, such as affordable loss logic, since it has been criticized in the literature as being applicable to a set of other logics as well (see Grandori, 2010; Moroz & Hindle, 2012).*Theoretical causal modeling* involves the formulation of causal hypotheses and the ability to 'bootstrap knowledge' much

beyond what has been observed (Chomsky, 1986). It addresses why what is observed, or has not been observed yet, should be observed and aims at explaining the development of phenomena for which there are no signals within observed sequences. The aspect of theoretical causal modeling, on which this work will focus, is the ability to bootstrap knowledge and imagine possible scenarios for future development of opportunities, by extracting possible theoretical laws that can guide this process (Felin & Zenger, 2009). Given that both effectuation and causal modeling tend to facilitate the perception of many different relations among available resources, it is expected that the cognitive mechanisms, which could foster reliance upon such logic should then have the potential to facilitate flexible structuring of one's problem space.

Furthermore, following recent research, this work also incorporates forecasting and experience-based pattern recognition, albeit being often modeled as opposites to

effectuation and theoretical modeling, as their joint application has been shown to decrease judgment error and support effective decision making (s.f., Cholakova & Grandori, 2012). For example, Felin and Zenger (2009) have argued in favor of relying on both the more traditional experience-based logic, and theoretical causal modeling approaches, for entrepreneurial decision making. In addition, even though Sarasvathy operationalizes causation as an opposite to effectuation, reliance on more standard forecasting methods is not necessarily negative for one's judgments (so long as they are not applied with a utility maximization focus). Previous research has actually shown that the complementary reliance on these strategies can decrease judgment error in the evaluation of novel opportunities (see Cholakova & Grandori, 2012). Therefore, in capturing the effective decision making strategies under high uncertainty, this work will address all four types of heuristics, and explore the factors that can allow decision makers to integrate these

strategies within their decision making process and apply them effectively. In doing so, I develop a cognitive structural framework, within which I outline a configuration of factors that can positively influence individuals' reliance on multiple effective decision making strategies and facilitate good judgments under strong uncertainty.

Cognitive Structure and Cognitive Content

The ability to form multidimensional, flexible cognitive representations of one's problem space, and to develop a dynamic, rather than a static frame for one's judgments, can be reflected in the complexity of individuals' cognitive structure (Schroder et al., 1967). Cognition is defined as the "processes by which sensory input is transformed, reduced, elaborated, stored, recovered and used" (Neisser, 1967, p.4), as well as the representation of what the individual experiences as reality itself (Streufert & Swezey, 1986), and the ability to "make sense of other people and themselves" (Fiske & Taylor, 1991, p.14). The concepts or attributes

developed by an individual to identify, differentiate, and group objects, or unite them according to particular criteria, are then known to represent an individual's "cognitive universe" (Zajonc, 1960: 159). A cognitive domain within a person's cognitive universe can be described in terms of its *content* and its *structure.* Cognitive *content* is composed of the specific concepts and attributes of one's mental representations, whereas cognitive *structure* captures the relationships that one builds among these concepts (Scott, 1962). The operating definition of *content* that will be adopted throughout this paper addresses *what* aspects one relates within a domain, whereas the definition of *structure* considers "*how* one ties to the differentiated aspects of his world" (Harvey & Schroder, 1963, p.110). The majority of research on cognition has tended to focus on content (that is, mapping the specific elements within a cognitive structure) (Harvey & Schroder, 1963). However, this research will focus on cognitive structure instead, as it allows to capture people's

ability to reorganize effectively the elements within their conceptual space and build multidimensional representations of their problem space. This is considered important as it can facilitate reliance on different decision making strategies and allow one to focus and explore a larger set of factors and connections among them prior to forming a judgment. In addition, content refers to what people think, whereas the present work is much more interested in *how* they think and the dynamic characteristics involved in this process.

One's ability to develop such a multidimensional mental representation of a specific cognitive domain has been defined as cognitive complexity. Two perspectives on the complexity of cognitive structure can be found in the literature: one based on the complexity of one's representation of a problem space (*external* domain), and one based on the complexity of one's mental representation of the *self* domain (see Rafaeli-Mor & Steinberg, 2002). For simplicity of notation throughout the paper, studies referring to individuals' perceptions of objects

or groups of factors of an external domain will be referred to as complexity of the *beheld,* whereas studies focusing on the complexity of a person's mental representation of a self-domain will be referred to as complexity of the *beholder*. I outline the relevant theories within both domains (beholder and beheld) in the following sections and explain their implications for entrepreneurial judgment.

Complexity of the Beheld

Complexity of the beheld is based upon two building blocks, namely cognitive differentiation and cognitive integration (see for instance the work of Harvey, Hunt, & Schroeder, 1961; Schroeder, Driver, & Streufert, 1967; Scott Osgood, & Peterson, 1979; Streufert & Swezey, 1986). According to Lewin (1936), one of the first authors who discussed the concept of cognitive structure, *differentiation* can be seen as the number of regions within a person's life space, whereas *integration* as the extent to which distant regions within one's (topological) space are merged or

connected. Other definitions of differentiation refer to it as dimensional complexity, which represents the number of concepts constituting a certain part of a person's world and the "distinctiveness of the elements" which compose it (Scott, 1963, p.277). Integration, on the other hand, captures the number of connections that a person is able to draw (and re-draw) among the set of elements within a cognitive domain (Streufert & Swezey, 1986). When a person's conceptual system is characterized by both high differentiation and high integration, it is more adaptive, allows for flexible interrelations among ideas (Harvey et al., 1961; Scott et al., 1979), and facilitates a person's ability to rely on multiple categories when forming a judgment. This can have important implications for one's ability to perceive potential resources in the environment and draw connections among them, thus possibly increasing the propensity to apply multiple effective strategies in one's judgment. On the other hand, people characterized by high differentiation, yet no or too little

integration, are likely to experience disconnectedness of their ideas, the latter oftentimes resulting in stereotypical or inflexible ideas. Furthermore, as elaborated by Schroder and colleagues (1967), having low integration results in static relations among the different parts of a cognitive domain and a hierarchical structure, in which one's rules are fixed. In contrast, high integration stands for having greater connections among rules and the ability to formulate alternative perceptions or hierarchies (Schroeder et al., 1967). It is then expected that people's ability to achieve such a well-differentiated *and* integrated representation of a specific cognitive domain (their problem space) can facilitate their perception of interconnections among available resources in the environment, which, in turn can help them apply a set of effective strategies in their decision making process. It is thus predicted that:

Hypothesis 1: Investors with a high level of both differentiation and integration of their cognitive

representations of a problem space (high complexity of the beheld) will integrate and apply a greater set of effective strategies in their judgments under high uncertainty.

Furthermore, as outlined earlier, individuals who have incongruent levels of cognitive differentiation and integration tend to have relatively static relations among factors and develop ideas, which are stereotypical and often inflexible. Therefore, decision makers characterized by incongruent levels on these two variables will have a lower propensity to apply effective strategies.

Complexity of the Beholder

When applied to one's domain of self (or the beholder), the concepts of differentiation and integration can find an equivalent in the terms self-pluralism and self-unity (Campbell, Assanand, & Di Paula, 2003). As Robins, Norem, and Cheek (1999) have argued, there is significant ambiguity

attached to the construct of *self*, which has been explored from a set of perspectives, stemming from philosophical, psychological, sociological and anthropological traditions (see Logan, 1987; Sarbin, 1952). It is beyond the scope of the present work to outline each of these views, however, for the purposes of this paper, the notion of self will be understood and treated as a multifaceted cognitive structure (e.g., see Epstein, 1973; Kihlstrom & Cantor, 1984), rather than a unitary and monolithic one, as earlier research has argued (for an overview, see Markus & Wurf, 1987)[8].

When studying the cognitive domain of *self*, unity and pluralism factors have often been addressed in separation from one another in the literature and their interplay has been less explored (for an exception, see Lutz & Ross, 2003), as compared to research on complexity of the beheld. The

[8] As Rafaeli-Mor and colleagues (1999) point out, it is only with the advent of social-cognitive theory and methodology that *structural* properties of the self started to be considered and then further explored by self-theorists both within the fields of psychology and sociology (e.g., Markus & Wurf, 1987; Thoits, 1983).

pluralism of a person's self-concept has been understood as having multiple specialized identities or roles, which allow people to quickly adapt to the demands of changing circumstances. According to Campbell and colleagues' classification (2003), the factors which should be included under pluralism include self-complexity (Linville, 1985, 1987) and self-compartmentalization (Showers, 1992). The *unity* of a person's self-concept has been defined as the ability to develop "coherent, integrated selves that provide continuity and psychological adjustment" (Campbell et al., 2003: 121). The factors, which Campbell and colleagues (2003) have included under a unity categorization, include self-concept differentiation (Block, 1961; Donahue et al., 1993) and self-concept clarity (Campbell et al., 1996).

In this research framework, the construct selected to represent pluralism is self-complexity and the construct selected to represent unity is self-concept clarity, as they have received the most research attention in previous work. *Self-*

complexity implies that people are capable of organizing their self-knowledge into multiple, distinct (non-overlapping) cognitive structures (self-aspects), which can also reduce their experience of negative affect (Linville, 1985). The underlying mechanism is that the more self-representations a person has, and the lower the overlap among them, the lower the spillover of any negative experience to unrelated structures within the self-domain. On the other hand, *self-concept clarity* is defined as the "extent to which the contents of the self-concept are clearly and confidently defined, internally consistent, and temporally stable" (Campbell, Assanand, & Di Paula, 2003: 122). The complex interplay between unity and pluralism factors has not been well-explored so far. Even though self-concept clarity has been associated positively with an individual's well-being (Campell et al., 1996), self-complexity has been related to both positive and negative outcomes for the individual. Earlier research associating pluralism or multiplicity of self to adaptability or well-being

includes the works of Gergen (1971) and Goffman (1959), whereas research considering pluralism as fragmenting, or not allowing the individual to have a clear sense of self, has been developed by Block (1961). The positive aspect of pluralism is that it helps one adapt to the demands of a situation faster and perceive more ways in which this can be achieved. The negative aspect, stemming from the fragmentation view, however could be reduced, if pluralism is coupled with high self-unity, as it would eliminate the lack of clear sense of self. Therefore, as with the hypotheses on complexity of the beheld, it is argued that having high pluralism, matched with high self-unity will allow for more flexible representations and a greater ability to actively project one's self across different situations. It is then expected that:

> *Hypothesis 2: Investors with a high level of both self-pluralism and self-unity (high complexity of the beholder) will integrate and apply a greater set of*

effective strategies in their judgments under high uncertainty.

As with the propositions on the complexity of the beheld, incongruent conditions with regards to complexity of the beholder are expected to be less adaptive under high uncertainty (as they could, for instance, foster fragmentation of self), and thus would be characterized by lower reliance on effectual logic.

Complexity of the Beheld and the Beholder

Taking into consideration research on complexity of the beholder and the beheld, it is surprising that no work has actually explored the joint impact of the two systems on decision makers (see Rafaeli-Mor & Steinberg, 2002). As discussed earlier, research on complexity of the beholder has mostly developed without acknowledging earlier findings on complexity of the beheld or addressing explicitly the parallels between differentiation-integration and unity-pluralism.

Nonetheless, this work brings these two perspectives together, exploring their joint potential and thus broadening the theoretical contribution of this research. In particular, a high complexity of the *beheld* suggests that individuals can perceive a larger set of factors within a cognitive domain and can draw more connections among them, thus preserving a high level of flexibility within their cognitive structure. High complexity of the *beholder*, on the other hand, implies that individuals have a larger repertoire of roles, which they can enact in order to adapt to the changing demands of a situation and can develop a more effective response tendency. Therefore, when the multiplicity of self is matched with having a complex representation of one's problem space, decision makers can not only perceive available resources in the environment, and draw more connections among them, but also conceive of themselves as capable of pursuing the desired opportunities (and thus act upon them), thus

increasing the likelihood of applying a set of effective decision making strategies[9].

To the contrary, if individuals have high complexity of beholder (multiplicity of self), yet low complexity of the beheld, they may have a too undifferentiated representation of their problem space and little understanding of how the different elements relate to each other, thus decreasing their ability to apply effective strategies. At the same time, if they are characterized by high complexity of the beheld, but not the beholder, they may not be able to perceive the necessary resources in terms of their own role identities that could help them enact a certain line of behavior, even if they have a well-structured representation of the problem itself. Thus, aligning these two perspectives and exploring their joint benefits also

[9] The propositions developed in this work, however, should only be interpreted in the context of high uncertainty because, as a number of authors have acknowledged before, greater complexity is not necessarily always being better for the individual (see Satish, 1997). Instead, the appropriateness of each different level depends on the environmental circumstances, and as Streufert and Swezey (1986) have argued, a highly integrated response to a very simple event could actually lead to failure.

provides novel insights and a broader theoretical contribution of the paper. Therefore, it is argued that:

> *Hypothesis 3: Investors with a high level of complexity of both the beheld (high differentiation and high integration) and the beholder (high self-complexity and high self-concept clarity) will integrate and apply a greater set of effective strategies in their judgments under high uncertainty.*

Because of the increased complexity of these propositions, the incongruent conditions will be outlined based upon the empirical results of this work.

METHOD

Research Setting

I have chosen to focus on business angel investors in order to test the hypotheses of this study, because, as serial investors and professional economic decision makers, they

operate under conditions of high Knightian uncertainty. In particular, business angels are high net worth individuals, who are able to invest their own resources in unquoted businesses with no family connection, in which they take a stake in the post-investment development process (Mason & Harrison, 2008). They are interesting to study because they represent the largest source of external seed funds for innovative start-ups and invest more than twice the amount of venture capital investors (BBAA, 2010). Therefore, angels provide the necessary capital for bridging the equity gap left by venture capitalists (Avdeitchikova, Landstrom, & Mansson, 2008; Berggren & Fili, 2008; Clarke, 2005). More than 50 % of angel investments are in the very risky end of pre-revenue early-stage level, with 56% of all existing investments being reported as losses and 44% as gains with a factor of return between 1 and 10 times the original investment (Wiltbank, 2009). Thus, business angels' investment process is strongly affected by uncertainty and

provides a rich context in which to study the cognitive factors that influence investors' ability to apply effective strategies when evaluating novel opportunities.

Sample

In order to guarantee a large enough sample of experienced angel investors, I approached members of the British Business Angels Network (BBAN) with an initial request for the contacts of individual investors or partnering organizations. Envestors, a company engaged with matching entrepreneurs and business angels, agreed to collaborate and facilitated the contact between the research team and individual investors. I contacted sixty experienced investors, registered with Envestors[10], twenty-eight of whom responded positively to the invitation to participate in a ninety-minute semi-structured interview. From these investors, one participant was not comfortable with the 'think aloud'

[10] Investors were selected on the basis of their experience, as well as on how active they have been over the past two years in participating in the company's events and in soliciting new projects in which to invest.

procedure, required during the interview, whereas two others preferred to discuss past investments rather than engage in the task at provided, therefore they were excluded from the analysis, leaving a total sample of twenty-five. The collaborating company arranged to have all interviews conducted at their offices, thereby providing a standardized setting for all interviews and controlling for any external influences. In addition, I was invited to attend several investor events where entrepreneurial pitches took place, which allowed me to familiarize myself well with the actual settings and to discuss with attending angels about their impressions of the investment process[11].

Within the current sample, the average amount invested in pre-revenue or early-stage entrepreneurial projects by the investors amounted to £127,045, with a minimum investment of £10,000 and a maximum investment amount of £650,000 per investor. The total number of projects in which

[11] The authors are indebted to the host company for their kind collaboration and support throughout the entire duration of this project.

the angels in the present sample had invested was 329 and the total number of successful exits was 61, where the average number of projects, which a single investor had funded, was 13 (with a minimum for the sample of 4 and a maximum of 50). In terms of their years of angel investing experience, the average was 9 years of active investing, with a minimum of 3 and a maximum of 35. Lastly, the average number of successful exits of the investors was 3, with a minimum was 0 and the maximum 13. Within the sample, 19 of the investors reported having previous experience in starting up their own business. Please refer to Table 1 in Appendix A for a summary of participants' characteristics. All of the investors had advanced degrees and were evenly distributed within the 36 to 45 and 46 to 55 age brackets.

Data Gathering Technique

In order to capture the reliance of decision makers on effective strategies and trace the process through which they structured their problem space throughout the project

evaluation, I relied on a think aloud procedure and verbal protocol analysis. The think aloud task requires participants to speak out everything that comes to their minds when engaging in the task (yet without providing any justifications), and allows for the observation and interpretation of concurrent behavior, thus accounting for biases in retrospective reporting (see Ericsson & Simon, 1984; Nisbett & Wilson, 1977). The methodology has been applied successfully when studying the decision-making of venture capitalists (s.f., Hall & Hofer, 1993; Zacharakis & Meyer, 1995) and is therefore deemed suitable for the purposes of the present work. Even though some authors have argued that verbalizing during a task could influence one's decision making, Schweiger (1983) has reported no significant differences between subjects who verbalized and those who did not in terms of their task performance.

Stimulus Material

The materials chosen for this study were actual business plans produced and distributed to investors during entrepreneurial pitches. The cases were selected so that they were within different industries to ensure that they capture investors' diverse competences and preferences, such that two of the projects involved the use of a new technology and two were based upon a tangible product. All plans had the same format as developed by the host company (Envestors) and were of comparable length, thus offering a similar amount of information per single category (e.g., market proposition, team, financial details). In addition, they were selected so that the amount of total financing required was approximately similar for each project and considered with the possibility range of the investors (around £250,000). I distributed four plans stacked together to each investor and I randomized their order across the different interviews to prevent any primacy or recency effects. As Roure and Keeley (1990) have argued,

a lot of the important information about a new project can be extracted from its business plan, which makes it a suitable stimulus material for the purposes of this study.

Procedure

I contacted participants two weeks prior to the interview date with a short survey, aimed at collecting some of the individual level measures, described in the next sections, as well as a set of demographic questions (i.e., age, gender, education level, number of successful exits, etc.). In the next stage, participants arrived individually at the office of Envestors, where they were introduced to the think aloud procedure and informed that the following study aims at understanding better the decision making process involved in the evaluation of early-stage projects. Afterwards, they were distributed four actual two-page business plans produced by Envestors[12]and asked to imagine that they have just received

[12] The reason for selecting this format of the business plans is that the majority of business angel networks follow the same setup. I also ensured

them as they normally would, either during an event or at their offices, and then invited to share how they would usually proceed with evaluation of the projects. More specifically, they were asked to choose the project, which would interest them the most and then verbalize their thoughts as they reviewed the selected business plan. Upon the approval of each individual, sessions were tape-recorded, transcribed and content-analyzed in order to map the process that investors followed and the heuristics that they applied.

Measures and Operationalization: Independent Variables

Complexity of the Beheld

I measured complexity of the beheld by means of a process-tracing technique, called a time-event matrix. Time-event matrices are a graphical representation of a person's thought process based on a set of observable actions throughout a specified time frame. Initially this method was

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that investors had not seen the selected projects before or received any prior information about them.

developed by Streufert and Swezey (1986) and was used to depict information processing under fluid and complex task settings such as strategic planning (see also Streufert & Satish, 1997). I adapted this technique for the purposes of angel investing as it allowed me to trace the actual decision making process and how it developed over the course of one's evaluation. The time-event matrix is built upon two dimensions, namely time and factors considered in the decision, the latter being represented by individual points in the matrix. Time is typically plotted horizontally and there are no restrictions as to the specific time intervals used. Independent sequential events should then appear on different time sections. As far as the factors are concerned, they are expected to be based on the categories that decision makers are likely to rely upon in a specific situation (Streufert & Swezey, 1986). An average of 10 to 15 factors are usually used within a time-event matrix analysis. In the current study, I derived a set of 10 factors (each with a subset of 4-5factors),

based on existing theory (see Maxwell et al., 2011) and investors' practice, and used them within the time-event matrix in order to trace the decision process. A detailed list of these factors is provided in Appendix B. More specifically, I mapped the factors that investors considered throughout their judgment of a project, as well as the interconnections they built across these factors until they finally arrived at their decisions. Decisions executed at the same time are connected with vertical lines, whereas decisions capturing the same type of information are connected with horizontal lines. In order to indicate the structural (causal) links across factors, forward or backward diagonals are drawn. Each individual's time-event matrix was drawn on the basis of their interview protocol and the respective measures were computed following the guidelines of Streufert and Swezey (1986). The degree of *differentiation* was measured as the number of categories, or the total number of factors, that an individual addressed during the evaluation process (in the present study, the

maximum is 9). The degree of *integration* was measured by counting the forward and backward diagonals within the matrix, to and from any specific point, and then applying the algorithm, developed by Streufert and Swezey (1986) in order to arrive at the final score for each decision maker. Examples of participants' matrices across the different levels of complexity (both beheld and beholder) are provided in Appendix C.

Complexity of the Beholder

As outlined earlier, complexity of the beholder is based upon two main factors, namely self-unity and self-pluralism. Pluralism was computed based upon Linville's (1985, 1987) instructions for assessing self-complexity. Participants were handed a number of cards with adjectives written on them, and instructed that using these adjectives they should try and form as many trait sorts as they feel could be meaningful and descriptive of them. Trait sorts represent how individuals perceive themselves in a particular role (for

instance, when I invest, I feel confident, mature, happy, anxious, etc.) and people are invited to form for as many sorts as they think are important and characteristic of them. The same adjectives could be used repetitively across trait sorts and each group could contain as many adjectives as they want. The information from individuals' trait sorts was then transformed into self-complexity scores by using the H-statistic (see Linville, 1987). Please, refer to Appendix D for more information on the computation of the index. Self-unity was measured with the self-concept clarity scale, developed by Campbell and colleagues (1996). The scale is composed of 12-items with anchors ranging from 1 (strongly disagree) to 7 (strongly agree) (alpha=0.92) and it is provided in Appendix E.

Measures and Operationalization: Dependent Variable

Multiple Effective Heuristics Index

The effective strategies considered in this work are effectuation logic and theoretical causal modelling logic.

However, as argued in previous research (see Cholakova & Grandori, 2012 for a review), the application of the so called opposites to these two logics, namely expectation/forecasting and experience-based pattern recognition has a complementarity effect, whereby joint reliance on them further improves effective judgment. Therefore, an index of the use of the four different logics was developed for the purposes of the present work, capturing individuals' reliance on effectuation, forecasting, theoretical causal modelling and pattern recognition when evaluating a novel project. The decision process of each investor was coded by counting all instances, or short text segments that referred to a specific heuristic type (see Newell & Simon, 1972). Effectuation and forecasting were coded by partially following Sarasvathy (2008), yet excluding the components referring to affordable loss, which, as outlined earlier, have been recently criticized (Moroz & Hindle, 2012). Furthermore, following recent research (Grandori, 2010), rather than contrasting effectuation

with causation, as done by Sarasvathy (2001), I contrasted it with and coded for forecasting logic instead. The reason for this choice is that even when starting with means and looking for possible uses of resources, decision makers are still formulating causal hypotheses about the possible effects of those means and resources (see Grandori, 2010).

In order to map decision makers' reliance on theoretical causal modelling and pattern-recognition, I developed a coding system, based on the work of Felin and Zenger (2009), Magnani (2000) and Bandura (1986). Thus, using investors' evaluation of the provided business plans, I coded investors' scripts for instances of the four effective heuristics in their analysis of the business plans.

On average, investors used 2.2 instances of effectuation-based logic within their analysis of the business plans (min 0, max 6) and 1.92 forecasting-based segments (min 0, max 7). The total number of instances of effectuation-based logic for all subjects was 51 and the total number of

instances of forecasting 46 respectively. Furthermore, investors in the sample used 2.16 instances of pattern-recognition (min 1, max 4) and 1.87 instances of theoretical causal modelling logic (min 0, max 5). The total number of instances of pattern-recognition was 44 and of theoretical causal modelling 57. Given the specificity of the information being coded, an independent coder, blind to the purpose of the study, was solicited. He reached an agreement with the authors' coding and categorization of instances in 87% of the cases. The disagreements were reviewed again and reclassified upon discussion. The index of effective strategies was based on the total number of instances within each of the four categories, whereby the average was 6.92 (min 2, max 14). For notational simplicity, this index of reliance on multiple effective heuristics will be referred to as MEHS index in subsequent sections of the paper.

ANALYSIS

In testing the hypotheses of this paper, two types of analysis were applied, aiming to get a better understanding of the phenomenon, namely simple frequency analysis (relying on crisp sets) and qualitative comparison analysis (relying on fuzzy sets), which will be outlined in this order below. For the former, I coded individuals' reliance on multiple effective heuristics (MEHS) index and their level of complexity of beheld and beholder by taking the respective averages on each variable and dividing participants as above or below these levels (as there are no universally established high versus low levels on these measures per se, they were coded with reference to the averages for the current sample). Therefore, a *high* score implies above average for the sample and a *low* score – below average respectively.

In order to test Hypothesis 1 and 2, I assessed reliance on MEHS by participants characterized with high complexity of the beheld and those characterized with high complexity of

the beholder respectively. With respect to complexity of the beheld, 9 investors in the sample were characterized by both high integration and high differentiation scores, 8 of whom were also characterized by above average reliance on the MEHS index, thus offering support to Hypothesis 1. On the other hand, there were 10 participants with high complexity of the beholder, namely scoring high both on self-complexity and self-concept clarity measures, 4 of whom were also reported to rely above average on the MEHS, thereby offering little support to Hypothesis 2. In order to explore the joint influence of these two factors on one's ability to sustain conflicting decision making strategies, their interaction was explored in Hypothesis 3. In order to do so, four groups were composed, namely high complexity of beholder and beheld, low complexity of beholder and beheld, as well as the two mixed conditions (high complexity of beholder and low of beheld and the reverse). There were four participants within three of the groups and five within the forth one (resulting in

a total of 17 investors)[13]. The first group, namely individuals with high levels of both complexity of the beheld and the beholder, were all characterized by an above average score on the MEHS index (4 investors out of 4). This result is in line with the prediction that scoring high on both types of complexity (beholder and beheld) is going to relate positively to one's ability to rely upon effective strategies under high uncertainty, thus providing support to Hypothesis 3. In contrast, in Group 4 investors scored low (below average for the sample) on all four complexity factors and were characterized with no above average use of the MEHS index (0 investors out of 4). With reference to the mixed conditions, decision makers in Group 2, who had high complexity of the beheld, yet low complexity of the beholder (that is high complexity of the representation of external

[13] The reason that not all participants can be classified under this matrix is that differentiation and integration, as well as unity and pluralism are independent components, which jointly lead to complexity of beheld and beholder respectively. Therefore, to meet the criteria for complexity of beheld for instance, one needs to score high simultaneously on both factors (as it is not a cumulative index on its own).

events, yet low complexity of self-representations), had a mixed reliance on the MEHS (2 investors out of 4 had an above average score on the index). Lastly, Group 3, who had a low complexity of the beheld (namely they had less differentiated and integrated cognitive maps of the problem space) and a high complexity of the beholder (in terms of high complexity and unity of self), were characterized by no above average reliance on MEHS (0 investors out of 5).

Based on these results, it can be argued that the joint effect of complexity of external and self representations supports decision makers' ability to rely on multiple effective decision making strategies. Nonetheless, the results also point to a relatively stronger role of complexity of the beheld, rather than the beholder, in fostering reliance on the MEHS. Furthermore, 7 investors could not be classified within the four groups above and their characteristics are reported below. Four of these investors had high integration and high self-unity (and below average differentiation and self-

complexity). From them, 3 out of 4 reported above average reliance on MEHS. Two other investors were characterized by high differentiation and low self-unity and they showed no reliance on MEHS. The last one was characterized by high integration and low self-unity and reported above average reliance on MEHS. Therefore, the results from these additional cases suggest that differentiation per se, may be more expendable as a factor in the evaluation process, and emphasize the importance of integration in fostering reliance on MEHS. A similar result was reported by Cholakova and Grandori (2012) with reference to the relevance of integration and differentiation in avoiding Type I and Type II errors in judgments under high uncertainty, namely selecting bad or rejecting good opportunities.

One concern with this first analysis so far, however, is that it captures well the extremes but fails to differentiate among participants who score close to the average level on the different factors. A technique that has been recently

developed in the literature, which aims to tackle this problem, is to rely upon fuzzy sets (which allows different degrees of membership within a category), rather than the previous type of analysis, which is based on crisp sets (0 if non-membership and 1 if membership based on a pre-specified threshold).

Therefore, in order to capture better the variance in respondents' data, in addition to applying the current analysis and using the average scores of the individuals in the sample, I also applied Qualitative Comparative Analysis, based on fuzzy-sets logic. The benefits of using such an analysis is that it is suited for small sample sizes and allows for the exploration of configurational solutions (rather than linear), thus outlining all combinations of the proposed cognitive factors that could lead to reliance on MEHS. In order to extract the set of solutions, it applies Boolean logic to explore the commonalities of the configurations that lead to the expected outcome. Boolean algebra helps create logical statements, which can then be reduced with the set-theoretic

approach and counterfactual logic. Following the guidelines by Ragin (2008) and Fiss (2007, 2011), I calibrated my variables by taking the 5^{th}, 50^{th} and 95^{th} percentile, using the fs/QCA (Drass & Ragin, 1999) software. The program allows one to calibrate the variables using these percentiles and then to recode them within a range from 0 to 1, depending on individuals' level of membership in each category (full membership (95^{th}), full non-membership (5^{th}) and cross-over point or point of maximum ambiguity (50^{th}). I applied this type of calibration to the measures of effectuation, forecasting, theoretical causal modelling, experience-based pattern-recognition, differentiation, integration and pluralism. For self unity (self-concept clarity), which was measured on a 7-point Likert scale, I followed Fiss (2011) and established 1 as the point of maximum non-membership (equivalent to the 5^{th} percentile in the upper cases), 4 as the point of max ambiguity or the cross-over point (equivalent to the 50^{th} percentile in the upper cases) and 7 as the point of full

membership (equivalent to the 95th percentile in the upper cases).

As a next step, in order to explore which combination of the variables produces the desired effect, the set theoretic analysis produces a truth table, which lists all possible configurations of the factors (and their link to the outcome). The number of rows within such a truth-table is 2^k-1, where k is the number of predictors (in this study, k=4). The algorithm required for the logical reduction of statements within the truth table is the Quine-McCluskey (see Drass & Ragin, 1992 for further review). The number of rows of the solution of the truth table is then reduced based on the *number* of observations required to accept a solution and the minimum level of *consistency* of each solution. For small sample sizes, the minimum number of observations accepted is 1 or 2 (per row). Consistency represents the proportion of cases consistent with the outcomes (cases that exhibit a configuration of attributes and the outcome, divided by cases that exhibit the same

configuration of attributes but not the outcome) (Fiss, 2011). The minimum acceptable consistency level recommended by Ragin (2006) is 0.75.

Based on the theoretical framework of this study, I then performed an analysis of the role of complexity of the beheld (differentiation and integration) and beholder (self-unity and self-pluralism) for individuals' ability to apply MEHS. I set the lowest acceptability consistency level as greater or equal to 0.8 (which is above the recommended 0.75 by Ragin, 2006, 2008), and the minimum acceptable solution frequency to 2 cases. The results from applying the analysis offer two potential configurations. The first one emphasizes the role of integration and unity and signals the absence of differentiation and pluralism. It therefore suggests that even though both complexity of beheld and beholder are still important for developing MEHS, the critical pieces are in terms of building flexible interconnections (rather than just focusing on many factors) and having a clear sense of self

(rather than having many identities per se). The consistency level for this solution is 0.9, with a raw coverage of 0.26 and unique coverage of 0.1. The results emphasize an aspect of both complexity of self and of their problem space, thereby remaining aligned with Hypothesis 3. For a summary of these results, please refer to Table 2, Appendix F. The second and highest coverage solution is also in line with Hypothesis 3, whereby the presence of all four complexity factors is indicated as a configuration required in order to observe the application of MEHS. The solution's raw coverage is 0.4 and unique coverage 0.28, with a consistency of 0.95, which is well above the recommended ranges for acceptability (Ragin, 2006). Therefore, it provides support to Hypothesis 3. To further corroborate my results, I also analyzed the alternative scenario (namely factors not leading to MEHS) using the four cognitive predictors. None of the solutions reached the 0.75 consistency threshold, which further strengthens the proposition that complexity of beheld and beholder support

individuals' ability to synthesize multiple strategies in the evaluation of novel opportunities and engage more effectively in the decision making process under high uncertainty.

CONCLUSION & LIMITATIONS

Overall, the results from the study support the relevance of cognitive structural complexity in fostering reliance on effective heuristics under high uncertainty. In particular, decision makers whose mental representations of their problem space are characterized by a high differentiation (focusing on a large set of factors) and integration (building various interconnections among these factors) (*complexity of the beheld*), and who can perceive themselves differently across a number of roles and enact these based upon the demands of the situation (*complexity of the beholder*), had a greater propensity to apply effective strategies in their evaluation of novel opportunities. These results are important as they provide insight on the factors that foster the decision

making process in the context of high uncertainty, which have remained largely underexplored so far. Nonetheless, several limitations of this work should be noted. First of all, in order to effectively extract the reliance on the specific decision making strategies, the present work required a technique that could capture investors' decision making as it unfolds. Therefore, it relied upon interview data and verbal protocol analysis, which despite its important benefits in providing rich data and accounting for biases in retrospective reporting, comes at the expense of having a relatively small sample size. Given that there has been very little research on the specific questions that this paper addresses, relying upon richer data and a sample of experienced decision makers was considered essential in order to explore well the phenomenon. However, future research may adapt some of the measures of this study and test them on a larger sample using experimental design. Furthermore, since this paper is innovative in studying *effective* heuristics and our ability to apply a set of them,

some viewed as opposite to each other, it has chosen to focus on a selected few, which have been best addressed in the literature so far. This, however, does not imply that this set of heuristics is exhaustive, as the field is still developing and thus more work is certainly needed in expanding this framework.

One of the limitations of the proposed model also comes from the difficulty in capturing cognitive structure. Some authors have argued that there is no actual clear-cut definition of it (Scott, Osgood & Peterson, 1979) or that it is characterized by "confusing, inconsistent terminology" (Streufert & Streufert, 1978: 20). Nevertheless, the conceptual confusion has mostly stemmed from the lack of cross-talk between the two different fields (beheld and beholder), and the present work has aimed at resolving this issue by revisiting research on both, thus addressing the intricate interplay between them. This also represents a broader theoretical contribution of the paper, especially since it is also

then applied in the context of decision making under uncertainty. Furthermore, some of the common limitations associated with having angel investors as a sample should be noted, namely survivor bias, self-selection bias, and the overall difficulty of identifying practising angels per se. Self-selection implies that the analysis may not be representative of the angel investors' population and therefore the results may not generalize to all investors. In line with this, it should be noted that the study was conducted with practising angel investors in the United Kingdom, which does not exclude the presence of certain cultural differences with respect to investors' practices in other countries. Nonetheless, this was done in order to ensure that the interviews are conducted in the native language of the investors since verbal protocol analysis may not be reliable if the subjects think aloud in a foreign language. Furthermore, the decision task per se was selected so that it is very similar in format and type to the practices used across various European and American angel

networks. Survivor bias, on the other hand, implies that the investors in this sample are only the ones who have been successful or at least still remain in the business, rather than the ones who have failed. Nonetheless, given that the focus of this work is to study the effective heuristics decision makers apply, it was intentionally decided that the interviews will be conducted with investors who have funded at least one project so that they have some hands-on experience and understanding of the process. In addition, the sample does involve investors who have not yet exited successfully from a business and investors with as many as 13 successful exits. Overall, the results and recommendations of this work should be evaluated in light of the above-listed limitations.

DISCUSSION

This paper explores the cognitive factors that facilitate investors' ability to engage in a set of effective decision making strategies in the process of evaluating novel

opportunities. In doing so, it focuses on decision makers' ability to apply effortful, procedurally-correct heuristics in the context of judgment under high uncertainty (see Grandori & Cholakova, forth, for an overview), rather than adopting the perspectives emphasizing reliance on shortcuts (Tversky & Kahneman, 1974), fast and frugal heuristics (Gigerenzer & Selten, 2001), or simple cognitive rules (Bingham & Eisenhardt, 2011). Furthermore, it aims to address the *how*- and *why*-, rather than the *what*-questions of entrepreneurship, following a functional approach to entrepreneurial judgment (see Foss & Klein, 2012, for an overview). Therefore, it focused on the *process* (Zahra & Wright, 2012), rather than the specific *stages* (e.g., Reynolds & White, 1997), *factors* or *outcomes* of entrepreneurial decision making. Adopting such a process-based perspective to cognition is important as it differentiates from previous efforts to single-out individual characteristics and their influence on entrepreneurial outcomes (Gartner, 1988; Shane, 2003). More specifically,

the study showed that having a high complexity of the beheld (how one structures information about external factors) and high complexity of the beholder (complexity of one's own self-representations), is related to greater reliance on effective judgment strategies, such as theoretical causal modelling, experience-based pattern recognition, effectuation and expectation (Bandura, 1986; Felin & Zenger, 2009; Sarasvathy, 2001). Given that some of these strategies are modelled as opposites in the literature, this work also showed that high cognitive complexity enables decision makers to engage in both types of effective strategies and integrate them successfully into their decision making process. In particular, the results suggest that the ability to effectively structure and restructure one's problem space prior to 'freezing' onto a certain cognitive representation (and judgment) of a project, coupled with the ability to enact a larger set of non-overlapping identities increases decision makers' ability to form better judgments. This finding applies specifically to

novel and uncertain settings, whereby fixating quickly upon a problem representation maybe desired by decision makers in order to cope better with the uncertainty, however, it may also work against them by limiting their ability to process information more effectively.

An interesting extension of this work in future research would be to explore the interplay not only between complexity of the beholder and the beheld, but also complexity on the *individual* and the *organizational* level. The constructs of differentiation and integration are certainly not new to scholars in organization theory research and the important role that the two factors play in an organization has been introduced by Lawrence and Lorsch (1967). As these authors have proposed, subunits within an organization should ideally possess both a high degree of differentiation, and a good level of integration between units in order to deal with environmental uncertainties. Differentiation has been characterized by the relative level of subunit segmentation of

the organization, whereas integration as the amount of joint effort of units in completing an organizational level task. This parallel of the complexity debate on the organizational and individual level is quite intriguing as it poses another question, namely whether an individuals' cognitive processing approach can actually be related to the way in which individuals shape and structure the institutions in which they choose to take an active part.

In summary, this paper is expected to have not only important theoretical contribution, by bringing together constructs from the often disconnected areas of cognition and decision making in order to explain the features of an effective entrepreneurial process, but also relevant practical implications, by providing valuable investment insights to investors.

APPENDIX A

Table 1. Investors' Sample Characteristics

	N	Minimum	Maximum	Mean	Std. Deviation
Average Investment (£)	25	10,000	650,000	127,045.00	176,105.32
Number of projects invested	25	4	50	13.12	11.95
Years of experience (since first investment)	25	3	35	9.20	8.40
Number of *successful* exits	24	0	13	2.54	3.34

Total number of projects in which the participants in the sample had invested: 329

Total number of successful exits for all participants in the sample: 61

APPENDIX B

A List of Informal Investors' Decision Making Criteria

11. Product
- a. Product interest
- b. Benefits, applications, product extensions
- c. Technological Innovativeness, Differentiator
- d. IP and Protectability
- e. Development and technology risks
- f. Clarity of the proposition

12. Market validation (demand for product)
- a. Interest by third parties
- *b. Customer traction*

13. Route to market
- a. Distribution partners
- b. Market entry (clarity of business model)
- c. Marketing channels
- d. Projected customer base

14. Market potential
- a. Size
- b. Growth
- c. Competitiveness

15. Team Industry Experience
- a. Recognized industry expertise
- b. Track record in previous ventures

16. Team Personal Characteristics
- a. Managerial capability
- b. Trustworthiness
- c. Ability to work as a team

17. Financial results
- a. Realistic forecast
- b. Profitability
- c. Cash flow

18. Financing
- a. Projected use of funds

b. Previous funding
c. Managers' financial contribution

19. Deal criteria

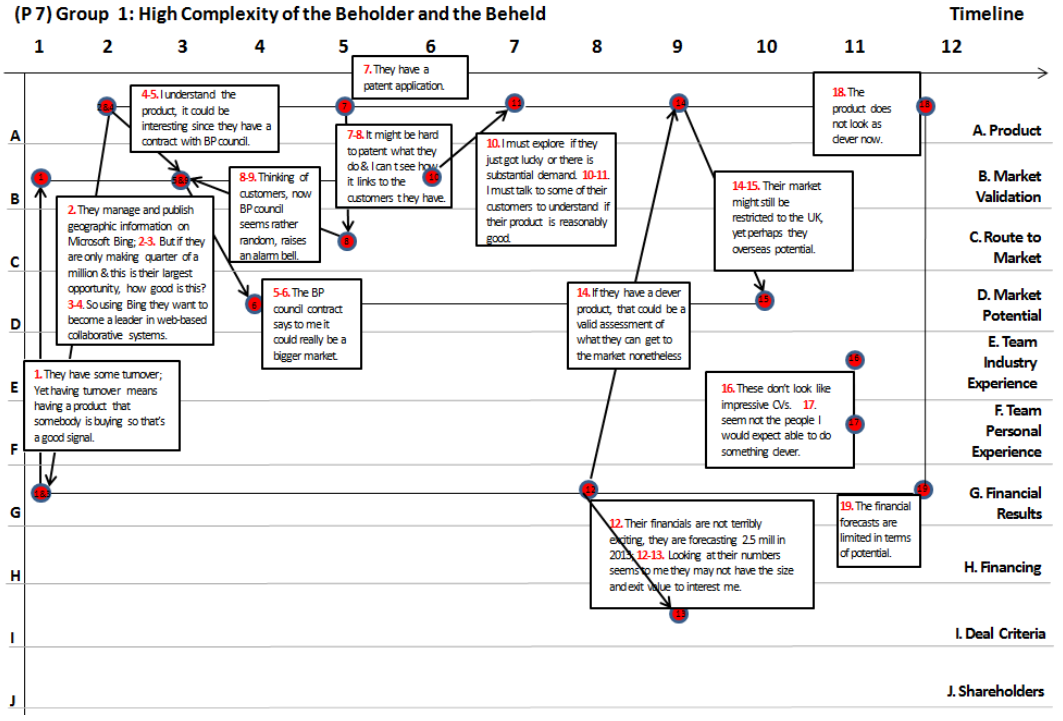
a. Valuation
b. Amount required
c. % of company currently offered
d. Projected exit

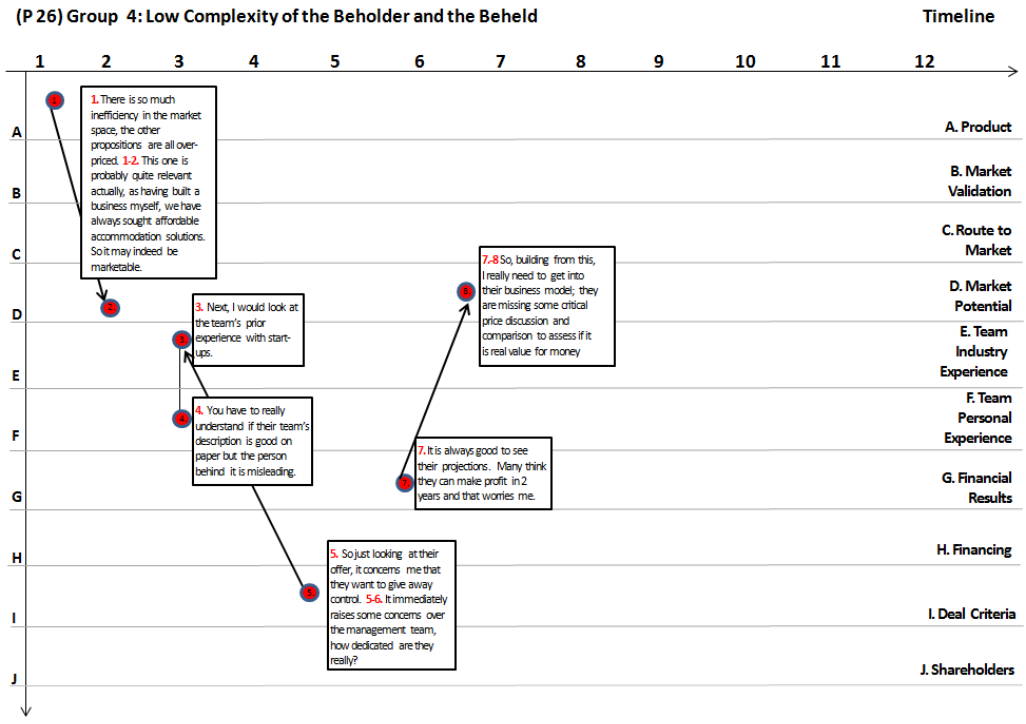
20. **Shareholders**

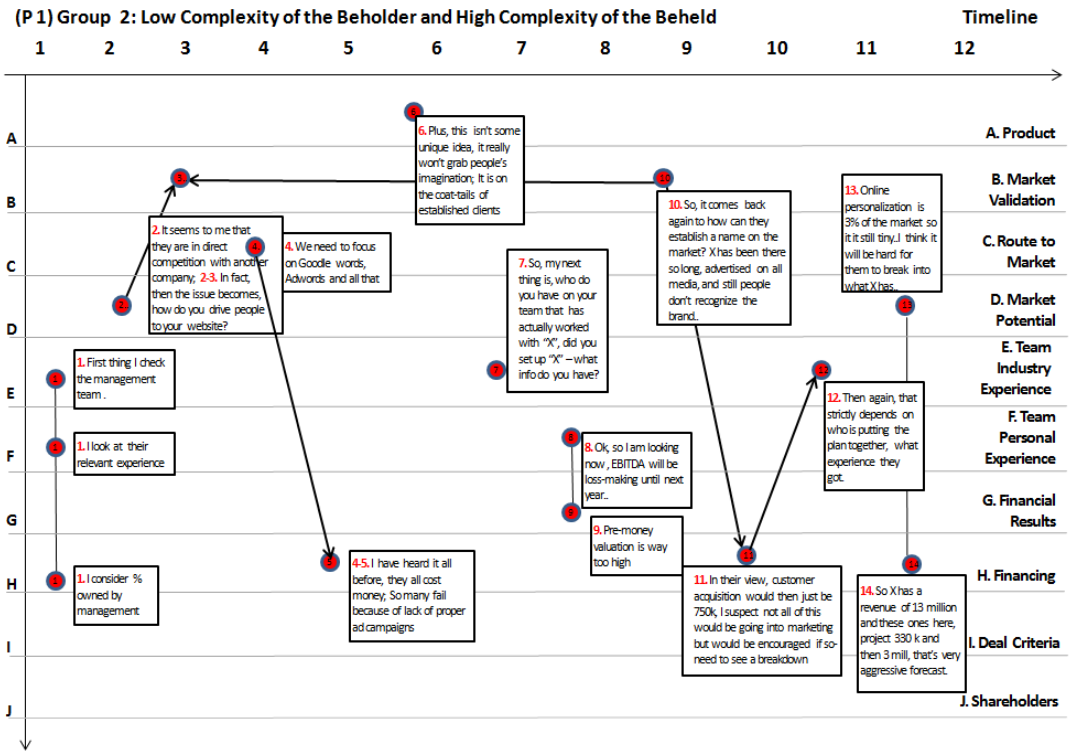
APPENDIX C

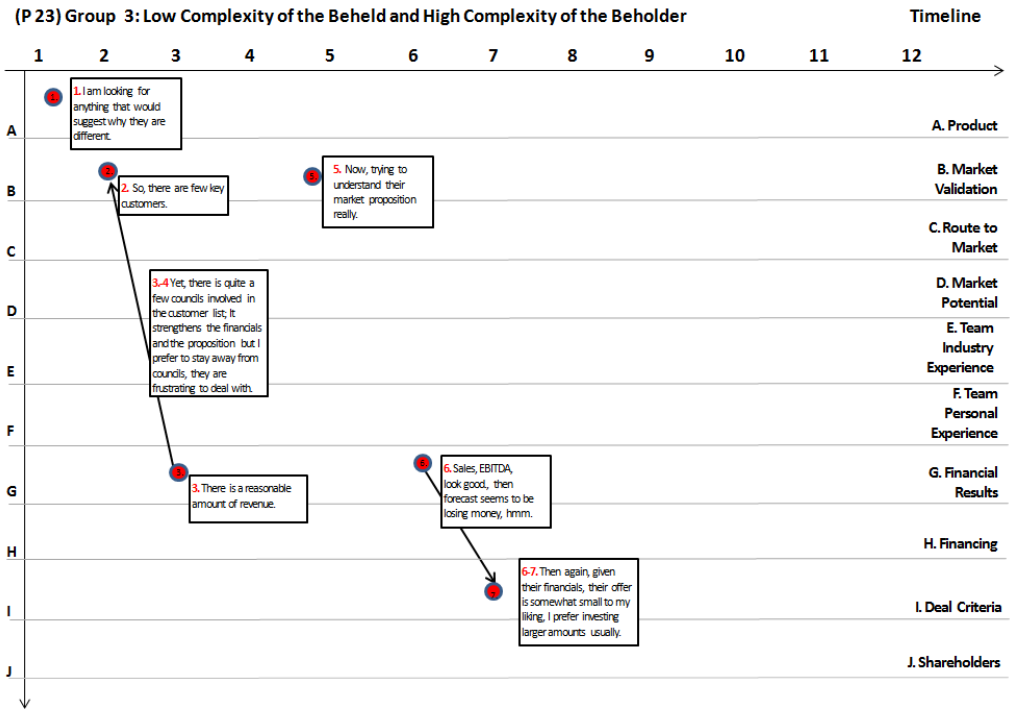
Examples of Time-event Matrices of Investors with High, Low and Mixed Levels of Complexity

(Refer to the next four pages)









APPENDIX D

Self-Complexity Calculation

Self-complexity has been usually assessed using the H-statistic as an indicator of dimensional complexity of the cognitive domain. This index considers the number of distinctions made among each group of adjectives, e.g., "with *k* independent groups the maximum number of distinctions is 2^k". The H-statistic is assessed using the following formula:

$$SC=\log_2 n - (\sum_i n_i \log_2 n_i) / n$$

where n_i represents the number of adjectives that appears in a particular combination of groups, and n is the total number of non-repetitive adjectives. The greater the number of groups created and the smaller the overlap between the adjectives used to characterize each group, the higher the level of a person's self-complexity.

In the current study, the measure was based upon Linville's guidelines (1985), taking into account the modifications, proposed by Rafaeli-Mor and colleagues (1999).

APPENDIX E

Self-Concept Clarity Scale

Instructions: In the next **twelve** questions you will be shown statements with which you may agree or disagree. Using the provided scale, 1(Strongly Disagree) - 7 (Strongly Agree), please indicate your level of agreement with each item.

Scale Format:

1. My beliefs about myself often conflict with one another. (R)
2. On one day I might have one opinion of myself and on another day I might have a different opinion. (R)
3. I spend a lot of time wondering about what kind of person I really am. (R)
4. Sometimes I feel that I am not really the person I appear to be. (R)
5. When I think about the kind of person I have been in the past, I am not sure what I was really like. (R)
6. I seldom experience conflict between the different aspects of my personality.
7. Sometimes I think I know other people better than I know myself. (R)
8. My beliefs about myself seem to change very frequently. (R)

9. If I were asked to describe my personality, my description might end up being different from one day to another day. (R)

10. Even if I wanted to, I don't think I would tell someone what I'm really like. (R)

11. In general, I have a clear sense of who I am and what I am.

12. It is often hard for me to make up my mind about things because I don't really know what I want. (R)

Source: Campbell, J., Trapnell, P., Heine, S., Katz, I., Lavallee, L., & Lehman, D. (1996). Self-concept clarity: Measurement, personality correlates, and cultural boundaries. *Journal of Personality and Social Psychology, 70*, 141-156.

APPENDIX F

Table 2. Qualitative Comparative Analysis Results

Algorithm: Quine-McCluskey

True: 1

0 Matrix: 0-CL

--- TRUTH TABLE SOLUTION ---

frequency cutoff: 2.000000

consistency cutoff: 0.900602

Assumptions:

	raw coverage	unique coverage	consistency
int*~dif*~plur*uni	0.264836	0.104517	0.900602
int*dif*plur*uni	0.439327	0.279008	0.955684

solution coverage: 0.543844

solution consistency: 0.916418

Note:" ~ " denotes the absence of a factor

CHAPTER 3.

COUNTERFACTUAL THINKING AND INNOVATIVE DECISION MAKING: EVALUATING NOVEL BUSINESS OPPORTUNITIES

ABSTRACT

The present paper focuses on decision making in novel and uncertain contexts and explores the role of counterfactual thinking in fostering individuals' reliance on effective decision making heuristics. It primes participants with an additive (if only I had done X), subtractive (if only I had not done X) and no prime (no manipulation) mindsets and hypothesize that temporarily activating such counterfactual thinking in participants can influence their ability to apply effectuation-based logic in a subsequent, unrelated task. The results from two studies support this hypothesis and show that

individuals who engage in unrelated *additive* counterfactual thoughts reported significantly greater reliance on effective explorative heuristics on a subsequent judgment task, compared to participants in the subtractive and control conditions. Therefore, this work contributes to entrepreneurship research by providing evidence that effective entrepreneurial logic can be externally fostered and is not necessarily an individual-specific trait.

INTRODUCTION

'If I had never dropped in on that single course in college, the Mac would have never had multiple typefaces or proportionally spaced fonts. And since Windows just copied the Mac, it's likely that no personal computer would have ever had them'.[14] Counterfactual thoughts, like the one from Steve Jobs' quote, are something we commonly experience and resort to in our daily life, as they influence our affective reactions to events (Landman, 1987), help us cope with negative experiences (Taylor, Pham, Rivkin, & Armor, 1998), direct our judgments of causality (Boninger, Gleicher, & Strathman, 1994), and outline potential trajectories within our cognitive problem space (Sanna, 2000). Counterfactuals also play a role in determining individuals' future behaviour (Boninger, Gleicher, & Strathman, 1994) and preparing people better for future actions (Markman et al., 1993).

[14] Steve Jobs Stanford Commencement Speech (2005). Accessible at http://news.stanford.edu/news/2005/june15/jobs-061505.html

In entrepreneurship research, counterfactual thinking has been associated with entrepreneurial imagination and opportunity creation (Felin & Zenger, 2009), as well as with opportunity recognition (Gaglio, 2004). According to Gaglio (2004), opportunity finders are better able at engaging in various types of focused counterfactual thinking as compared to non-finders. On the other hand, Baron (1999) has shown that entrepreneurs, compared to potential entrepreneurs and non-entrepreneurs, report a lower tendency to engage in counterfactual thinking. Rather than focusing on counterfactual thinking as an individual-specific trait that may or may not characterize entrepreneurs, this research, sets on to explore whether activating a counterfactual mindset per se can have a beneficial influence on one's ability to engage effectively with the entrepreneurial process. As emerging research on decision making has argued, even if the standard principles of utility maximization cannot be applied under such conditions, one can still apply a set of effective strategies

that can support the decision maker's judgment positively (see Felin & Zenger, 2009; Grandori, 2010; Grandori & Cholakova, 2012; Sarasvathy, 2001).

The purpose of this work, therefore, is to explore whether mentally rehearsing a past experience and engaging in counterfactual thinking over this experience can influence individuals' ability to engage in exploration of potential new objectives and actions. We still know very little about why some individuals have a greater propensity to apply such decision making strategies, whereas others do not. Therefore, this work aims to explore whether temporarily fostering counterfactual thoughts could increase one's propensity to engage in effective decision making heuristics when making judgments under high uncertainty. Given that these types of heuristics are based upon noticing resources in the environment and potentially ending up producing novel and unplanned outcomes, I argue that activating a counterfactual mindset can actually influence the type of information

individuals notice in the environment when forming a judgment and the connections they are able to draw among specific resources. In particular, I propose that simply activating a counterfactual mindset, even if completely unrelated to the content of the decision making task itself, would increase one's ability to apply effective judgment strategies in a subsequent task. This proposition is novel because so far in research within the entrepreneurship tradition, counterfactuals would typically be applied to the actual task (for instance, the evaluation of novel opportunities and possible ways that events could have turned out differently), which does not necessarily control for the possible role of experience or knowledge in this process. To the contrary, I aim to show in this work that simply fostering a specific type of counterfactual mindset (even if based upon a task that is completely independent from the evaluation of the opportunity at hand) would still have a positive role in

fostering decision makers' ability to engage effective reasoning under high uncertainty.

Counterfactual thoughts have been associated with one's ability to mutate the causal chain of events, and to observe how outcomes could have turned out differently (Sanna, 1996), as well as sustain unexpected or contradictory events in one's problem space. Counterfactuals can be additive or subtractive, such that the former is characterized by expanding one's problem set, following an 'if only I had' question, whereas the latter by shrinking it, following an 'if only I had not' question, effectively removing elements from the problem space instead. Therefore, I hypothesize that generating *additive* (rather than subtractive) counterfactual thoughts would be positively related to individuals' propensity to engage in effectual logic. As outlined earlier, in difference to prior research, I focus on the relevance of activating an additive counterfactual mindset per se, unrelated to the actual projects that individuals will be judging, arguing

that its positive role is not related to having more knowledge about the project or any other experience-related advantages, but is simply a factor of enlarging one's problem space and fostering a hypothesis-testing frame of reasoning.

Furthermore, counterfactual thoughts can be upward and downward, the former focusing on how things may have turned out for the better, whereas the latter comparing how things may have turned out worse (Roese, 1994). Upward counterfactuals have been shown to prepare one better for the future, however, at the expense of eliciting short-term negative affect (Boninger, Gleicher, & Strathman, 1994). Given that counterfactuals are more commonly experienced as a result of negative events (for instance, close counterfactuals when one has missed an opportunity to do something just within seconds), and that in entrepreneurship context it is the more effective approach to preparing one's self to cope with failure or hardship, I will address only upward, rather than downward counterfactuals in this study.

Therefore, in order to understand well the effect of counterfactuals on one's ability to engage in effectual logic, the influence of the accompanying emotions is also taken into account. Even though recent calls have already started to acknowledge the need for greater attention to affective factors both within entrepreneurship and strategy literatures (Cardon et al., 2012; Felin & Zenger, 2009; Gavetti, Levinthal, & Ocasio 2007; Gavetti, 2011; Hodgkinson & Healey, 2011; Peters, Vastfall, Garling & Slovic, 2006), they have still remained relatively underexplored (Powell, Lovallo, & Fox, 2011). The present work brings emotions into the existing frameworks on entrepreneurial decision making by exploring their influence on one's information processing during a judgment. In particular, I focus on certainty appraisals (see Lerner & Keltner, 2000, 2001; Smith & Ellsworth, 1985), rather than the traditional positive or negative approach to emotions. This choice is motivated by previous research, which has shown that same valence emotions, such as sadness

and anger (negative valence), can actually have very different implications for a person's information processing approach and behavior (see Lerner & Tiedens, 2006), with the former fostering a more systematic, whereas the latter a more holistic approach. Therefore, in order to effectively capture such difference, I rely on an appraisal, rather than a valence-based framework to emotions. In particular, I predict that even though both upward additive and upward subtractive counterfactuals would generate negative valence emotions (Roese, 1994), they are going to foster different certainty appraisals: additive counterfactuals would generate certainty appraisal emotions, whereas subtractive uncertainty appraisal emotions. Therefore, rather than arguing that upward counterfactuals may be effective for decision making because they can foster a more systematic information-processing, it is actually the reverse: upward additive counterfactuals are predicted to foster certainty emotions, which in turn increase reliance on holistic information processing instead.

To capture the relevant level of uncertainty, the focus of this work will focus on individuals' evaluation of pre-revenue start-up projects, for which there is often no prior track record or available financial performance indicators (Mason & Harrison, 2002). As recent research within entrepreneurship has argued, decision makers within such settings can rely on positive strategies, which are not necessarily effort-saving (as the shortcuts or simple rules traditions) but simply engage individuals in a different type of reasoning (such as effectuation or theoretical causal modelling) (see for instance, Felin & Zenger, 2009; Magnani, 2000; Cholakova & Grandori, 2012). In this work, I will focus on one of these strategies, namely effectuation-based logic and explore whether counterfactual thinking can foster our ability to apply such effective rather than effort-saving strategies in decision making under uncertainty. The hypotheses will be tested with two studies using experimental design. The rest of the paper is organized as follows. An

overview of the characteristics of counterfactual thinking will be developed below, followed by a definition of effectual processing and its expected relation to counterfactual mindsets. Given that counterfactual thoughts tend to be elicited in response to emotional events, the paper will then outline the valence and appraisal framework on emotions and how these can be used to understand better the decision makers' information processing approaches. The experimental design of this research, as well as the results from two studies will then be presented. Finally, the conceptual and practical implications, as well as some suggestions on how this work could inform future research are discussed. Overall, this work aims to contribute to research, which emphasizes that entrepreneurial thinking can be externally fostered and stimulated, and it is not necessarily a factor of individual differences (Shane, 2003).

THEORETICAL BACKGROUND

Mental Simulations: Pre- and Counterfactual Thinking

Mental imagery makes an essential part of our everyday life, as people perform it regularly when they think about past experiences, perceive themselves in the present, or chart out steps for goal-directed future behaviour (Libby, Eibach, & Gilovich, 2005; Roese & Olson, 2007). Mental simulations are based on a so-called risk-free experimentation or 'offline' learning (Gavetti & Levinthal, 2000; Marks, 1999; Richardson, 1969) and have been considered a key quality (or *modus operandi*) of many historically significant creative geniuses (McKellar, 1957). Understanding better the role of mental rehearsals is further motivated by the fact that mental practice allows one to fine tune their future actions in a manner that matches closer their goals and aspirations, and to perfect their steps of future action without any unnecessary energy expenditure (Marks, 1999). Such simulations allow the decision maker to cognitively reconstruct an image of

themselves, the environment and the interconnections among the self and the other actors (see Henry, 1999). Simulations can be based on pre-factual or counterfactual thoughts (Sanna, 1996). Pre-factual thinking requires one to generate a set of potential future scenarios in response to a specific opportunity (Sanna, 1998), whereas counterfactuals allow one to mutate the possible causes of already experienced events and explore how they could have turned out differently (Roese, 1994). This work focuses on counterfactual thoughts as it wants to explore how simply activating a counterfactual mindset can influence decision makers' reliance on certain types of reasoning. Counterfactuals, in contrast to pre-factuals, do not require individuals to generate scenarios of future outcomes (thereby actively engaging their imagination in building plans for future development). Instead, they focus on the sequence of actions that has already caused an event to happen and explore the possible scenarios (in the past) within which the respective event could have been avoided or could have

turned out differently. Engaging in such a type of retrospective simulations is particularly important because, as outlined by Koehler (1994), generating a set of scenarios allows the individual to temporarily treat them as actually true, which influences how they process information. In particular, when listing how things could have turned out differently, individuals search for potential claims that could substantiate each of these scenarios, thereby increasing the amount of information they acquire as part of their judgment.

The function of these simulations is both affective and preparatory, namely they allow the decision maker to re-experience certain emotions and to anticipate possible difficulties (Sanna, 2000). Mental imagery is also particularly relevant for entrepreneurial decision making as it has been related to having a better ability to recognize (Gaglio, 2004) and seize novel opportunities (Hodgkinson & Healey, 2011; Teece, 2007). In addition, mental images are "never copies of experience" (Marks, 1999, p.577), and what makes them

particularly interesting to study in the context of entrepreneurship is that they are perceived as *creative constructions* of the individual (Neisser, 1976). Therefore, they capture *how* one dynamically puts together elements from past experience and the present in order to build effective representations of future outcomes in their minds.

A related construct, proposed by Gavetti and Levinthal (2000) refers to *offline learning*, whereby the decision maker does not need to engage with or experience any actual behaviors in order to test certain ideas. More specifically, offline learning implies that one can assess possible alternatives without necessarily implementing or engaging actively in the evaluation process per se, but relying mostly on one's mental model of the world and on representations of how certain actions can influence their outcomes. The authors argue that offline learning allows one to explore a larger set of alternatives and does not limit the individual to processing them in a sequential manner, which is predicted under the

online learning model. Felin and Zenger (2009) build upon these ideas and develop another framework, which captures both past experiences and theory-driven behavior when developing and assessing novel ideas. In particular, they suggest that being able to imagine possibilities for one's courses of action is what generates the possibility space for an entrepreneur. This is achieved through a process of ideational trial and error. Importantly, however, the authors argue that it is not simply a factor of bringing up past experience and observations into perception or a matter of information processing. Instead this process relies upon fragments from experience, which serve as a trigger rather than a fully causal mechanism in generating the possible options in the mind of the entrepreneur. The elements involved in the generation of possibilities include imagining novel scenarios, developing counterfactual ideas and engaging in thought experimentation.

In both of these problem modeling frameworks, the underlying mechanism involves mentally drawing a

'problem' space and rehearsing a set of possible scenarios that could help the individual form a better understanding of the past and/or prepare them for future actions. One way to *actively* direct the individual to engage in such mental simulations and structure their problem space is to engage them in *counterfactual thinking*. Counterfactuals are typically characterized by 'if only' and 'what if' logics, whereby the individual is comparing reality with how things might have been (Kray, Galinsky, & Wong, 2006). Counterfactual thinking has been shown to increase one's likelihood to perceive relationships and to structure their thoughts (Kray et al., 2006). According to Kray and colleagues, engaging in counterfactual thinking is like conducting an experiment, as it requires one to map out the connections among different elements and consider the possible causal links involved (see also Einhorn & Hogarth, 1986; Mandel, 2003). Reliance upon counterfactuals has also been related to a greater search for disconfirmatory information (Kray & Galinsky, 2003),

whereby generating more counterfactuals in response to a scenario resulted in a greater search for disconfirming information in a subsequent task. Nonetheless, as suggested by Kray and colleagues (2006), there is still a relative paucity in terms of understanding the exact process based upon which counterfactual mindsets affect one's performance.

Counterfactual thoughts have been characterized by their direction (upward or downward) and their structure (additive or subtractive). *Upward* counterfactuals focus one's attention on how things might have turned out for the better (thereby increasing negative affect and feelings of regret), whereas *downward* ones direct the decision maker to how things might have been worse (thereby decreasing the negative affect) (Markman et al., 1993). It has been argued that upward counterfactuals are most effective in preparing one for the future (Sanna, 1996). On the other hand, *additive* counterfactuals require one to expand his or her set of means-ends relationships as they necessitate the development of

more causal antecedents (Roese & Olson, 1995), whereas *subtractive* counterfactuals simply remove an aspect of the already established causes for an outcome.

As argued earlier, counterfactual scenarios require the ability to maintain surprising or unexpected events in one's mind and make sense of a situation (most likely by adding antecedents) rather than simply undoing it. Therefore, additive counterfactuals are seen as more *creative* compared to subtractive, for they, by definition, require the generation of additional options that may have not been considered in the past (Markman et al., 2007). Previous work has also shown that subtractive counterfactuals increase one's performance on a syllogism task (e.g., Markman et al., 2007), whereas additive counterfactuals increase one's performance on a creative task, such as scattergories. Activating counterfactual thoughts in an individual's mind influences their information processing by fostering a more relational, connections-oriented approach. Importantly, previous research has shown

that the activation of such a relational approach can carry over to unrelated tasks in the immediate future, thereby affecting the subsequent behavior of the individual (see Galinsky & Kray, 2004). This work will therefore adopt the idea of temporarily activating (priming) a counterfactual mindset and explore whether unrelated counterfactual thoughts primed immediately prior to a decision making task can also have a positive influence on the individual's ability to handle novel information. The construct of priming stems from research in psychology, whereby it refers to focusing participants on a specific idea or feeling, typically by asking them to read or write on a topic or watch certain stimuli, without explicitly making them aware of the reason this exercise is done (see Fiske & Taylor, 1991).

In studying better this topic, it is important to note that previous research on the impact of counterfactual thoughts in entrepreneurial decision making has offered mixed results. On the one hand, it has been theorized that counterfactual

thinking would facilitate one's ability to engage with novel information (Felin & Zenger, 2009) and to recognize opportunities (Gaglio, 2004). More specifically, Gaglio (2004) suggests that opportunity finders are more likely to generate additive rather than subtractive, upward rather than downward counterfactuals and would vary the causal sequence each time they try to form an evaluation of an action. In addition, they would generate so called forward counterfactuals, whereby they maintain the unusual events in their minds (thus temporarily treating them as true) rather than discard them (thus decrease their problem space). On the other hand, however, Baron (1999) has shown that entrepreneurs, compared to potential entrepreneurs and non-entrepreneurs, report a lower tendency to engage in counterfactual thinking. Nonetheless, the former hypothesizes over the direct impact of counterfactuals on one's outcomes, whereas the latter focuses only on the

perceptions of the entrepreneurs and does not manipulate one's counterfactual mindset directly.

This work aims to take these ideas a step further and focus not on individuals' inherent predispositions to generate additive or subtractive counterfactuals (as for instance the work of Gaglio, 2004), but rather on how priming counterfactual logic (unrelated to the task at hand) and thus temporarily activating a specific counterfactual mindset can then influence their ability to engage in the entrepreneurial process. More specifically, it aims at exploring whether simply priming (making temporarily accessible) counterfactual thoughts, prior to their evaluation of a novel opportunity, can still facilitate their ability to engage in effectuation-based reasoning on a subsequent, unrelated task. In the following section, I will outline the specific characteristics of effectuation logic and will further flesh out its expected relation to counterfactual thinking.

The Entrepreneurial Process: Effective Strategies under Uncertainty

As uncertainty increases, decision makers within the economic and behavioral decision making traditions are typically seen as boundedly rational, thus relying on shortcuts that may bias their judgments (Tversky & Kahneman, 1974). Recent work has attempted to reconsider this idea by proposing strategies that albeit still not allowing the individual to maximize on outcomes, can actually maximize in terms of the logical procedures that they apply throughout their judgment in order to bootstrap the missing knowledge (see Grandori, 2010 for an overview). In particular, even though individuals do not have enough information and cannot necessarily asses neither the outcomes they might get, nor the probabilities attached to these outcomes (referred to as Knightian uncertainty), they can construct that information following a rational approach (Grandori, 1984; Grandori & Cholakova, 2012). One such strategy outlined as effective

under high uncertainty is to engage in reasoning based on available resources, rather than focused on outcomes (Sarasvathy, 2001). This type of logic is defined as *effectuation* and it refers to people's ability to use a set of available means to generate effects as opposed to the traditional causation-oriented models, which are focused on delivering forecasts instead (Sarasvathy, 2001). What it implies, is that one can approach the decision by transforming the problem definition from seeing it as a performance *gap* to seeing it as a performance *potential*. Therefore, effectual logic means that decision makers are able to use any presently available resources in order to create certain effects, rather than to focus on specific outcomes and try to secure all resources necessary in order to arrive at pre-specified goals (Sarasvathy, 2008). Reliance on such logic has been associated with making larger investments and experiencing less negative exits among angel investors (Wiltbank et al., 2009) and it has also been observed to a greater extent among

expert than novice entrepreneurs (Dew et al., 2009). A recent meta analysis has further shown that using several effectual principles are positively related to new venture performance (Read, Song, & Smit, 2009) and their application has also been observed in case studies on new venture creation (Harting, 2004; Sarasvathy & Kotha, 2001).

What is important about effectual logic for the purposes of the present work, however, is that it facilitates the individual in perceiving a larger set of resources in the environment and potentially generating more outcomes than the originally intended ones (Sarasvathy, 2001). Therefore, *additive* counterfactuals, with their relevance for expanding one's problem space and sustaining a set of unusual scenarios within it, are expected to facilitate an individual's ability to engage in such *effectual* logic. Therefore, it is hypothesized that:

Hypothesis 1: Participants primed with additive counterfactuals would report a higher level of effectuation in a subsequent evaluation of a start-up project, compared to participants in the subtractive or control conditions.

Nonetheless, counterfactual thoughts, especially upward ones, which consider how things might have turned out for the better, are accompanied by affective responses within individuals. Currently, one of the main limitations of mental imagery research is that it tends to offer a purely cognitive account of the phenomenon, stripping it off from its associated goals, motives and emotions, which nonetheless play a significant role for the individual's dedication to obtain the simulated outcomes (Marks, 1990, 1999). In order to address this, my research adopts a more comprehensive representation of mental imagery as "a continuous sequence of interacting processes" (p.579), which incorporates schemata, goals, emotions and actions (Marks, 1999). Therefore, I also consider the relevant emotional states of

individuals, since as Simon argued (1967) they represent "an interruption mechanism", which allows the individual to respond to present overarching needs. The relevant framework to affect that will be adopted in the present study is outlined below.

Affective Factors

Emotions, in this work, are defined as characterized by a faster onset, and seen as synchronized, appraisal driven and event focused[15] (see Scherer, 2005 for a detailed review). As Peters, Vastfall, Garling and Slovic (2006) have pointed out, the role of emotions in the context of high uncertainty is a topic that has still not unfolded all its potential and has received less research attention. Nonetheless, the disciplines of decision making, entrepreneurship and economics have already made advances in incorporating the role of affect. For

[15] Given the plurality of research on emotions, and the divergent definitions in the literature, this differentiation is used here only for methodological clarification and does not aim to capture all relevant differences both with respect to mood and emotions, as well as with reference to definitions of emotions per se.

example, traditional expected utility and discounted utility theories have acknowledged the important implications that affect can have on human decision making (see Loewenstein & Lerner, 2003). Some of these efforts, as outlined by the authors, include the relaxation of the asset integration assumption (Markowitz, 1952), the acknowledgement of the role of counterfactual thinking in making and evaluating decisions (e.g., Mellers et al., 1997) and the importance of nonlinear probability weighting (Prelec, 1998). In addition, certain advances have also been made with respect to the temporal dynamics of decisions, such as acknowledging the impact of hyperbolic discounting and affective forecasting (see Loewenstein & Lerner, 2003 for further review). Despite such relative advances in the role of affect in decision making, Loewenstein and Lerner (2003) have further argued that the direct and indirect effect of immediate affect is still not well-incorporated into these models, which tend to focus mostly on what is considered as expected affect (anticipated).

Yet, the overall notion, which is important, is that affect is an essential factor in facilitating decisions (see Barsade & Gibson, 2007; Isen, 2004; Lyubomirsky, King, & Diener, 2005) and as Barsade and Gibson (2007) point out, positive affect leads to more accurate decision making, greater efficiency and clarity, as well recognition of contingencies, more flexibility and greater application of new information (Amabile, Barsade, Mueller, & Straw, 2005). The research outlined so far, however, focuses strictly on a valence-based view of affect, such that it addresses it mainly by splitting emotions into positive versus negative (see Fiedler& Bless, 2001; Forgas, 2007; Schwarz & Clore, 1983). Rather than adopting this classification, however, I address the role of emotions using a so-called appraisal-based perspective (Smith & Ellsworth, 1985). In adopting such a dimensional approach to understanding emotions[16] (based on the work of Scherer,

[16] As stated earlier, there are different approaches to the study of emotions, a review of which is beyond the scope of the present work. However, briefly, there are four different emotion theory frameworks, namely

1982 and Roseman, 1984), this work will evaluate people's emotions with respect to a number of different cognitive dimensions, more precisely certainty and anticipated effort, rather than simply splitting them on the basis of their valance. As Tiedens and Linton (2001) have argued, same valence emotions can actually be characterized by very different *certainty* appraisals and different information processing tendencies. Therefore, they argue that simply splitting emotions based on valence can result in a loss of information. Specifically, using Smith and Ellsworth's (1985) framework, Tiedens and Linton (2001) emphasize that we can differentiate emotions with respect to their certainty appraisal content, thus putting different valence emotions such as anger, disgust and happiness on the same side of the continuum. They find that people who experience certainty-

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evolutionary or Darwinian, Jamesian, Cognitive and Social Constructivist (for an overview see Cornelius, 1996). Each of these approaches describes emotions and their antecedents and consequences based on the psychological tradition of their research school (or the Zeitgeist), as well as their theoretical and methodological preferences.

imbued appraisals are more likely to follow *effort-saving* information processing patterns, whereas inducing uncertainty-imbued emotions, such as hope and sadness, makes individuals process information more *systematically* instead. Furthermore, Lerner and Tiedens (2006) have also argued that people's appraisals of their valence-states could influence their subsequent perceptions of the likelihood of certain events, the certainty associated with them, as well as the perceived level of control, responsibility and blame. Lastly, they also indicate that the emotions elicited in a certain situation tend to carry over to other, often unrelated, settings, thus having an impact also on people's risk-taking tendencies. For example, only fearful people make pessimistic risk assessments, whereas angry people make optimistic risk assessments (see Lerner & Keltner, 2000, 2001; Lerner & Tiedens, 2006) and even though happy participants report much more optimistic risk estimates, they are less willing to gamble (see Isen, Nygren, & Ashby, 1988). In addition,

Loewenstein and colleagues (2001) argue that traditional research in decision making has mostly focused on *anticipated* emotions and neglected the importance of *anticipatory* emotions. The former refer to people's ability to predict how they would feel in a certain context in the future, whereas the latter are considered to be the immediate visceral responses to risk and are expected to overrule cognitive processing efforts should the two be diverging from one another, as the emotions tend to take a dominating role.

Taking this idea into consideration, it is then explored whether this interplay between valence and certainty/uncertainty appraisals can influence people's processing of novel information and affect their judgments in the context of the evaluation of novel opportunities. Specifically, previous research has shown that even when controlling for individuals' mood, counterfactual thoughts continue to influence decision makers' judgment (Kray et al., 2006). Nonetheless, previous research has largely observed

the role of positive versus negative emotions (i.e., following a valence-based framework). In contrast to this, the present research will focus on certainty-uncertainty appraisals instead and more specifically will address negative emotions. The main motivation for this choice is that, as argued earlier, counterfactuals are more commonly experienced and produced in response to negative events, thus focusing on negative emotions would capture more closely a realistic decision making scenario. Furthermore, this work would also focus on upward, rather than downward counterfactuals, as the former have been shown to have a greater preparatory value for the individual (in terms of coping better with such situations in the future, despite experiencing a temporary negative affect).

More specifically, I argue that additive counterfactuals, which positively influence individuals' perceived level of control and likelihood of events, would actually tend to elicit more certainty-appraisal emotions,

whereas subtractive counterfactuals would more likely evoke uncertainty-appraisal emotions. If this hypothesis is confirmed, it would imply that even though it is expected that the upward counterfactual (focusing on how things could have turned out for the better) would generate negative effect, the type of counterfactual (whether additive or subtractive) is likely to foster either certainty or uncertainty appraisal emotions, which in turn can produce either more holistic or systematic information processing. This is novel as no work so far has demonstrated this differential effect of counterfactual type on the appraisal experienced, and it is important as it sensitizes us to a potential shortcoming of previous results taking a valence view only. In addition, it provides a further explanation on the relevance of counterfactual thoughts for decision makers' ability to apply effectual logic, such that additive counterfactuals foster a certainty appraisal of situations, which in turn, jointly affect

the propensity to apply effectual logic. Therefore, it is proposed that:

Hypothesis 2a: Participants primed with an additive counterfactual would report greater certainty appraisal emotions (than uncertainty) during the evaluation task, compared to participants in the subtractive and no prime conditions.

Hypothesis 2b: Participants primed with a subtractive counterfactual would report greater uncertainty appraisal emotions (than certainty) during the evaluation task, compared to participants in the additive and no prime conditions.

RESEARCH METHOD: STUDY 1

Design

The hypotheses of this study were explored using an experimental design. Participants were randomly assigned to the conditions of a one-way (Prime type: control vs. additive vs. subtractive) between-subjects design.

Participants

Participants for this study were 102 undergraduate students, completing a business degree and attending a course on business planning (in order to ensure sufficient background knowledge in start-up project evaluation). Seven participants failed to follow the instructions for the study during the simulation and had incomplete surveys therefore they were excluded from further analysis. The subsequent analysis was therefore conducted on the remaining 95 participants. The average age of the sample was 21.3 years old (std. = 0.88), of which 49 were female and 46 male.

Stimulus Material and Procedure

The stimulus material chosen for this study was an actual business plan, of the same format as typically produced and distributed to early-stage investors during entrepreneurial pitches[17]. The case concerned the introduction of a new face recognition technology, which could then be implemented into greetings cards and sold to the general public. It was intentionally selected so as to be sufficiently interesting and at the same time comprehensive enough for a business students' sample. The clarity and level of difficulty of the case was pre-tested with an independent sample of 31-students prior to the study. As Roure and Keeley (1990) have argued, a lot of the important information about a new project can be extracted from its business plan, which makes it a suitable stimulus material for the purposes of this study. Participants were involved in the study during one of their lectures on business

[17] The author is indebted to Envestors, a London-based company involved in matching entrepreneurs and angel investors, for their collaboration in sharing business plans and consulting the lead author as regards the decision making procedure during entrepreneurial pitches.

planning and were invited to participate in a 50-minute simulation, evaluating a novel business project. All participants who submitted fully-completed surveys were entered into a raffle for €40. Upon completion of the study, participants were thanked and debriefed.

Measures

Counterfactual mind-set primes. In order to activate in participants a counterfactual mindset, participants were invited to read a scenario which stated either "If only I had NOT …, then the outcome would have been better" in order to foster a subtractive counterfactual, or "If only I HAD …, then the outcome would have been better". The two variations were used within a standard scenario, following the guidelines outlined by Markman and colleagues (2007). The complete scenarios of both types are provided in Appendix A.

Effective Decision Making Heuristics. The scale developed by Wiltbank and colleagues (2009), capturing

reliance on effectuation and forecasting, will be used as a proxy for reliance on effective decision making heuristics. The instrument consists of 14 items, addressing effectual (labeled also as non-predictive control) and forecasting (prediction-based) logics in the process of deciding how to proceed with the implementation of a novel business project. Following the authors' guidelines, the two dimensions were measured separately by summing the responses for each type and dividing by the total possible score for each factor. Rather than using the scenario developed by Wiltbank and collegues (2009), to which the scale's responses are related, the present study adapted the task, thereby asking the participants to evaluate the business plan provided for the simulation and to respond to the effectuation questionnaire with reference to their evaluation of this project. Participants' responses were measured on a 7-point Likert scale, ranging from 1 Strongly Disagree to 7 Strongly Agree. The scale and instructions for the task are provided in Appendix B.

Mood & Emotions related to Counterfactuals. In order to assess the emotional reaction elicited by the counterfactual event which participants were required to describe, I asked them to indicate the extent to which the event they described earlier made them feel sad, angry, fearful and guilty. An additional question with the possibility of writing out another emotion that participants experienced was also included, both as a control to ensure the upward counterfactual manipulation worked and in order to provide a more comprehensive set. All responses were measured on a 7-point Likert scale. A question on general mood was also included.

RESULTS

Participants were instructed to generate as many counterfactual thoughts as they could (M=4.80, SD=2.31, range = 1-10). An independent coder evaluated each participant's list of counterfactual thoughts in order to assess whether indeed they were in the direction of the prime,

namely additive or subtractive. The rule of three, developed by Markman and colleagues (2007) was applied, in which if the participants listed different counterfactuals in the first three lines (than the direction outlined in the priming instructions), they were excluded from analysis, which resulted in further 6 exclusions, leaving the total sample size at 89. Participants in the additive and subtractive conditions did not differ significantly in terms of the number of counterfactual thoughts listed in response to the task ($t<1$, $p=.797$, $n=62$).

In order to test the role of *prime type* on individuals' ability to engage with effectual logic, a one-way between-subjects analysis of variance was conducted. As predicted, the results show a significant main effect of prime type on reliance on effectual logic when evaluating a novel business plan $F(2,86)=4.112$, $p=0.02$ (please, see Table 1, Appendix C).

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place Table 1 about here

Post hoc analysis using a Bonferroni test showed that the additive condition differed significantly from the no prime condition (p=0.01), whereby participants who were instructed to enlarge their problem space by adding more antecedents and thus generating novel scenarios that may have lead to the observed outcome were more likely to engage in effectual logic. What is particularly interesting about the results is that they hold even when the counterfactual thoughts were elicited not in response to the actual business plan but rather with respect to the unrelated task, in which participants engaged prior to the project evaluation simulation. This serves to suggest that simply activating additive counterfactual thoughts in one's mind can enlarge their problem space and facilitate the ability to notice more means in the environment when forming a subsequent judgment. No other mean

differences between the three conditions reached significance. Therefore, the results provide support to Hypothesis 1.

In order to test Hypothesis 2 and explore the relevance of certainty and uncertainty appraisals for individuals' ability to evaluate novel information, an independent samples t-test was conducted over the additive and subtractive groups[18]. An index of certainty appraisal was computed by taking the ratio of individuals' ratings on the certainty over the uncertainty appraisal emotions. These ratings were reported immediately after the participants completed the counterfactual priming task, where they were asked to indicate the extent to which the negative event that they described earlier made them feel any of the following emotions (anger, guilt, sadness, fear) on a scale of 1 to 7. Anger and guilt are characterized by a certainty appraisal, whereas sadness and fear by an uncertainty appraisal (as outlined in Smith & Ellsworth,

[18] Given that affect was measured only in response to the generated counterfactual scenarios, the no prime condition was excluded from analysis.

1985). Participants were also given the opportunity to indicate if the emotion they experienced was different from the ones listed, which was then coded according to its appraisal. Previous research has extensively argued that the influence of counterfactual priming on various tasks is independent from the affect that the participants report. Nonetheless, affect has typically been measured as a scale composed of individuals' responses on a number of diverse emotions, which are then summated based on their valence (e.g., Markman et al., 2007). Taking into consideration the argument outlined earlier on the difference among same valence emotions, such an approach might however lose important information.

To test whether the same counterfactual priming (namely asking participants in the additive and subtractive conditions to think of a *negative* event) can actually evoke different emotion appraisals and different information processing patterns respectively, an independent samples t-test was conducted on the two conditions (additive and

subtractive) using the certainty-uncertainty emotion index (as there was no emotion manipulation elicited in the control group). As predicted, the results showed that there is a significant difference between the two conditions in terms of the emotion experienced t(61)=(-2.072), p=0.043. In particular, participants in the additive condition were characterized by significantly higher scores on the certainty emotion appraisal index (μ=1.64), than those in the subtractive condition (μ=1.14). This has important implications as it shows that the same procedure can generate different results as a function of the type of emotional response it evokes, and can, in turn, affect participants' information processing (e.g., holistic or systematic) in subsequent tasks (Lerner & Keltner, 2000). Therefore, engaging in additive counterfactual thinking fosters individuals to focus on the broader overall framework of a decision problem, rather than on separate elements of it. Certainty appraisals tend to be associated with a greater

tendency to perceive individual control when faced with novel situations, as well as to perceive less risk with novel settings (Lerner & Keltner, 2000).

Furthermore, in order to control whether the observed effect of counterfactual priming on effectuation is not due to the way in which participants perceived the specific business opportunity, I tested the influence of priming on participants' perceptions of the quality and novelty of the business plan, as well as the amount they are willing to invest and their overall liking. In particular, an ANCOVA was conducted controlling for participants' perceptions of quality, novelty, and liking (inserted as covariates). The analysis showed that the effect of prime type on effectuation remained significant $F(2,83)=3.907$, $p=0.025$, thereby ruling out the possibility that any project-specific differences may explain the effect.

DISCUSSION

Overall, the results from Experiment 1 provide support to Hypothesis 1, showing that priming an additive counterfactual mindset generates significantly greater reliance on effectual logic on an unrelated subsequent task, compared to priming a subtractive counterfactual mindset and the control group. This finding has interesting implications for two reasons: a) effectuation has been shown to play an important role for new ventures' performance, and for experiencing less negative exits for investors and b) this study demonstrates that effectuation can actually be situationally induced (by the additive counterfactual prime), therefore suggesting that it is not necessarily trait specific to certain individuals. Furthermore, contrary to the traditional argument that affect does not influence the results of the counterfactual priming, additive and subtractive counterfactuals, even when both request one to think about a 'negative experience', generated significantly different appraisal emotions. More

specifically, additive counterfactuals generated certainty appraisal emotions, whereas subtractive – uncertainty. This is important because the former entail a more holistic information processing approach, whereas the latter has been associated with a more systematic one instead, which in turn could affect how one searches, evaluates information and forms judgments.

RESEARCH METHOD: STUDY 2

In order to explore whether the effects observed in Study 1 are robust and would also replicate if a different project is used in the simulation, a second study was conducted. It preserved the questions from Study 1 and added a set of additional measures, which aimed at measuring people's ability to apply decision rules effectively. According to De Bruin and colleagues (2007), individuals tend to differ in their susceptibility to common biases. As a way to check this, the authors have developed an Adaptive Decision

Making Competence (ADMC) scale, which assesses people's path-dependence, resistance to framing and susceptibility to sunk costs, consistency in risk-perception and ability to apply decision rules. This scale relates well to a number of self-report measures of decision-making success, as well as to people's cognitive ability and decision-making style. The authors further develop a decision outcomes inventory (DOI), which aims at assessing people's success in decision making over the past 10 years. Within the DOI, the authors ask about a variety of social situations and whether they *could have* experienced versus have *actually* experienced any of the listed outcomes (such as got a parking ticket, lost car keys, etc.). Overall, they found that with the exception of *resistance to framing* and *path-dependence*, people who have a higher overall score on the ADMC scale also report better decision-making success. This effect remains largely stable even after controlling for decision-making styles and cognitive ability. In addition, ADMC is also negatively correlated with regret,

preoccupation with decision maximization, when satisficing would be acceptable, and reliance on avoidant, rational and spontaneous decision-making (see Schwartz et al., 2002; Epstein & Meier, 1989; Scott & Bruce, 1985). This difference among individuals is particularly interesting as it implies that this differential susceptibility to biases may interfere with their ability to process information and apply certain effective heuristics in the context of their project evaluations.

Hypothesis 1: Participants primed with additive counterfactuals will report higher reliance on effectual logic compared to participants in the subtractive or control conditions.

Hypothesis 2: Participants primed with additive counterfactuals will perform better on the ADMC scale, compared to participants in the subtractive and no prime condition.

Participants & Procedure

A questionnaire was distributed to participants as part of an in-class exercise on business project evaluations. Sixty-five undergraduate students, following a business planning course participated in the study, which lasted about 1h and 30 mins. Upon completion of the questionnaire, participants were entered in a raffle for € 40.

Stimulus Material

The same format of the evaluation simulation used in Study 1 was applied in Study 2, however, a different business plan was used in order to validate whether any of the effects observed in Study 1 may not be influenced by the specific project used in the simulation (the business plan had the same general format and concerned a company developing an online platform where one could watch chefs cook recipes selected by the client).

Measures

The main measures involved in Study 1 were also applied in Study 2. In addition, the relevance of several other factors, tapping at individuals' ability to apply decision rules were explored. The ability of decision makers to apply decision rules correctly and avoid commonly established biases was also measured, inviting participants to fill in the Adult Decision Making Competence index, developed by De Bruin, Parker, and Fischoff (2007), more specifically the sections on resistance to framing, sunk costs and decision rules. Resistance to framing captures the extent to which participants respond to valence framing, specifically risky-shift gain loss variations of decision problems (see Fischoff, 1983). Decision rules represented a set of tasks, which tested participants' ability to follow elimination by aspects, equal weight, lexicographic and satisficing rules (originally adapted from Payne, Bettman, & Johnson, 1992). Finally, the

resistance to sunk costs measure focused on participants' ability to forego prior investments upon subsequent decisions.

RESULTS

In order to test the role of *prime type* on individuals' ability to engage with effectual logic, a one-way between-subjects analysis of variance was conducted. Six participants failed to follow the counterfactual priming task and were excluded from analysis. As predicted, there was a significant main effect of prime type on effectuation $F(2, 57) = 5.94$, $p=0.005$, which replicates the results from Study 1. Please, refer to Table 2, Appendix B for a plot with the results.

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place Table 2 about here

Post hoc analysis using a Bonferroni test showed that the additive condition differed significantly from the subtractive condition ($p=0.003$), whereby participants who were

instructed to enlarge their problem space were significantly more likely to engage in effectual logic, compared to those engaged in subtractive logic. Therefore, the results are aligned with the ones in Study 1, indicating that activating an additive counterfactual mindset can greatly enhance one's ability to engage in effectual logic, and provide support to Hypothesis 1. In order to explore whether participants' perceptions of the novelty, quality, and liking of the project influence the results, I conducted an ANCOVA analysis using novelty, quality and liking as covariates, effectuation as the dependent and priming manipulation as the independent variable, where the main effect of priming remained unchanged $F(2,51)=4.41$, $p=0.017$.

In addition, Study 2 also explored whether the priming manipulation influenced decision makers' ability to correctly apply decision rules and avoid common biases, based on De Bruin and colleagues (2007) Adaptive Decision Making Competency Scale. A one-way ANOVA on the role of

counterfactual priming on one's ability to apply decision rules showed a significant main effect F (2,52)=3.058, p=0.05, whereby a Bonferroni test indicated that participants primed with subtractive counterfactual thoughts had significantly lower ability to apply correctly decision rules, compared to those in the no prime condition. There was no significant main effect of prime type on resistance to framing F(2,43)=0.663, p=0.518 or resistance to sunk cost F(2,48)=0.128, p=0.880. Therefore, these findings only partially support Hypothesis 2, whereby activating a subtractive mindset seems to foster more rigid, structured thinking that, in turn, could explain why subtractive priming may hinder the ability to engage in effectual logic.

DISCUSSION

Overall, the results from the study replicate successfully the results from Study 1, showing that additive counterfactuals increase one's propensity to rely upon

effectual logic. In addition, they also set the stage for further research, by providing several interesting insights with respect to the role of counterfactual thinking in avoiding common biases. In particular, the results also show that engaging in subtractive counterfactuals could decrease individuals' propensity to apply decision rules correctly.

CONCLUSION

This work addresses a novel perspective on decision making under uncertainty, aiming to understand how counterfactual thinking and emotion appraisals can influence individuals' ability to engage in procedurally-correct judgments. An interesting result, corroborated within two experimental studies, shows that temporarily activating an additive counterfactual mindset, prior to engaging in a project evaluation task, leads to a significantly higher reliance on effectual logic, compared to the no prime condition. This finding is interesting for it shows that rather than seeing

entrepreneurs as thinking 'differently' per se, people's reliance on useful decision making strategies, such as effectuation (which has been shown to positively influence both opportunity recognition and new ventures' performance) can also be situationally induced. More specifically, in the present research, counterfactual thinking was not case-specific (namely generating alternative scenarios for the venture under evaluation) but was elicited in response to an unrelated task instead. This serves to suggest that simply engaging in counterfactual reasoning (by adding factors to one's problem space, rather than subtracting) fosters an information processing pattern, which positively affects individuals' ability to apply effective decision making strategies (such as reasoning on resources/effectuation). The results also showed that upward counterfactuals (focused on negative emotions) produce different emotional reactions in individuals, whereby the additive counterfactuals foster certainty emotions, and the subtractive counterfactuals foster

uncertainty emotions. This has so far remained unnoticed in past research as it has tended to rely upon a valence-based framework in assessing emotions, thus putting all negative emotions under the same denominator. Nonetheless, this research shows that the effect of additive counterfactuals is accompanied by certainty appraisals, which tend to also foster a more holistic information processing.

Finally, in addition to its theoretical contributions, this research provides some important practical implications, as it focuses on the evaluations of early-stage entrepreneurial projects. Such informal investing practice has received fairly little systematic research attention, as angel investors are difficult to track (Sudek, 2007) and report little self-awareness of the decision strategies they apply (Paul et al., 2007). Yet, informal investing represents the largest source of external seed funds for innovative start-ups and is responsible for fostering innovation (Van Osnabrugge & Robinson, 2000; Sudek, 2007) and filling the equity gap left by venture

capitalists (Avdeitchikova, Landstrom, & Mansson, 2008; Berggren & Fili, 2008; Clarke, 2005). Therefore, exploring better the manner in which emotions and counterfactual thinking can influence the decision making process under uncertainty, and the strategies that potential investors can apply throughout the evaluation process, can have important financial implications.

APPENDIX A

Counterfactual mind-set priming manipulation

I. Subtractive Counterfactual Priming

*People often have thoughts like "if only . . ." after negative events, in that they can see how things might have turned out differently in a better way. For example, a woman who recently got injured during a passing street protest told reporters, "**IF only I had NOT** started taking pictures of the protestors, I would've been fine." Often, we wish we **hadn't done** something that led to a negative outcome.*

In the space below, please list some specific actions that, in retrospect, could have improved the outcome of the negative event that you described earlier if you had not done them.

*You will have **FIVE** minutes to list as many thoughts as come to your mind. Each thought you list should complete the phrase "**IF I HAD NOT** . . . the outcome would have been better."*

*The event I thought about was:*_____

_____

1. *IF I HAD NOT*
2.

APPENDIX A

II. Additive Counterfactual Priming

*People often have thoughts like **"IF ONLY . . ."** after negative events, in that they can see how things might have turned out differently **in a better way**. For example, a woman who recently got injured during a passing street protest told reporters, "If only I had taken my colleague's advice, I could have called a cab and I would've been fine." Often, we wish we had done something to **avoid** a negative outcome.*

*NOW, think of an event that strongly affected you **negatively**. In the space below, please **list some specific actions** that, in retrospect, could have been taken to **improve** the outcome of this negative event.*
*You will have **FIVE minutes** to list as many thoughts as come to your mind. Each thought you list should complete the phrase **"IF I HAD … the outcome would have been better."***

The event I thought about was:_____

1. *IF I HAD*
2.

Adapted from Markman, K., Lindberg, M., Kray, L., & Galinsky, A. (2007). Implications of counterfactual structure for creative generation and analytical problem solving. *Personality and Social Psychology Bulletin*, 33, 312-324.

APPENDIX B

Scale for evaluating reliance on effectuation and forecasting.

"Think again about the project you evaluated. To what extent do the following items relate to your approach when evaluating the business plan?"

1. As you assemble information on this business, you would:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
Reflect on the people who would be important to involve in this project in order to make it become a reality.	○	○	○	○	○	○	○
Explore expert predictions of where the market is "heading".	○	○	○	○	○	○	○

2. If you are asked to envision a marketing approach for this product, you would:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
Research the competitors' approaches.	○	○	○	○	○	○	○
Imagine possible courses of action based on your prior experience.	○	○	○	○	○	○	○

3. When you think about the uncertainty for this product, you move forward anyway because:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
Your expertise allows you to influence that uncertainty.	○	○	○	○	○	○	○
Your actions can create a future you value.	○	○	○	○	○	○	○

4. **If you are involved in the management of product development, you will be driven by:**

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
Comparing your progress against the development of competitors.	○	○	○	○	○	○	○
Creating new solutions on your own terms, any competitors will have to keep up.	○	○	○	○	○	○	○

5. If you were to look at predictions for where potential markets are heading, you would:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
Use them to create forecasts of what your business might accomplish over time.	○	○	○	○	○	○	○
Discount them as they do not incorporate the impact of your innovation.	○	○	○	○	○	○	○

6. Under such conditions, it is important to base strategy on:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
Relevant forecasts and analyses.	○	○	○	○	○	○	○
What you are capable of, given the means available to you.	○	○	○	○	○	○	○

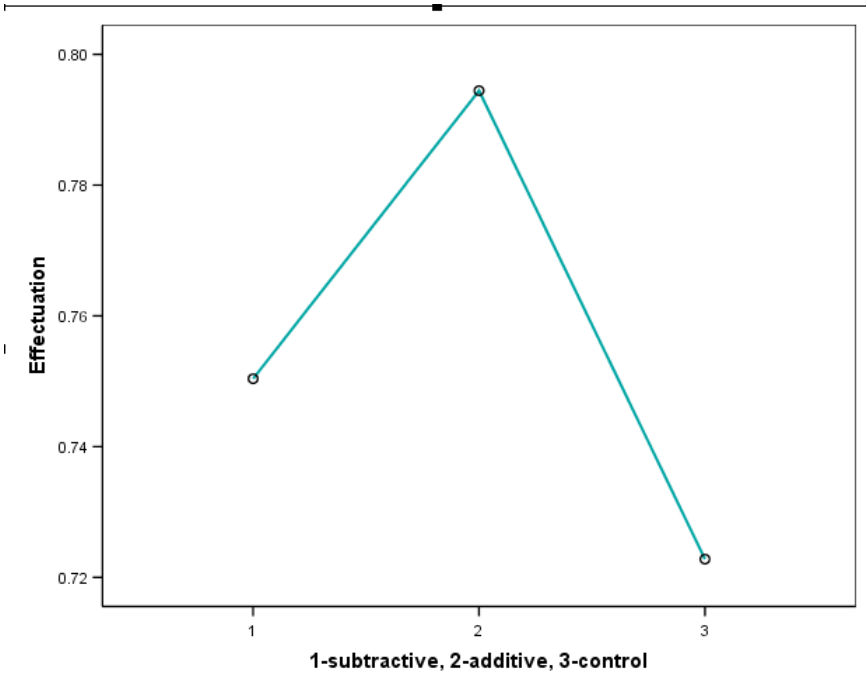
7. **As you learn about the expectations other people have for this industry, you:**

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
Imagine ways your venture will change aspects of the situation they are forecasting.	○	○	○	○	○	○	○
Form updated predictions of likely outcomes for the business.	○	○	○	○	○	○	○

Adapted from: Wiltbank R, Read S, Dew N, & Sarasvathy SD. (2009). Prediction and control under uncertainty: Outcomes in angel investing. *Journal of Business Venturing*, *24*, 116-133.

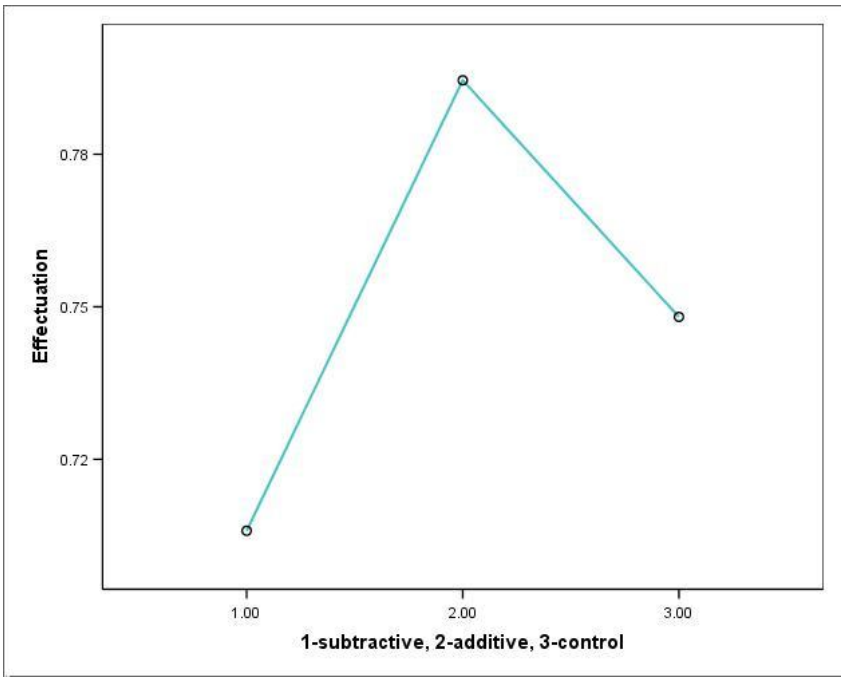
APPENDIX C

Table 1. Main Effect of Prime Type on Effective Heuristics, Study 1



APPENDIX C

Table 2. Main Effect of Prime Type on Effective Heuristics, Study 2



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