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Frederiks, Arjan J.; Englis, Basil G.; Ehrenhard, Michel L.; Groen, Aard J.

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**Entrepreneurial cognition and the quality of new venture ideas:  
An experimental approach to comparing future-oriented cognitive processes**

Arjan J. Frederiks <sup>a,\*</sup>, Basil G. Englis <sup>b,c</sup>, Michel L. Ehrenhard <sup>c</sup>, Aard J. Groen <sup>a,c</sup>

<sup>a</sup> *University of Groningen, University of Groningen Centre for Entrepreneurship, P.O. Box 72, 9700AB Groningen, The Netherlands*

<sup>b</sup> *Berry College, Department of Management, Marketing and Creative Technologies, 2277 Martha Berry Hwy NW, Mount Berry, GA 30149, United States*

<sup>c</sup> *University of Twente, Netherlands Institute for Knowledge Intensive Entrepreneurship, P.O. Box 217, 7500AE Enschede, The Netherlands*

\* Corresponding author. Tel.: +31 50 363 7298.

*E-mail addresses:* [a.j.frederiks@rug.nl](mailto:a.j.frederiks@rug.nl) (A.J. Frederiks), [benglis@berry.edu](mailto:benglis@berry.edu) (B.G. Englis), [m.l.ehrenhard@utwente.nl](mailto:m.l.ehrenhard@utwente.nl) (M.L. Ehrenhard), [a.j.groen@rug.nl](mailto:a.j.groen@rug.nl) (A.J. Groen).

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## **Entrepreneurial cognition and the quality of new venture ideas:**

### **An experimental approach to comparing future-oriented cognitive processes**

#### **Abstract**

In the research reported here, we compared how future-oriented cognitive processes underpin differences in the quality of new venture ideas (NVIs) generated by respondents. We primed the use of future-oriented cognitive processes in two experiments. The first experiment shows that prospective thinking leads to NVIs of higher quality in comparison to counterfactual thinking, perspective taking and a control group. The second experiment shows that prospective thinking and perspective taking result in NVIs of higher quality compared to counterfactual thinking and the control group. We also find that prior knowledge of technology strengthens these effects. *Post hoc* analyses show that these effects are present when respondents are prompted to generate NVIs, but not when they spontaneously generate NVIs, and that respondents with more prior business experience are more likely to spontaneously generate NVIs. Finally, we discuss contributions our research makes to the literature on entrepreneurial cognition and opportunity recognition, and to practice.

## **Entrepreneurial cognition and the quality of new venture ideas:**

### **An experimental approach to comparing future-oriented cognitive processes**

#### **1. Executive summary**

Innovative entrepreneurial firms typically start with a creative new venture idea (NVI) (Amabile et al., 1996; Gemmill et al., 2011; Vogel, 2017). NVIs are preliminary, mostly incomplete, and not well articulated mental representations of the concept for a possible future venture. They are often accompanied by high levels of uncertainty (Davidsson, 2015). To explain how entrepreneurs come up with NVIs, entrepreneurship research has studied various future-oriented cognitive processes, such as counterfactual thinking (Baron, 2000; Gaglio, 2004) and perspective taking (Prandelli et al., 2016). However, the relative effectiveness of these cognitive process has so far been neglected. This question is important, because understanding the differences in the effects these cognitive processes have on the quality of NVIs, can contribute to our understanding of a core question in the entrepreneurial cognition literature concerning why do some people recognize opportunities, but others do not (Grégoire et al., 2011; Mitchell et al., 2007).

As new ventures are necessarily future oriented, our research investigates the effects of three future-oriented cognitive processes on the quality of NVIs generated by study participants. In two experiments, we prime prospective thinking, counterfactual thinking, and perspective taking, hypothesizing that these will lead respondents to generate NVIs of higher quality than in a control condition. We also hypothesize that the effect of prospective thinking will be the strongest and the effect of counterfactual thinking the weakest.

In Study 1, we find that only the priming of prospective thinking leads to NVIs of higher quality. In Study 2, we refine the research design and measures, as well as increasing our sample size. In addition, we examine the moderating effects of prior market knowledge and prior knowledge of technology. We then find that prospective thinking and perspective

taking lead to NVIs of higher quality than either counterfactual thinking or the control group. We also find that prior knowledge of technology strengthens the positive effect of prospective thinking and perspective taking. Hence, using prospective thinking or perspective taking is more beneficial to individuals with more prior knowledge of the technology. In neither study did we find an effect of counterfactual thinking on the quality of NVIs.

*Post hoc* analyses revealed that our findings obtain when respondents are prompted (by the researchers) to generate NVIs, but not when the respondents spontaneously generate NVIs. These analyses show that respondents who spontaneously generated NVIs had more relevant prior business experience than the respondents who had to be prompted. It is possible that experienced entrepreneurs cannot be primed to use these processes more than they already have, due to their already developed entrepreneurial mindset.

Our research has several implications for both academics and practitioners. First, we show that it matters which cognitive processes individuals evoke in generating NVIs. The use of prospective thinking and perspective taking lead to NVIs of higher quality than does counterfactual thinking. Second, the positive effects of these cognitive processes on the quality of NVIs is not equal for all individuals. The benefit is stronger for individuals with higher levels of prior knowledge of the relevant technology. This means that training perspective taking and prospective thinking can help potential entrepreneurs to generate NVIs of higher quality. Additionally, having a team member with higher levels of prior knowledge of technology can also be beneficial in the NVI generation phase.

## **2. Introduction**

An NVI is “an imaginary combination of product/service offerings, markets, and means of bringing the offering into existence” (Davidsson, 2015, p. 676). Because NVIs are future-oriented mental images that come into existence when cognized, future-oriented cognitive

processes are used to generate NVIs. Our focus here is on such future-oriented cognitive processes. Prior work has shown that cognitive processes that generate mental images are used throughout the entrepreneurial process (e.g., Baron, 2000; Gaglio, 2004; McMullen, 2010; Prandelli et al., 2016). Also, some researchers have specifically examined future-oriented cognitive processes. For example, Gaglio (2004) argues that counterfactual thinking is helpful in finding opportunities, and Prandelli et al. (2016) show that perspective taking is beneficial for opportunity recognition. While such future-oriented cognitive processes have been examined before, research has not directly compared the various processes to answer questions on whether evoking one process is likely to affect the quality of NVIs more positively than another. Of course, good ideas are only the beginning, and such ideas will continue to develop and change throughout the entrepreneurial process; even so, generating higher quality NVIs can save the entrepreneur time and money, making available resources for researching, developing, and pivoting NVIs of better quality.

We draw on the (entrepreneurial) cognition literature and focus specifically on the differential effects three future-oriented cognitive processes have on the quality of NVIs, namely prospective thinking, counterfactual thinking, and perspective taking. Building on the notion that individual cognitive differences influence NVI generation (Davidsson, 2015), we suggest that those using prospective thinking develop NVIs of the highest quality, followed by those who use perspective taking, and then by those using counterfactual thinking. Additionally, we argue that prior knowledge of the market and of technology positively moderate the effects future-oriented cognition has on the quality of NVIs.

The work reported here makes two primary contributions. First, we seek to determine which cognitive processes are evoked in generating NVIs. We experimentally study the role of three future-oriented cognitive processes in the generation of NVIs: prospective thinking, counterfactual thinking, and perspective taking. Second, we investigate the effects of future-

oriented cognitive processes on the quality of NVIs generated following the assumption that these effects are not the same for everyone. We distinguish between spontaneously generated and prompted NVIs. We also study the roles of prior knowledge on NVI generation.

In the following sections, we first provide a literature review pertaining to the generation of NVIs. We then provide a theoretical framework concerning the role of prospective thinking, counterfactual thinking, and perspective taking as future-oriented cognitive processes that form part of the imagined mental images of a possible future venture (cf. Davidsson, 2015; Vogel, 2017). We also provide the rationale for the experimental hypotheses tested in the present research.

### **3. Theoretical framework**

#### *3.1 New venture ideas*

An NVI is “an ‘imagined future venture’; i.e., an imaginary combination of product/service offering, markets, and means of bringing the offering into existence” (Davidsson, 2015, p. 676). Although opportunities have been defined as ideas before (Kornish and Ulrich, 2011; Short et al., 2010), NVIs refer to the content, not how favorable the ideas are, of what has previously been called ‘opportunities,’ ‘opportunity recognition,’ ‘opportunity identification,’ or ‘(entrepreneurial) discovery’ (Davidsson, 2015). NVIs can be of any quality, do not need to be innovative, complete or well-articulated, and neither do they need to be acted upon or successful, nor inherently favorable (Davidsson, 2015).

#### *3.2 Quality of new venture ideas*

As noted, NVIs need not be particularly “good ideas,” but the quality of NVIs is of obvious interest to the field. The quality of an NVI can be assessed by looking at “... meaningful characteristics that can be assessed and compared across ventures. These characteristics seem to have considerable variance and may prove to have probabilistic

effects that can be meaningfully construed as, at least in part, actor-independent” (Davidsson, 2015, p. 687). This gives rise to the question of which NVI characteristics are, at least in part, actor-independent? As NVIs are the impetus for what could later in the entrepreneurial process be called opportunities, we examined the literature on opportunities and (business) ideas for characteristics of opportunities that are “actor-independent.” Several characteristics can be used to evaluate NVIs, namely desirability (Baron, 2006; Baron and Ensley, 2006), novelty or newness (Baron, 2006; Baron and Ensley, 2006; Hill and Birkinshaw, 2009; Hoever et al., 2012; Stumpf and Porter, 2012; Ucbasaran et al., 2009; Zhou and Oldham, 2001), and potential economic value (Baron, 2006; Baron and Ensley, 2006; Keh et al., 2002).

First, desirability, is taken as “moral and legal acceptability of the new product or service in society” (Baron, 2006, p. 107), which to a large extent, is actor-independent.<sup>1</sup> Whether a society regards a product or service as morally acceptable, depends on the moral values of the set of individuals in a society. As the actor is likely to be an individual in this society, her or his individual moral values could be influential, but that influence is likely to be (very) small compared to the society as a whole. The legal acceptability of an NVI is governed by the laws operating in the legal region in which the entrepreneur resides. Since a certain product can be legal in one country, but not in another, there is a geographical-dependency, but not an actor-dependency.

The second characteristic, the novelty of an NVI (Baron, 2006; Zhou and Oldham, 2001), to a large extent, is similarly actor-independent. It is important here to distinguish between newness and novelty: newness is time-related, whereas novelty is related to

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<sup>1</sup> In this research, we follow Baron (2006) and define perceived desirability from an external, actor-independent perspective: “moral and legal acceptability of the new product or service in society” (p. 107). This is different to the more internal perspective on perceived desirability as it is used in other entrepreneurial cognition and intentions studies (e.g., Krueger and Brazeal, 1994; Krueger and Carsrud, 1993; Krueger et al., 2000), where perceived desirability is described as the desirability to the individual and hence is actor-dependent.



uniqueness (Amason et al., 2006). The novelty of NVIs can be compared and ranked to all currently existing products and services (cf. Hoever et al., 2012; Zhou and Oldham, 2001). As not every idea is highly novel, and some are more novel than others, there is considerable variance on this characteristic (Hill and Birkinshaw, 2009).

Finally, the potential (economic) value of an NVI is to a large extent actor-independent. Although some actors would be able to create more value out of an idea than others, based on their skills, knowledge, and networks, the potential value of an idea is largely actor-independent. The potential economic value of a new venture idea depends, for example, on the importance of the technological innovation on which it is based: “The importance of an invention should increase the likelihood that a new firm will be founded to commercialize it because more important inventions have higher economic value (Harhoff et al., 1999) and, therefore, provide a larger potential pay-off to firm formation” (Shane, 2001, p. 207). The potential economic value also depends on the risk that is attached to the idea. Following the risk-return tradeoff (Lundblad, 2007), ideas that contain a higher risk, require a higher return. Riskier ideas therefore also may have a higher potential economic value. Hence, if all other things are equal (including the entrepreneur), one idea can have a higher *potential* economic value than other ideas (Baron, 2006; Baron and Ensley, 2006).

In the research reported here, we evaluate these three characteristics of NVIs as measures of the quality of the NVIs generated by respondents. These characteristics are to a large extent actor-independent, can be assessed and compared across NVIs, and are likely to show considerable variance across NVIs (Baron and Ensley, 2006; Hill and Birkinshaw, 2009; Hoever et al., 2012; Keh et al., 2002; Ucbasaran et al., 2009; Zhou and Oldham, 2001).

### *3.3 Future-oriented cognition*

As NVIs are largely comprised of “imagined future ventures” (Davidsson, 2015, p. 684), they are created via future-oriented cognition. In psychology a broad range of future-

oriented cognitive processes have been studied (e.g., Szpunar et al., 2014). However, in an entrepreneurship context only limited empirical research has been conducted on future-oriented cognitive processes, studying counterfactual thinking and perspective taking separately (Baron, 2000; Prandelli et al., 2016). In the present research, we compare three future-oriented cognitive processes that have been shown individually to be relevant to entrepreneurial cognition: prospective thinking, counterfactual thinking and perspective taking. Prior research suggests that envisioning the future (prospective thinking), imagining alternatives to past outcomes (counterfactual thinking), and placing oneself in the ‘shoes’ of others (perspective taking) take place in the same core brain network (Addis et al., 2009; Buckner and Carroll, 2007; De Brigard and Giovanello, 2012). Therefore, these processes are likely to be activated in service of similar cognitive tasks, such as decision making (Schacter et al., 2015).

Before we elaborate on these three processes in more depth, we will briefly discuss the degree of dependence or independence of these processes. It seems possible that these processes are, to a certain extent, dependent on each other. However, these three processes each have their own distinct focus. Prospective thinking focuses on possible future scenarios, counterfactual thinking focuses on alternatives to past or future events in preparing for the future, and perspective taking on past, present, or future internal states of others in preparing for the future. Although these future-oriented cognitive processes may co-occur, it is not necessary that they do so.

### *3.3.1 Prospective thinking*

By combining incoming information with stored information, the brain builds mental representations of the world around us. As future events have not yet occurred in reality, mental representations of future events are simulations (Gilbert and Wilson, 2007). These mental simulations can be used to obtain hedonic reactions to potential future events in the

present (Silk, 2002; Widdig et al., 2001). These hedonic reactions are used as predictors of the hedonic reaction people are likely to have when the simulated event actually comes to pass (Silk et al., 2006a; 2006b; Smith et al., 2003). Thus, prospective thinking is the “ability to ‘pre-experience’ the future by simulating it in our minds” (Gilbert and Wilson, 2007, p. 1352).

Prospective thinking is used to prepare for the future (Bulley et al., 2016; Osman, 2015) by representing and considering the future value of decisions (Worthy et al., 2014). Due to prospective thinking, people can attempt to ensure future success and prevent future loss or failure (Zheng et al., 2014), or choose between immediate pleasure or long-term rewards (Bulley et al., 2016). Thus, through prospective thinking, entrepreneurs can obtain information about possible futures. Although the entrepreneur cannot know *a priori* which future will occur, the mental simulations generated by prospective thinking widen the spectrum of information one has and with more information available, one can make better judgments on the value of the ideas. Better judgments on the value of the potential economic value of the idea and its perceived desirability, enable entrepreneurs to select the idea with the highest quality.

Access to more information (e.g., information retrieved from imagining different futures), leads to a larger number of ideas, as well as to more varied ideas (Gruber et al., 2013) and more novel business ideas (Gielnik et al., 2012), and therefore to NVIs of higher quality. As the past and present are fixed, but the future can still be shaped, when thinking about the future, one’s thoughts are less bounded by the facts of the past or present. Instead, prospective thinking can generate imagined futures where things that were not possible in the past or the present, become possible. These new circumstances lead to new possibilities that were unthinkable without having imagined these futures, and hence, these ideas can be considered as newer. Therefore, we hypothesize that:

H1: *The greater the use of prospective thinking, the higher the quality of NVIs.*

### 3.3.2 Counterfactual thinking

Whereas prospective thinking generates mental representations of future events, counterfactual thinking generates “mental representations of alternatives to the past” (Roese, 1997, p. 133), “that is, thoughts of what might have been” (Epstude and Roese, 2008, p. 168). However, because counterfactual thoughts are constructed *ad hoc* instead of retrieved from past experience, they are not simply memories of the past (Kahneman and Miller, 1986, p. 136). Moreover, because they involve alternative ways in which past events could have occurred, they possess characteristics of future-oriented thinking, conceptualizing how these events could occur differently in a possible future.

Thus, one of the functions of counterfactual thinking is preparation for the future<sup>2</sup> (Epstude and Roese, 2008; Roese, 1994). Counterfactual thinking can help one to learn from the past and prepare for the future (Roese, 1994). In generating counterfactual thoughts, actors engage in a process of causal inference. One could, e.g., generate a false<sup>3</sup> alternative to the past antecedent and therefore a false consequence, as in “If I had studied harder, I would have passed the test,” resulting in a causal relationship between the (false) antecedent – studying – and the (false) consequence – passing the test. This would lead to a causal conclusion that studying harder can lead to passing a test in the future. In the preparative function of counterfactual thinking, actors look for explanations of causation, pose alternatives, and estimate the value of their explanations under other conditions (Arora et al., 2013). Counterfactual thinking contains useful instructions for future ways of behaving, “heighten[ing] success-facilitating intentions and corresponding behavior” (Markman and

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<sup>2</sup> The other function of counterfactual thinking is an affective function. By generating counterfactuals that are worse than the past the actor experienced (Taylor et al., 1983) – “it could have been worse” – counterfactuals can be used for mood-repair (Sanna, 1998; Sanna et al., 1999).

<sup>3</sup> These are false alternatives in the sense that they did not in fact occur in the past, but could conceivably have occurred.

Tetlock, 2010, p. 313). Additionally, counterfactual thinking can help an individual to prepare for the future by developing useful information on which actions had led to negative consequences and how to stop them from happening in the future (Mandel and Lehman, 1996; McMullen and Markman, 2002; Roese, 1997). Via these processes, actors increase their feelings of personal control (Olson et al., 1996) and prepare themselves for possible futures (Roese, 1994).

In generating and testing a multitude of counterfactual causal sequences, entrepreneurs generate ideas of more causal relationships which adds to the set of information they already have (Gaglio, 2004). With more information on what could be possible, entrepreneurs can make better judgments on what has economic value and what customers value, which enables them to generate NVIs of higher quality. In addition, by maintaining the unusual event in the counterfactual causal sequence of events, entrepreneurs can create NVIs that are newer than those when the unusual event was discounted. Hence, greater use of counterfactual thinking can lead to NVIs of higher quality. Therefore, we hypothesize that:

*H2: The greater the use of counterfactual thinking, the higher the quality of NVIs.*

### *3.3.3. Perspective taking*

Perspective taking is “the cognitive capacity to consider the world from another individual’s viewpoint” (Galinsky et al., 2008, p. 378). Although one can imagine another person’s perspective in thinking about how this person reacted to a given situation in the past, perspective taking is often carried out in the service of future events, because perspective taking “allow[s] an individual to anticipate the behavior and reactions of others” *in the future* (Davis, 1983, p. 115). Although empathy is frequently used interchangeably with perspective taking and the processes are certainly related, previous research has shown that the two concepts are distinct (Coke et al., 1978; Davis, 1983; Hoffman, 1977; Lamm et al., 2007; Oswald, 1996). While empathy is “an other-focused *emotional* response that allows one

person to affectively connect with another” (Galinsky et al., 2008, p. 378 emphasis added), perspective taking is a *cognitive* capacity.

Many entrepreneurs start by creating a solution to a personal frustration or problem that they have with the current offerings in the market (McMullen, 2010). Along the way they find out that they are not alone, but that others have experienced similar problems. Therefore, coming up with a solution to the problem can potentially be profitable, as others might buy the new solution. By taking the perspective of others, an entrepreneur can also experience the current product offerings vicariously (Zhao et al., 2012). As these other users may differ from the entrepreneur in some aspects, they could face different problems or frustrations with the same offering, or could face problems with different offerings. By taking the perspective of others, entrepreneurs can detect issues in the current offerings that are problems for others even if not necessarily for themselves. Therefore, by opening up to other perspectives, one can imagine a broader set of potential problems, and gain a better understanding of them (Sciangula and Morry, 2009).

Detecting problems is, on its own, not enough to create a viable business; solutions to these problems are needed. By taking the perspective of various stakeholders, entrepreneurs can develop a deeper understanding of the different obstacles that need to be overcome to create a product or service that will be attractive to potential customers and other stakeholders (Galinsky et al., 2008). Using internal dialogues can help in these analyses. Such dialogue, for example, could take the form of: “Would this solution appeal to the user? No, it is socially inappropriate, it is too expensive, too cumbersome, too ugly, etc. What changes in design might overcome these objections?” (McMullen, 2010, p. 121) or “Would this solution appeal to investors? No, the target market is too small, it is too costly, too risky, etc. What changes in design might overcome these objections?” (McMullen, 2010, p. 121). It is important to note that these internal dialogues are also attempts to predict likely future

responses, such as “If it is too costly, there will be fewer buyers.” Internal dialogues such as these also help the imagination to generate novelty that is based on plausibility regarding potential customer responses (Chiles et al., 2010; McMullen, 2010).

While generating possible solutions, entrepreneurs also need to identify possible target markets for the solution. Having a solution to a problem is not enough for an NVI; there needs to be a group of customers who experience the same problem and who are willing to pay for a solution. For each potential market segment, the entrepreneur needs to engage in perspective taking with a variety of constituents, asking, for example, “How will the product or service offering be a solution to the problems of these different types of potential customers?” “How will different customers use the offering?” “In which circumstances will these customers use the offering?” “What elements of our offering make it a better solution to some customers, but perhaps not others?” “How is our offering better than our competitors’?” “Via which channels would these customers want to buy our offering?” By putting themselves mentally into the shoes of potential customer groups, and simulating the decision-making processes of these different groups, entrepreneurs can get a better understanding of the nuances between the different reasons potential customer groups might (or might not) have for buying the offering (McMullen, 2010). This better understanding will help entrepreneurs in deciding which target markets are potentially more valuable than others.

In similar ways as to how entrepreneurs put themselves into the ‘shoes’ of different customers, they also need to take the perspective of other relevant stakeholders. Relevant questions regarding such stakeholders would be: “How can I make my NVI more interesting to investors?” “How may my competitors react on the introduction of my idea into the market?” or “Which other stakeholders will be affected by my new product or service?” By taking the position of others, entrepreneurs can identify who the relevant stakeholders are,

and how they can anticipate the actions and thoughts of these stakeholders to generate the NVI accordingly. Therefore, we hypothesize that:

H3: *The greater the use of perspective taking, the higher the quality of NVIs.*<sup>4</sup>

### 3.4 Comparing the future-oriented cognition processes

In the foregoing we have argued that all of the three future-oriented cognitive processes will have a positive effect on the quality of NVIs. However, it is possible that some cognitive processes have a stronger effect on the quality of NVIs than others. As NVIs are “*imagined future ventures*” (Davidsson, 2015, p. 684 emphasis added), and prospective thinking is the process to “‘pre-experience’ the *future by simulating it in our minds*” (Gilbert and Wilson, 2007, p. 1352 emphasis added), prospective thinking seems a quintessential future-oriented cognitive process for influencing the quality of NVIs. We therefore expect prospective thinking to result in NVIs that are of higher quality than NVIs generated through counterfactual thinking or perspective taking.

Counterfactual thinking could lead to alternatives that can be better or worse than the starting point on which alternatives are created (Roese, 1997). Entrepreneurs who think of other ways to solve the problems of potential customers, might not only generate good solutions to the customers’ problems, they could also generate ‘solutions’ that at first seem to exacerbate the problem. Although entrepreneurs could discard such ideas and not consider them any further, the quality of the ideas generated through counterfactual thinking might not be as high as the quality of the ideas generated through prospective thinking. We therefore expect counterfactual thinking to result in NVIs that are of poorer quality than NVIs generated through prospective thinking.

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<sup>4</sup> This hypothesis could seem similar to the one put forward by Prandelli et al. (2016). They focus on what they call ‘user perspective-taking,’ which they define as “the cognitive ability to infer customer mental states, to consider their perspective and to interpret and predict their actions with respect to processes of consumptions” (p. 290). We do not focus specifically on the perspective of the user or customer. Instead we focus on the use of the process itself without specifying whose perspective to take. A person who is inclined to take the perspective of an investor, is not better or worse in perspective taking than one who takes the perspective of the customer.



Perspective taking is critical in understanding the problems and needs of potential customers, as well as in envisaging how these needs could be fulfilled (McMullen, 2010). However, ideas generated through perspective taking are based on an individual's subjective estimate of the perspective of one or multiple other persons. These ideas therefore might not always take into account that the external surroundings of such a person can change over time. Although these ideas could fit the current or near future market demand, due to one being bound to one's estimates of others' thoughts, they may not be very new, nor take into account that external surroundings can change. We therefore expect perspective taking to result in NVIs of poorer quality than NVIs generated through prospective thinking, but of higher quality than NVIs generated through counterfactual thinking. This gives rise to the following hypotheses:

*H4a: Prospective thinking has a stronger effect on the quality of NVIs than counterfactual thinking.*

*H4b: Prospective thinking has a stronger effect on the quality of NVIs than perspective taking.*

*H4c: Perspective taking has a stronger effect on the quality of NVIs than counterfactual thinking.*

### *3.5 Prior knowledge of the market and technology*

Prior knowledge is an important antecedent to opportunity recognition, and has been shown not only to increase the number of opportunities an individual recognizes (Shepherd and DeTienne, 2005) but also to influence the type of opportunities an individual recognizes (Ardichvili et al., 2003; Arentz et al., 2012; Shane, 2000). Prior knowledge contributes to opportunity recognition due to information asymmetry (Shane, 2000). Some people have certain information, which others do not. Having certain information allows individuals to recognize the value of new information, and therefore enables them to generate NVIs,

whereas others who do not have this information are unable to recognize the value of new information, and therefore do not generate NVIs. Moreover, prior knowledge contributes to successful opportunity recognition because greater knowledge about markets, customers' problems, industries, and technology enables individuals to develop more accurate prototypes of opportunities. These prototypes facilitate the recognition of opportunities (Baron, 2006; Baron and Ensley, 2006).

On the other hand, prior knowledge can also inhibit the generation of NVIs through a form of "cognitive entrenchment." Dane (2010) argues that experts lose flexibility regarding problem solving, adaptation, and creative idea generation due to cognitive entrenchment which he defines as "a high level of stability in one's domain schema" (Dane, 2010, p. 579). This "stability" causes experts to follow established patterns in seeking solutions to problems so that they are not open to new ways of solving problems (Rudolph et al., 2009). Thus, although experts have access to high levels of prior knowledge, the resulting stability, or cognitive entrenchment, can limit the cognitive processes associated with generating new ideas (Dane, 2010).

We argue that using future-oriented cognitive processes could help to lessen the negative effects of cognitive entrenchment of individuals with high levels of prior knowledge by shifting their attention beyond the domain of expertise. Such a shift in focus attenuates the relationship between expertise and cognitive entrenchment (Dane, 2010). Using prospective thinking, individuals focus their attention on possible future scenarios and gain more knowledge on possible futures. Using counterfactual thinking enables individuals to turn their attention to testing cause-and-effect relations that could be used in the future. Finally, using perspective taking enables individuals to focus their attention on how other people think and how they experience situations. These future-oriented cognitive processes would then

strengthen the positive effect of prior knowledge on the quality of NVIs and diminish its negative effects.

Based on the literature on opportunity recognition, we argue similar results should obtain for NVIs. Moreover, we expect that stimulating the use of future-oriented cognitive processes will attenuate cognitive entrenchment effects among knowledgeable individuals. Therefore, we include measures of prior knowledge of market and technology as possible moderators in the present research (e.g., Siegel and Renko, 2012), and we hypothesize that:

H5: *The relationship between (a) prospective thinking, (b) counterfactual thinking, (c) perspective taking and the quality of NVIs is positively moderated by the entrepreneur's prior knowledge of the market.*

H6: *The relationship between (a) prospective thinking, (b) counterfactual thinking, (c) perspective taking and the quality of NVIs is positively moderated by the entrepreneur's prior knowledge of the technology.*

#### **4. Research Approach**

Both studies reported here used experimental designs to examine the influence of future-oriented cognitive processes on the quality of NVIs generated by participants. One of the advantages of experimental research design is their ability to examine causal relationships between the independent variables manipulated in the experiment and the dependent variables of interest (Shadish et al., 2002). By randomly assigning research participants to experimental conditions the research can control for potentially confounding factors (e.g., Bruhn and McKenzie, 2009; Davidsson, 2008) and for alternative potential explanations of the results (Fitzsimmons and Douglas, 2011).<sup>5</sup> Experimental methods also permit researchers

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<sup>5</sup> Random assignment of respondents to experimental conditions is a crucial feature of experimental research, as it ensures the *a priori* equivalence of participants assigned to those experimental conditions on all variables, whether they are measured (i.e., control variables) or not (Shadish et al., 2002). Moreover, experimental design permits the researcher to manipulate the constructs of interest independently of other participant characteristics

to examine the effects of variables that may be difficult to isolate and observe in “natural settings” (Shadish et al., 2002).

Although long used in the natural sciences and in other social sciences, experimental designs have only recently been taken up by researchers in the field of entrepreneurship (e.g., Acs et al., 2010; Chan and Park, 2015; Lerner, 2016; Vandor and Franke, 2016). Moreover, recently several studies have called for more research using experimental methods in business research in general (e.g., Colquitt, 2008) and in entrepreneurship research in particular (e.g., Acs et al., 2010; Aguinis and Lawal, 2012; Hsu et al., 2017).

We responded to these calls by conducting active participation experiments with a randomized multi-group between-subject design (Hsu et al., 2017) in which respondents were given different tasks to prime the three future-oriented cognitive processes of interest. The aim of Study 1 was to compare the effects of the three future-oriented cognitive processes on the quality of the NVIs generated by respondents. The aim of Study 2 was to replicate and extend the findings of Study 1 by examining the difference between spontaneous and instructed (by the researcher) NVI generation, and to add and examine the potential moderating effect of prior knowledge.

## **5. Study 1: Methodology**

### *5.1 Participants*

The sample in Study 1 consisted of 137 students who were enrolled in an elective entrepreneurship course at a university in the Netherlands. As noted by Hsu et al. (2017), student samples are more appropriate when three conditions are met: (1) “when students are or resemble the population of interest,” (2) “when the manipulation is likely to be confounded

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and thereby permits the isolation of specific effects those constructs have on the outcomes of interest (Gatewood et al., 2002).

by the professional experience of the participants,” and (3) “when the relationships under investigation are grounded in a broad theory” (Hsu et al., 2017, p. 385). University students enrolled in entrepreneurship courses show characteristics of nascent entrepreneurship behavior (McGee et al., 2009) and, similar to other potential entrepreneurs, we can assume them to have little experience in entrepreneurship (see Table 1). Therefore, university students enrolled in entrepreneurship courses resemble the population of interest. Moreover, studies have shown that individuals with more domain knowledge create more practical ideas (Ward, 2008) and can make more reliable judgments (Hofmann, 2010) than individuals who lack such knowledge. Therefore, the cognitive priming used here could be confounded by the professional experience of entrepreneurs. Because our research setting fulfills the abovementioned three conditions (Hsu et al., 2017), and given that other research shows that samples of entrepreneurship students give reliable results when studying the cognitive processes of opportunity recognition (Gaglio and Katz, 2001), our use of a sample of university students enrolled in entrepreneurship courses is appropriate for the objectives of our study.

Due to non-response or unreadable answers, we had to remove 17 cases (12.4%) from our sample, leaving a final sample of 120. The average age of participants was 21.2 years, of whom 70.0% were male, see Table 1.

=====Insert Table 1 Around Here=====

## *5.2 Treatments*

We used direct process priming (Janiszewski and Wyer, 2014) to trigger the use of one of the three future-oriented cognitive processes (prospective thinking, counterfactual thinking, and perspective taking) in respondents. As noted, by Jiménez-Jiménez and Rodero-Cosano (2015, p. 94), “Priming activates in subjects’ minds a mental process which affects behaviour.” The execution of a process during a cognitive task at one point in time (the

prime), makes that same process more accessible for use in a subsequent cognitive task.<sup>6</sup> A typical priming experiment has two phases: (1) a priming phase, in which the respondents are exposed to the prime, and (2) a seemingly unrelated task in which respondents' responses to a target stimulus are examined (Förster and Liberman, 2007).

In the priming phase, respondents in the prospective thinking condition were primed by filling out the Subjective Probability Task (MacLeod et al., 1996). In this task, participants are asked to judge how probable it is that certain future events will happen to them, which prompts them to use prospective thinking to imagine the future (Szpunar et al., 2014).

Respondents in the counterfactual thinking condition were primed following a procedure described by Sanna (1998; 1996). They were asked to solve twenty anagrams that were randomly selected from those of Gilhooly and Johnson (1978) within nine minutes (Sanna, 1996).<sup>7</sup> We then asked the participants to generate and write down “what if...?” and “if only...” thoughts about their performance on the anagram task. We explained that these thoughts can either be about how their performance could have been better, or could have been worse (Sanna, 1996).<sup>8</sup>

We primed respondents in the perspective taking condition by using a procedure described by Galinsky and Ku (2004). We showed a color picture of a young woman sitting on a couch, and asked the participants to take the perspective of the individual in the picture, to imagine a typical day for this individual and to write down a typical day for this person in as much detail as possible. No priming task was used in the control group condition. Instead, we asked the participants to fill out the International English Big Five Mini-Markers personality inventory (Thompson, 2008).

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<sup>6</sup> Förster and Liberman (2007) and Wyer (2008) provide more information on how knowledge accessibility affects cognition and behavior.

<sup>7</sup> To keep the conditions comparable in duration and cognitive effort, we included this anagram task as a filler for all conditions. However, respondents in the other conditions did not receive any additional instructions about the anagram task.

<sup>8</sup> The “counterfactual thinking instructions” were omitted for all other groups.

### *5.3 Experimental Task*

During the second phase of the experiment, all participants were presented with the same task. We presented the respondents with a press release of the invention of SMART<sup>®</sup> (Self-Mastery and Regulation Training) by NASA, which “could revolutionize the way all sorts of people could improve their attention and concentration skills” (Grégoire et al., 2010, p. 428). This technological innovation acted as the external enabler (Davidsson, 2015) because technological inventions often lead to new firm creation (Shane, 2001). Participants were then asked to describe in their own words a high-quality business opportunity<sup>9</sup> based on a technology we described.

After the participants had described their business opportunity, we asked them several clarification questions, inspired by the lean canvas (Maurya, 2012), to get a more complete understanding of the business opportunity they had recognized. The following open-ended questions were asked: (1) What is the product or service? (2) What problem(s) will it solve? (3) Who are the target customers? (4) What value does this deliver to the customer? (5) How does it solve this/these problem(s)? (6) Via which channel(s) will this product or service be sold? (7) How will it generate revenue? (8) What are the most important costs? (9) What are the key activities that will be involved in setting up this business? and (10) What is the competitive advantage of the product? Each question was followed by the prompt: “Please explain.”

### *5.4 Priming Manipulation Checks*

To check whether our priming of the three future-oriented cognitive processes was successful, we developed an 11-item scale to measure how frequently the participants experienced certain types of thoughts while performing the priming task. For the Prospective

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<sup>9</sup> Although we are studying the construct NVI, we asked the participants to come up with a business opportunity, as that term would be more familiar to them (Wood, 2017a; 2017b).

Thinking measure we selected and adapted four items from Deeproose and Holmes (2010) (Cronbach's  $\alpha = .86$ ). For the Counterfactual Thinking measure we selected and adapted three items from Rye and colleagues (2008) (Cronbach's  $\alpha = .87$ ). For the Perspective Taking measure we selected and adapted four items from a perspective taking manipulation check scale by Hoever and colleagues (2012) (Cronbach's  $\alpha = .81$ ). The participants answered these 11 items on a 5-point scale which ranged from “never” to “very often.” They were asked to fill out these items after both the priming and the experiment tasks had been completed.

We performed a confirmatory factor analysis (CFA) to ensure that the data had a good fit with the measurement model. To assess the model fit, we used the Satorra–Bentler scaled chi-square because of the small sample size ( $N < 250$ ) and the non-normally distributed data (Olsson et al., 2000; Satorra and Bentler, 2009), and we used well-established criteria and cut-off values (Hu and Bentler, 1999). The fit for our CFA was satisfactory, with CFI = .98, TLI = .97, RMSEA = .05, SRMR = .05,  $\chi^2(df = 41, n = 120) = 54.82, p < .08$ .

We then conducted three one-way between-subjects analyses of variance, comparing each of the three priming check measures across the four conditions (three experimental and one control condition). There were significant main effects for the three priming manipulation check measures: Prospective Thinking ( $F(3, 116) = 4.21, p < .008, \eta^2 = .10$ ), Counterfactual Thinking ( $F(3, 116) = 5.20, p < .003, \eta^2 = .12$ ) and Perspective Taking ( $F(3, 116) = 8.86, p < .001, \eta^2 = .19$ ). Tukey’s HSD test for post hoc analyses revealed that each treatment condition scored higher than the control condition on the respective manipulation check measure. As expected, the prospective thinking group scored significantly higher ( $M = 3.13$ ) on the Prospective Thinking measure than the control group ( $M = 2.39, p = .05$ ), the counterfactual thinking group scored higher on Counterfactual Thinking ( $M = 2.78$ ) than the control group ( $M = 2.03, p < .03$ ), and the perspective taking group scored significantly higher on the Perspective Taking measure ( $M = 3.55$ ) than the



control group ( $M = 2.76, p < .006$ ). Thus, the three cognitive process manipulations were successful. Further details of these results can be found in Table 2.

=====Insert Table 2 Around Here=====

### 5.5 *Dependent Variable Coding*

To assess the quality of the NVIs described by participants, we used the consensual assessment technique (Amabile et al., 1996; Grant and Berry, 2011), which is well established in creativity research (Amabile and Mueller, 2008), and has also been used in entrepreneurship experiments (e.g., Shepherd and DeTienne, 2005). Two independent judges experienced in evaluating NVIs in multiple industries rated each NVI. One judge was an entrepreneur, a successful investor, and a national best-selling author on investing. The second judge is a business panel member in a successful business incubator. The judges were asked to rate the participants' NVIs using three scales to measure the potential economic value, the newness, and the perceived desirability of the NVI (Baron, 2006; Baron and Ensley, 2006). They rated each criterion on a 7-point scale that ranged from "strongly agree" to "strongly disagree."

To determine the inter-rater agreement and inter-rater reliability we calculated the standardized  $r_{wg}$  values and intra-class correlation coefficients ( $ICC$ ) for a fixed set of judges rating each NVI (Cicchetti, 1994; James, 1982; Shrout and Fleiss, 1979). The results show acceptable inter-rater reliability and strong inter-rater agreement for standardized  $r_{wg}$  values based on slightly skewed distributions (Woehr et al., 2015): potential economic value  $ICC = .76$ , mean  $r_{wg} = .90$ ; newness  $ICC = .70$ , mean  $r_{wg} = .88$ ; perceived desirability  $ICC = .84$ , mean  $r_{wg} = .93$ . The overall quality of NVIs was calculated by averaging the scores on potential economic value, newness, and perceived desirability.

### 5.6 *Control variables*

We collected data on several control variables that are likely to influence the quality of NVIs. Age (Ucbasaran et al., 2008) and gender (DeTienne and Chandler, 2007; Ucbasaran et al., 2008) are known to predict opportunity recognition (Cooper et al., 1994). As relevant prior knowledge and experience influence opportunity recognition, we included the following variables: study program (0 = Business vs 1 = Science and engineering) (Rauch and Hulsink, 2015), nationality (0 = Dutch vs 1 = Non-Dutch) (Aldrich and Waldinger, 1990; Basu, 2009; Chaganti and Greene, 2002), and prior entrepreneurial experience (0 = No vs 1 = Yes) (Baron and Ensley, 2006; Ucbasaran et al., 2009).

### *5.7 Procedures*

The experiment was administered in a group setting as part of a class session. The study was briefly introduced as a study on business opportunity recognition and the participants were informed that their participation was not compulsory or in any way related to their evaluation in the course. Participants were also instructed to work on the task and fill out their questionnaires individually without discussion or collaboration with others. Besides a pen, they were not allowed use of any other resources to fill out the questionnaire. The participants were instructed first to fill out the demographic variables. After the introduction, questionnaires were distributed randomly. Respondents were then directed to fill out the anagram task, and informed that they had nine minutes to come up with as many correct answers as possible. After nine minutes the participants were instructed to fill out the rest of the survey, and not to go back to the anagram task. Participants took an average of 25 minutes to fill out the rest of the survey. After collecting all the questionnaires, the first author debriefed the participants by informing them about the goal of this research and then giving a short lecture on entrepreneurial cognition.

## **6. Study 1: Results**

To test whether using any one of the three cognitive processes has an influence on the quality of the NVIs, we performed hierarchical regression analyses (see Table 3). In the first model (3.1), we regressed the quality of the NVI on the control variables ( $R^2 = .03$ ,  $F(5, 110) = 0.778$ ,  $p < .57$ ). In the second model (3.2), we introduced the three experimental conditions ( $R^2 = .14$ ,  $\Delta R^2 = .10$ ,  $\Delta F(3, 107) = 4.30$ ,  $p < .01$ ,  $\eta^2 = .09$ ). First, we compared whether the future-oriented processes increased the quality of the NVIs compared to the control group ( $M = 5.19$ ). Prospective thinking significantly increased the quality of NVIs ( $M = 5.71$ ,  $b = 0.52$ ,  $p < .02$ ). Counterfactual thinking ( $M = 5.29$ ,  $b = -0.19$ ,  $p < .33$ ) and perspective taking ( $M = 5.02$ ,  $b = .09$ ,  $p < .64$ ) did not increase the quality of NVIs. These results support Hypothesis 1, but not Hypotheses 2 and 3.

=====Insert Table 3 Around Here=====

Subsequently, we compared the effects of future-oriented cognitive processes on the quality of NVIs. Prospective thinking leads to NVIs of significantly higher quality than counterfactual thinking ( $t(57) = 2.01$ ,  $p < .05$ ) and perspective taking ( $t(59) = 3.77$ ,  $p < .001$ ). No significant difference was found between the quality of NVIs generated by counterfactual thinking and perspective taking ( $t(58) = 1.42$ ,  $p < .17$ ). These findings support Hypotheses 4a and 4b, while Hypothesis 4c was not supported.

In this study, respondents were instructed to come up with an opportunity based on a press release. This instruction may have influenced our results in that by instructing participants to come up with an opportunity, the respondents in the control condition could also have used future-oriented cognitive processes as this could be a *sine qua non* for generating NVIs. We therefore replicated and extended our experiment in Study 2 by differentiating between instructed and spontaneous NVI generation. In addition, because perceived similarity between the ‘other’ and the ‘self’ affects perspective taking (Ames, 2004a; 2004b), we matched the gender of the person in the stimulus photograph with that of

the respondent, instead of showing a female subject as the stimulus. To improve the generalizability of our results, and to increase the power of the statistical tests, we conducted a second study on a different and larger sample. As discussed below, we added more control variables, modified the experimental task, and improved the priming manipulation check questions for the counterfactual thinking condition.

## **7. Study 2: Methodology**

### *7.1 Participants*

Following a recent call for using online labor markets for entrepreneurship experiments (Aguinis and Lawal, 2012), we recruited a sample from Amazon Mechanical Turk, an online labor market that connects workers to requesters of tasks that require human intelligence (HITs) (Amazon, 2011; Horton et al., 2011). Although the use of online labor markets for data gathering has been criticized (e.g., Landers and Behrend, 2015), recent research has shown Amazon Mechanical Turk to be a reliable data source for experimental research (Eriksson and Simpson, 2010; Inbar et al., 2012). Moreover, the findings from classic studies have been replicated successfully (e.g., Paolacci et al., 2010), and Amazon Mechanical Turk has been used successfully in experiments on entrepreneurial opportunities (Gupta et al., 2014).

We followed Amazon's "Requester best practice guide" (Amazon, 2011; Gupta et al., 2014) in setting up our HIT. We invited only US-based respondents who had an approval-rate<sup>10</sup> of 98% to participate in our study, in exchange for payment of 4 dollars each. We only considered responses from participants who filled out all questions, correctly answered our three attention check questions, and at the end of the survey confirmed that they had followed

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<sup>10</sup> Requesters can reject the work if it does not meet expected standards or requirements. This lowers the worker's approval rating. By inviting only respondents with an approval rate of 98%, we eliminate respondents who have not always shown good past performance.

each and every instruction we had given them. Thus, we eventually removed 346 participants from the dataset.<sup>11</sup> The average time to complete the survey was 31 minutes. Of the 279 respondents who successfully completed the survey, 46% were male, the average age was 35 years, and 24% of the respondents indicated they had started a business before (see Table 4).

=====~~Insert Table 4 around here~~=====

### *7.2 Experimental Treatments and Experimental Task*

We used the same priming manipulations in Study 2 as had been done in Study 1, showing all respondents a press release from NASA announcing the invention of SMART<sup>®</sup> (Grégoire et al., 2010). However, rather than instructing respondents to think of an NVI (as in Study 1), in this study we asked respondents to write down anything that came to mind after reading the press release. This provided us with their spontaneous responses, showing what came to mind first on encountering the press release. After the respondents had submitted that information, we asked them whether what had come to mind could be used for a new business. Those respondents who answered ‘No’ were given the press release again and asked to think of a new business idea based on the technology it described. Of the respondents, 45.9% indicated that their initial thoughts could be used for a new business idea. Thus, 55.1% of respondents were specifically instructed to think of a new business idea, while the remaining 45.9% spontaneously generated business ideas.

### *7.3 Priming Manipulation Checks*

Using similar procedures to Study 1, we checked whether our priming has been successful. Because the wordings of the priming manipulation check for counterfactual thinking in Study 1 could have unduly emphasized negative affect, lack of self-control over

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<sup>11</sup> Anonymous Internet surveys can suffer from careless responses (Meade and Craig, 2012). We removed 288 respondents (46.1%) because they failed at least one of the three attention checks. As Abbey and Meloy (2017) show, this is not uncommon, and removing this data significantly improves data quality. We removed 58 responses because their respondents had failed to complete all questions or failed to follow at least one of our instructions.

thoughts, and “downward” counterfactual thinking, we replaced two items with others that did not touch on affect or lack of self-control (from Rye et al., 2008). Internal consistency of the priming manipulation check scales was satisfactory: prospective thinking Cronbach's  $\alpha = .83$ ; counterfactual thinking Cronbach's  $\alpha = .77$ ; and perspective taking Cronbach's  $\alpha = .94$ . We performed a CFA to assure that the data had a good fit with the measurement model of the priming manipulation checks. The fit for our CFA was satisfactory, with CFI = .99, TLI = .98, RMSEA = .046, SRMR = .045,  $\chi^2(df = 41, n = 279) = 64.88, p < .02$ .

As in Study 1, we conducted three analyses of variance to compare each of the three priming manipulation check measures across the four conditions (details are provided in Table 5). There were significant main effects for the three priming manipulation check measures: Prospective-Thinking ( $F(3, 275) = 15.09, p < .001, \eta^2 = .14$ ), Counterfactual Thinking ( $F(3, 275) = 8.97, p < .001, \eta^2 = .09$ ) and Perspective Taking ( $F(3, 275) = 52.19, p < .001, \eta^2 = .36$ ). Tukey's HSD test for *post hoc* analyses again revealed that each treatment condition scored higher than the control condition on the respective manipulation check measure. As expected, the prospective thinking group scored significantly higher ( $M = 2.97, p < .001$ ) on the Prospective Thinking measure than the control group ( $M = 2.25$ ), the counterfactual thinking group scored higher ( $M = 2.75, p < .05$ ) on the Counterfactual Thinking measure than the control group ( $M = 2.23$ ), and the perspective taking group scored higher ( $M = 4.06, p < .001$ ) on the Perspective Taking measure than the control group ( $M = 2.46$ ). Thus, the priming manipulations were successful.

=====Insert Table 5 Around Here=====

#### 7.4 Dependent variable coding

The same coders coded the NVIs using the same procedures as in Study 1. The results show good inter-rater reliability (Cicchetti, 1994) based on intraclass correlation coefficients (ICC) for a fixed set of judges rating each NVI (Shrout and Fleiss, 1979), and strong inter-

rater agreement for standardized  $r_{wg}$  values based on slightly skewed distributions (Woehr et al., 2015): potential economic value  $ICC = .79$ ,  $r_{wg} = .91$ ; newness  $ICC = .68$ ,  $r_{wg} = .86$ ; and perceived desirability  $ICC = .68$ ,  $r_{wg} = .88$ .

### *7.5 Moderating Variables*

We measured prior knowledge of the market (two items) and prior knowledge of the technology (two items) using measures developed by Grégoire and Shepherd (2012). The items were presented on 7-point scales which ranged from “minimal knowledge” to “considerable knowledge.” The Cronbach’s alphas were both acceptable: Cronbach’s  $\alpha = .87$  for knowledge of the market and Cronbach’s  $\alpha = .88$  for prior knowledge of the technology.

### *7.6 Control variables*

Following the same reasoning as in Study 1, we collected data to control for age (Ucbasaran et al., 2008) and gender (DeTienne and Chandler, 2007; Ucbasaran et al., 2008). As prior knowledge (Shane, 2000; Shepherd and DeTienne, 2005) and experience (Cassar, 2014; Ucbasaran et al., 2009) have been shown to influence opportunity identification, we included measures of highest level of education (Davidsson and Honig, 2003), number of business classes taken (Davidsson and Honig, 2003), prior entrepreneurial experience (Davidsson and Honig, 2003; Hsieh and Kelley, 2016), years of work experience (Davidsson and Honig, 2003), years of management experience (Davidsson and Honig, 2003), and prior industry experience (Hsieh and Kelley, 2016). In addition, as generating NVIs is a creative task, we measured the personality trait ‘openness to experience’ (Goldberg, 1992; Kaufman, 2013; Kaufman et al., 2015).

### *7.7 Procedure*

The experiment was administered online by a standard survey software tool. Respondents were instructed not to open any other browsers or tabs, not to use any other device or talk to anyone else during the experiment. At the end of the survey, we asked them

whether or not they had complied with these instructions and those who answered “no” or “I don’t remember” were excluded from the final sample. The software used to administer the experiment randomly assigned respondents to one of the four conditions. During the anagram task respondents saw a timer counting down the nine minutes allotted to the task.

Respondents who finished before nine minutes were able to continue before the timer had run out.

## 8. Study 2: Results

First, we tested whether being instructed to come up with NVIs had had an effect. We performed hierarchical linear regression analyses on the full sample. Our estimations are reported in Table 6. We removed the control variable ‘years of work experience’ from this and future analyses due to a strong correlation with ‘age’ ( $r(277) = .88, p < .001$ ) and due to a moderately high generalized variance-inflation factor ( $GVIF > 5$ , Fox and Monette, 1992). In the first model (6.1), we regressed the quality of the NVI on the control variables ( $R^2 = .05, F(8, 270) = 2.86, p < .07$ ).

In the second model (6.2), we added the dependent variables and a dummy variable that captured whether respondents generated their NVI spontaneously ( $\Delta R^2 = .05, \Delta F(6, 264) = 2.48, p < .03$ ). First, we find that prospective thinking ( $b = 0.28, p < .02$ ) and perspective taking ( $b = 0.31, p < .02$ ) have positive significant effects on the quality of NVIs, which provides support for Hypotheses 1 and 3, whereas counterfactual thinking has no significant effect on the quality of NVIs ( $b = 0.08, p < .52$ ), hence no support for Hypothesis 2.

We also compared the effects of future-oriented cognitive processes on the quality of NVIs (see also Table 7). Prospective thinking leads to NVIs of significantly higher quality than counterfactual thinking ( $t(144) = 1.99, p < .05$ ). No significant difference was found between the quality of NVIs generated by prospective thinking as compared to perspective



taking ( $t(144) = 0.07, p < .95$ ). The difference in quality of NVIs generated by perspective taking and counterfactual thinking is marginally significant ( $t(144) = 1.89, p < .06$ ). These findings support Hypothesis 4a, do not support Hypothesis 4b, and marginally support Hypothesis 4c.

Further, we find that the way respondents came up with their ideas had a marginally significant effect. Respondents that came up with their NVI spontaneously after reading the press release, generated NVIs of a higher quality than respondents that generated NVIs only after being instructed to do so ( $b = 0.17, p < .06$ ).

In the third model (6.3), we added the interaction effects between spontaneously generated NVIs (vs instructed ones) and the three future-oriented cognitive processes. Spontaneous generation of NVIs does not moderate the relation between any of the cognitive processes and the quality of NVIs ( $b_{spontaneous \times prospective} = -0.18, p < .47$ ;  $b_{spontaneous \times counterfactual} = -0.10, p < .69$ ;  $b_{spontaneous \times perspective} = -0.25, p < .33$ ).

In the fourth model (6.4), we tested for interaction effects between prior knowledge of the market and the three future-oriented cognitive processes, and for interaction effects between prior knowledge of technology and the three future-oriented cognitive processes. We find that prior knowledge of the market has no significant interaction effect on the relation between either of the three cognitive processes and the quality of NVIs ( $b_{market \times prospective} = -0.06, p < .35$ ;  $b_{market \times counterfactual} = -0.10, p < .12$ ;  $b_{market \times perspective} = -0.07, p < .28$ ). We therefore do not find support for Hypothesis 5. However, we find that prior knowledge of the technology has a (marginally) significant positive interaction effect on the relation between the three cognitive processes and the quality of NVIs ( $b_{technology \times prospective} = 0.12, p < .10$ ;  $b_{technology \times counterfactual} = 0.17, p < .03$ ;  $b_{technology \times perspective} = 0.13, p < .08$ ). We therefore find marginal support for Hypothesis 6a and 6c and full support for Hypothesis 6b.

====Insert Table 6 and 7 Around Here=====

Additionally, spontaneous generation of NVIs correlated significantly with many of the control variables<sup>12</sup> (see Table 4), indicating that on these particular variables, the respondents who spontaneously generated NVIs could be different from respondents who were instructed to generate NVIs. Therefore, we decided to split our sample based on whether the respondents generated their NVI spontaneously, or only after they had been instructed to do so, and to repeat the analyses on each sub-sample.

We first conducted our analyses on the sample of respondents that spontaneously generated their NVIs (N = 128) (see Table 8 for the full results of the regression analysis). We found that none of the future-oriented cognitive processes significantly affected the quality of NVIs. Therefore, Hypotheses 1, 2, and 3 are unsupported for spontaneously generated NVIs.

=====Insert Table 8 Around Here=====

We then conducted our analyses on the sample of respondents that were instructed to generate an NVI after reading the press release (see Table 9 for the full results of the regression analysis). The quality of NVIs in the prospective thinking condition (M = 5.11) was significantly higher than in the control group (M = 4.71,  $b = 0.40$ ,  $p < .04$ ). This result supports Hypothesis 1 regarding NVIs generated after instruction. We did not find a significant difference between the quality of NVIs in the counterfactual thinking condition (M = 4.87,  $b = 0.18$ ,  $p < .35$ ) and the control condition. Hence, Hypothesis 2 is unsupported for NVIs generated after instruction. Additionally, we found that the quality of NVIs in the perspective taking condition (M = 5.17) was significantly higher ( $b = 0.50$ ,  $p < .01$ ) than in the control condition. This result supports Hypothesis 3 for NVIs generated after instruction.

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<sup>12</sup> *Post hoc* analyses showed that the respondents who spontaneously generated an NVI scored significantly higher on openness to experience ( $t(277) = 2.14$ ,  $p < .04$ ), number of business classes taken ( $t(277) = 2.18$ ,  $p < .03$ ), whether the respondent has ever started a business ( $t(277) = 2.19$ ,  $p < .03$ ), years of full-time paid work experience ( $t(277) = 2.83$ ,  $p < .01$ ), years of supervising or management experience ( $t(277) = 2.03$ ,  $p < .05$ ), and prior industry experience ( $t(277) = 3.82$ ,  $p < .001$ ).

Further, we compared the effects of future-oriented cognitive processes on the quality of NVIs (see also Table 7). The difference in quality of NVIs generated by perspective taking and counterfactual thinking is marginally significant ( $t(81) = 1.75, p < .09$ ). No significant difference was found between the quality of NVIs generated by prospective thinking as compared to counterfactual thinking ( $t(78) = 1.37, p < .18$ ) or to perspective taking ( $t(77) = 0.49, p < .63$ ). These findings do not support Hypotheses 4a and 4b, and marginally support Hypothesis 4c.

=====Insert Table 9 Around Here=====

Finally, we analyzed the effect of adding both moderators and the dependent variable to the baseline model, and we find that prospective thinking has a marginally significant positive effect on the quality of NVIs ( $b = 0.36, p < .06$ ), and that perspective taking has a significant positive effect on the quality of NVIs ( $b = 0.51, p < .01$ ). Neither prior knowledge of the market ( $b < 0.01, p < .93$ ), nor prior knowledge of the technology ( $b = 0.05, p < .20$ ) has a significant direct effect on the quality of NVIs.

Furthermore, we find that prior knowledge of the market has no significant interaction effect on the relation between the three cognitive processes and the quality of NVIs ( $b_{market \times prospective} = -0.06, p < .61$ ;  $b_{market \times counterfactual} = -0.13, p < .23$ ;  $b_{market \times perspective} = -0.11, p < .33$ ). However, we find that prior knowledge of the technology has a (marginally) significant positive interaction effect on the relation between the three cognitive processes and the quality of NVIs ( $b_{technology \times prospective} = 0.26, p < .07$ ;  $b_{technology \times counterfactual} = 0.28, p < .06$ ;  $b_{technology \times perspective} = 0.31, p < .03$ ). We therefore find no support for Hypothesis 5, marginal support for Hypotheses 6a and 6b, and full support for Hypothesis 6c.

In summary, we find that prospective thinking and perspective taking lead to NVIs of higher quality. These findings support Hypotheses 1 and 3. We did not find support for Hypothesis 2 concerning counterfactual thinking. Additionally, we find that using

prospective thinking and perspective taking lead to NVIs of higher quality than counterfactual thinking, which supports Hypothesis 4a, and marginally supports Hypothesis 4c. Having prior knowledge of the technology strengthens the effect of using future-oriented cognition on the quality of NVIs. This finding supports Hypothesis 6b and marginally supports Hypotheses 6a and 6c. No moderating effect was found for prior knowledge of the market. Hence, we find no support for Hypothesis 5. *Post hoc* analyses showed that most of these results hold when NVIs are generated after instruction, but not when NVIs are generated spontaneously. Those who spontaneously generate NVIs, i.e. unprompted by experimental instructions, tend to be more experienced and are unaffected by the cognitive priming used in the present study. Participants who did not spontaneously generate NVIs (but had to be instructed) tended to be less experienced, and using prospective thinking or perspective taking helped them to increase the quality of their NVIs. A complete overview of which hypotheses were supported in each study and sample is given in Table 10.

=====Insert Table 10 Around Here=====

## **9. Discussion**

To understand why some people generate NVIs whereas others do not, it is important to look at the cognitive processes of entrepreneurs (Busenitz and Barney, 1997; Grégoire et al., 2011; Mitchell et al., 2007). Our research offers novel insights on how entrepreneurs generate NVIs, and which future-oriented cognitive processes are more effective in generating them. Whereas previous research has studied different cognitive processes that generate NVIs (e.g., Gaglio, 2004; Prandelli et al., 2016), this is the first to directly compare these processes.

In Study 1, we find that participants who use prospective thinking are able to generate NVIs of higher quality than participants in the control group. In Study 2, we find that both prospective thinking and perspective taking increase the quality of NVIs. However, this effect is present specifically when respondents do not spontaneously generate NVIs (i.e. they

have to be prompted), and not when NVIs are generated spontaneously. Our *post hoc* analyses revealed that respondents with relevant past business experience are more likely to generate NVIs spontaneously, irrespective of the future-oriented cognitive process that is primed. Finally, we find that prior knowledge of technology strengthens the positive effect of the future-oriented cognitive processes on the quality of NVIs.

These insights are valuable because they support the notion that cognitive differences between individuals influence NVI generation (Davidsson, 2015), and provide an improved understanding of which cognitive processes are most important for NVI generation. Further, the insight gained from our research support the idea that higher levels of prior knowledge of technology contribute to better recognize opportunities (Shane, 2000; Siegel and Renko, 2012) through the quality of NVIs.

Our studies have important implications for the literature on entrepreneurial cognition. First, we found that that it matters which future-oriented cognitive processes is used to generate NVIs, as the quality of NVIs is affected more by prospective thinking and perspective taking than by counterfactual thinking. As NVIs are defined as “imagined future ventures” (Davidsson, 2015), it is perhaps not unexpected that prospective thinking affects the quality of NVIs most. However, this has not been studied in previous research on entrepreneurial cognition. We believe that prospective thinking could also be important as a precursor to other cognitive processes found to be important in entrepreneurial cognition, such as pattern recognition (Baron, 2006; Baron and Ensley, 2006) and structural alignment, as a form of analogical reasoning (Grégoire et al., 2010). The ability to envisage an imagined future through prospective thinking enables people to create mental images of possible futures, and could therefore help with recognizing patterns or in structural alignment (Baron and Ensley, 2006; Grégoire et al., 2010).

Our first study did not find support for our hypothesis that the use of perspective taking leads to NVIs of higher quality. In our second study, however, we did find an effect for perspective taking. Recently, Prandelli et al. (2016) were able to find support for a similar hypothesis. The main difference between their experimental manipulation and our priming task is that they focused on taking the perspective of one specific stakeholder group – the users – whereas we focused on using the process of perspective taking itself. To prime general perspective taking in Study 1, we used the procedure outlined by Galinsky and Ku (2004), which used a single photograph of a female subject as the stimulus. We reasoned that due to differences in perceived similarity (Ames, 2004a; 2004b), the priming might have been less effective for male, as compared to female, participants. Therefore, in Study 2 we matched the gender of the person in the stimulus photograph with that of the respondent. In Study 2 we found that perspective taking did have a significant effect on the quality of NVIs, although the effect was not as strong as for prospective thinking.

Based on previous work concerning the relationship between counterfactual thinking and opportunity recognition (Baron, 1998; Gaglio, 2004), we hypothesized that counterfactual thinking would affect the quality of the NVIs generated by our participants. However, this was not the case in our two studies. We came across one possible explanation for this in the literature on self-efficacy, according to which self-efficacy decreases, the more frequently counterfactual thinking is used (Arora et al., 2013). Therefore, it is possible that the increased use of counterfactual thinking in our studies negatively influenced the self-efficacy of participants, so that they generated weaker NVIs. In addition, as the participants in this condition were asked to engage in counterfactual thoughts, besides generating counterfactual thoughts about how they could have performed better on the anagram task (upward counterfactuals), they could also have been considering how their performance could have been worse (downward counterfactuals). Such downward counterfactual thoughts

have powerful effects in decreasing self-efficacy (Tal-Or et al., 2004). Participants in the counterfactual thinking condition might therefore have generated less ambitious opportunities due to being less confident of their abilities, resulting also in lower quality NVIs.

Scholarly literature on affect provides a second explanation for why counterfactual thinking did not influence the quality of NVIs our participants generated. Upward counterfactual thinking increases negative affect such as regret (Markman et al., 1993; 1995; McCrea, 2008; Roese, 1994). In generating upward counterfactuals, individuals think of better alternatives, which causes them to regret previous choices or actions that possibly prevented them from achieving the better alternative. Higher levels of negative affect have been shown to have a negative effect on entrepreneurial performance in general (Fodor and Pintea, 2017), and specifically so with respect to creativity (Hills et al., 1999). These two lines of argument could explain why we did not find an effect of counterfactual thinking on the quality of NVIs. Our results further provide an explanation for Baron's (2000) finding that entrepreneurs tend to use counterfactual thinking less often than non-entrepreneurs: entrepreneurs may not use counterfactual thinking very often because counterfactual thinking does not contribute to generating high quality NVIs.

Another implication of our research is the finding that these experimental effects obtain when the respondents are instructed to generate NVIs, but not when they are left to generate NVIs spontaneously. Those who do generate NVIs spontaneously, have significantly higher levels of relevant business experience compared to the respondents who did not generate NVIs spontaneously. Therefore, it is likely that experience had prepared these individuals in using these cognitive processes. Due to ceiling effects (cf. Shadish et al., 2002), our priming could have limitedly affected experienced individuals as their entrepreneurial mindset is better developed, and therefore these cognitive processes are more readily available to them (Krueger, 2007). This is also partly borne out by the fact that this experienced group's control

group performance was higher (even if not significantly so) compared to the less experienced group (see also Table 7).

### *9.1 Practical Implications*

The results of this research have several implications for practice. First, our finding that participants who used prospective thinking and perspective taking produced higher quality NVIs than the participants in the control condition, is important for (potential) entrepreneurs, business developers, and new product development teams. The latter interest groups would be well-advised to use prospective thinking and perspective taking more actively and explicitly, as it could help them to come up with NVIs, as well as new products and services. By training the use of these two future-oriented cognitive processes, less experienced entrepreneurs could develop a more experienced entrepreneurial mindset.

Second, having a team member with a high level of prior knowledge of technology could also be beneficial in NVI generation. Due to established knowledge of technology, such team members are likely to generate NVIs of higher quality through prospective thinking or perspective taking.

Third, our findings have implications for entrepreneurship education, and entrepreneurship support organizations such as incubators and accelerators. Entrepreneurship training programs aiming to raise entrepreneurial awareness, or to enhance the quality of NVIs, could provide training in prospective thinking and perspective taking. Studies have described perspective taking training and its effects on a wide range of outcomes such as problem solving (Marsh et al., 1980). Other work shows that training in mindfulness has a positive effect on perspective taking (Block-Lerner et al., 2007; Hölzel et al., 2011). Taken together with the present result, this suggests additional directions that training programs can take.

### *9.2 Limitations and Further Research*



In our study, we defined an NVI to be of high quality if it has potential economic value, is new, and is perceived to be desirable (Baron, 2006; Baron and Ensley, 2006). Although we did not study the effect of the cognitive processes on these three characteristics of the quality of NVIs individually, this would be interesting for future research. Showing which cognitive processes influence which characteristics of NVIs could give us a deeper understanding of how these processes influence the quality of NVIs.

In our experiments, we asked our respondents to generate NVIs. Prior research has used vignettes to present business ideas to their respondents, and has used manipulation to create similar business ideas that differed on crucial aspects. Although one has better control of NVIs in experimental studies using a vignette approach, because all respondents read similar business ideas, we think our novel approach enabled us to study the early stages of idea formation using a more natural task. Instead of guiding respondents towards recognizing business ideas they may never have thought of themselves, we studied the ideas that respondents generated themselves, based on their own subjective interpretation of an external enabler, which in our case was the presentation of a technology invented by NASA (Grégoire et al., 2010). We therefore developed an experimental design that could provide future research with opportunities to continue studying the generation of NVIs, for example, by presenting external enablers that have distinctly different characteristics (Davidsson, 2015).

We investigated three future-oriented cognitive processes: prospective thinking, counterfactual thinking, and perspective taking. Future research could study how more fine-grained distinctions within these processes affect NVIs. For example, given the lack of an effect of counterfactual thinking, it would be interesting for future research to attempt to disentangle the effects of upward versus downward counterfactual thoughts (Roese, 1994), or of upward versus downward characteristics of prospective thinking. Moreover, perspective

taking can be further broken down into imagined-self versus imagined-other perspective taking (cf. Batson, 2009).

Additionally, these three processes are not the only cognitive processes to influence the generation of NVIs. Other cognitive processes, such as predicting (Wiltbank et al., 2009) or divergent thinking (Gielnik et al., 2012) could also play a role in generating NVIs. Future research could study the effects such other cognitive processes have on the quality of NVIs.

Echoing a call for research on how emotions affect entrepreneurship (Shepherd, 2015), we encourage the future study of how emotions influence the relations studied in this research. Emotions can be used as information in future-oriented cognition (Marroquín et al., 2016). Future research could study how emotions affect the quality of NVIs through future-oriented cognition, as emotions influence prospective thinking (Worthy et al., 2014) and counterfactual thinking (Roese, 1997).

By focusing on NVIs, our study is limited to the very early stages of the entrepreneurial process. However, future-oriented cognitive processes can also play a role in other stages of the entrepreneurial process, such as opportunity evaluation (Wood and McKelvie, 2015), preparation, and exploitation. Future research therefore could investigate the effect of future-oriented cognitive processes at different stages in the entrepreneurial process.

## **10. Conclusion**

The results of our studies provide evidence that prospective thinking and perspective taking lead to NVIs of higher quality than counterfactual thinking does. In both experiments, the participants who were primed to use prospective thinking thought of higher quality NVIs than participants in the counterfactual thinking and the control groups. Using a refined priming task in Study 2, we find further that perspective taking also leads to NVIs of higher

quality. Not all future-oriented cognitive processes therefore generate new ventures of similar quality, which means it matters which cognitive process is evoked.

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Variable	<i>M</i>	<i>SD</i>	1	2	3	4
1. Age	21.23	1.96				
2. Gender	0.30	0.46	.21*			
3. Entrepreneurial Experience	0.17	0.38	.19*	.09		
4. Nationality	0.42	0.50	.22*	.17	.21*	
5. Quality of NVI	5.30	0.79	.02	.02	.15	-.01

*Note.* \* indicates  $p < .05$ . *M* and *SD* are used to represent mean and standard deviation, respectively. Gender (0 = Male, 1 = Female), Entrepreneurial Experience (0 = No, 1 = Yes), and Nationality (0 = Dutch, 1 = Non-Dutch).

Table 1: *Descriptive Statistics and Correlation Matrix of Study 1*

	<u>Prospective</u>		<u>Counterfactual</u>		<u>Perspective</u>		<u>Control Group</u>		<i>F</i> -test
	<u>Thinking Group</u>		<u>Thinking Group</u>		<u>Taking Group</u>				
	<i>Mean</i>	<i>S.D.</i>	<i>Mean</i>	<i>S.D.</i>	<i>Mean</i>	<i>S.D.</i>	<i>Mean</i>	<i>S.D.</i>	
Prospective thinking	3.13 <sup>a,b,1</sup>	0.82	2.43	1.11	2.19 <sup>a,3</sup>	1.15	2.39 <sup>b</sup>	1.25	4.21 <sup>**</sup>
Counterfactual thinking	2.28 <sup>1,2</sup>	0.81	2.78 <sup>e,d</sup>	1.16	1.81 <sup>c,4</sup>	1.07	2.03 <sup>d,5</sup>	0.92	5.20 <sup>**</sup>
Perspective taking	2.88 <sup>e,2</sup>	0.85	2.36 <sup>f</sup>	1.02	3.55 <sup>e,f,g,3,4</sup>	0.85	2.76 <sup>g,5</sup>	0.92	8.86 <sup>***</sup>

*Note.* \*\* indicates  $p < .01$ ; \*\*\* indicates  $p < .001$ . Means in a given row with the same superscript letter are significantly different from each other at  $p \leq .05$ . Means in a given column with the same superscript number are significantly different from each other at  $p \leq .05$ . All other pairwise comparisons are not significant.

Table 2: *Overview Priming Check Study 1*

<i>Predictor</i>	<i>Model 3.1</i>	<i>Model 3.2</i>
Constant	5.74**	5.80**
Age	-0.02	-0.03
Gender	-0.03	0.02
Entrepreneurial Experience	0.34 <sup>†</sup>	0.23
Nationality	-0.10	-0.05
Study program	-0.18	-0.18
Prospective thinking		0.52*
Counterfactual thinking		-0.19
Perspective taking		0.09
<i>R</i> <sup>2</sup>	.03	.19*
Log likelihood	-133.02	-126.41

*Note.* <sup>†</sup> indicates  $p < .10$ ; \* indicates  $p < .05$ ; \*\* indicates  $p < .01$ . Gender (0 = Male, 1 = Female), Entrepreneurial experience (0 = No, 1 = Yes), Nationality (0 = Dutch, 1 = Non-Dutch), and Study program (0 = Business administration, 1 = Science & engineering).

Table 3: *Overview Results Study 1*

Variable	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	35.05	9.82												
2. Gender	0.54	0.50	.08											
3. Openness to Experience	3.90	0.63	-.01	-.01										
4. Highest Education	4.67	1.11	.08	.03	.03									
5. No. of Business Classes	0.30	0.78	.06	-.04	.15**	.06								
6. Ever Started a Business	0.24	0.43	.17**	-.04	.19**	.06	.38**							
7. Full Time Paid Work Experience	12.97	9.30	.88**	.02	.05	-.06	.08	.23**						
8. Years of Supervising or Management Experience	3.24	5.05	.50**	.00	.15*	.05	.13*	.17**	.55**					
9. Prior Industry Experience	2.58	1.51	.01	-.15*	-.02	-.01	.26**	.17**	.09	.05				
10. Prior Knowledge of Market	4.11	2.48	-.01	-.08	.14*	-.02	.18**	.11	.03	.09	.46**			
11. Prior Knowledge of Technology	2.80	2.18	-.06	-.18**	.02	.04	.09	.00	-.01	.01	.48**	.62**		
12. Dummy Instructed vs Spontaneous	0.46	0.50	.11	-.11	.13*	-.02	.13*	.13*	.17**	.12*	.22**	.20**	.16**	
12. Quality of NVI	5.03	0.71	-.07	-.06	.06	.03	.02	-.14*	-.09	-.06	-.11	.04	.03	.08

Note. \* indicates  $p < .05$ ; \*\* indicates  $p < .01$ . *M* and *SD* are used to represent mean and standard deviation, respectively.

Table 4: *Descriptive Statistics and Correlation Matrix of Study 2*



	<u>Prospective</u>		<u>Counterfactual</u>		<u>Perspective</u>		<u>Control Group</u>		<i>F</i> -test
	<u>Thinking Group</u>		<u>Thinking Group</u>		<u>Taking Group</u>				
	<i>Mean</i>	<i>S.D.</i>	<i>Mean</i>	<i>S.D.</i>	<i>Mean</i>	<i>S.D.</i>	<i>Mean</i>	<i>S.D.</i>	
Prospective thinking	2.97 <sup>a,b,1,2</sup>	0.83	1.96 <sup>a,3</sup>	0.92	2.42 <sup>a,5</sup>	0.98	2.25 <sup>b</sup>	1.01	15.09***
Counterfactual thinking	2.59 <sup>c,1</sup>	0.96	2.75 <sup>d,e,3,4</sup>	0.87	1.94 <sup>c,d,5</sup>	1.09	2.23 <sup>e</sup>	1.15	8.97***
Perspective taking	2.49 <sup>f,2</sup>	1.09	1.83 <sup>f,g,4</sup>	1.08	4.06 <sup>f,g,5</sup>	1.04	2.46 <sup>g</sup>	1.18	52.19***

*Note.* \*\*\* indicates  $p < .001$ . Means in a given row with the same superscript letter are significantly different from each other at  $p < .05$ . Means in a given column with the same superscript number are significantly different from each other at  $p < .05$ . All other pairwise comparisons are not significant.

Table 5: *Overview Priming Manipulation Check Study 2*

<i>Predictor</i>	<i>Model 6.1</i>	<i>Model 6.2</i>	<i>Model 6.3</i>	<i>Model 6.4</i>
Age	-0.00	-0.00	-0.00	0.00
Gender	-0.11	-0.05	-0.04	-0.02
Openness to Experience	0.09	0.06	0.06	0.06
Highest Education	0.02	0.01	0.01	0.02
No. of Business Classes	0.09	0.07	0.07	0.06
Ever Started a Business	-0.27*	-0.24*	-0.23*	-0.24*
Years of Supervising or Management Experience	-0.00	-0.01	-0.01	-0.01
Prior Industry Experience	-0.06 <sup>†</sup>	-0.09**	-0.09**	-0.11**
Prior Knowledge of Market		0.02	0.02	0.08 <sup>†</sup>
Prior Knowledge of Technology		0.01	0.01	-0.09 <sup>†</sup>
Dummy: 0 = instructed; 1 = spontaneous		0.17 <sup>†</sup>	0.31 <sup>†</sup>	0.19*
Prospective Thinking		0.28*	0.38*	0.20
Counterfactual Thinking		0.08	0.14	0.02
Perspective Taking		0.31*	0.43*	0.24
Spontaneous x Prospective Thinking			-0.18	
Spontaneous x Counterfactual Thinking			-0.10	
Spontaneous x Perspective Taking			-0.25	
Prior Knowledge of Market x Prospective Thinking				-0.06
Prior Knowledge of Market x Counterfactual Thinking				-0.10
Prior Knowledge of Market x Perspective Taking				-0.07
Prior Knowledge of Technology x Prospective Thinking				0.12 <sup>†</sup>
Prior Knowledge of Technology x Counterfactual Thinking				0.17*
Prior Knowledge of Technology x Perspective Taking				0.13 <sup>†</sup>
<i>R</i> <sup>2</sup>	.05	.10**	.11*	.12*
Log likelihood	-292.95	-285.29	-284.72	-282.14

*Note.* <sup>†</sup> indicates  $p < .10$ ; \* indicates  $p < .05$ ; \*\* indicates  $p < .01$ .  $N = 279$ .

Table 6: *Regression results based on full sample*

<i>Quality of NVI</i>	<u>Prospective</u>		<u>Counterfactual</u>		<u>Perspective</u>		<u>Control Group</u>	
	<u>Thinking Group</u>	<u>Thinking Group</u>	<u>Thinking Group</u>	<u>Thinking Group</u>	<u>Taking Group</u>	<u>Taking Group</u>	<u>Mean</u>	<u>S.D.</u>
	<i>Mean</i>	<i>S.D.</i>	<i>Mean</i>	<i>S.D.</i>	<i>Mean</i>	<i>S.D.</i>	<i>Mean</i>	<i>S.D.</i>
Spontaneous	5.23	0.58	5.01	0.70	5.14	0.57	4.99	0.62
Instructed	5.11 <sup>a</sup>	0.69	4.87 <sup>b</sup>	0.88	5.17 <sup>b,c</sup>	0.67	4.71 <sup>a,c</sup>	0.81
Total	5.17 <sup>d,e</sup>	0.63	4.93 <sup>d,f</sup>	0.81	5.16 <sup>f,g</sup>	0.63	4.86 <sup>e,g</sup>	0.72

*Note.* Means in a given row with the same superscript letter are significantly different from each other at  $p < .05$ , excepting *b* and *f*, which are significantly different from each other at  $p < .10$ . All other horizontal pairwise comparisons are not significant. No significant differences were found between means of spontaneous and instructed NVIs in a given column at  $p < .05$ .

Table 7: *Overview of Means Grouped by Condition and Spontaneous vs Instructed*

<i>Predictor</i>	<i>Model 8.1</i>	<i>Model 8.2</i>
Age	-0.02*	-0.02*
Gender	-0.18	-0.17
Openness to Experience	0.21*	0.22*
Highest Education	-0.07	-0.07
No. of Business Classes	0.00	-0.00
Ever Started a Business	-0.22 <sup>†</sup>	-0.21
Years of Supervising or Management Experience	0.02	0.02
Prior Industry Experience	-0.00	-0.00
Prospective Thinking		0.16
Counterfactual Thinking		-0.00
Perspective Taking		0.14
<i>R</i> <sup>2</sup>	.15*	.16*
Log likelihood	-115.83	-114.87

*Note.* <sup>†</sup> indicates  $p < .10$ ; \* indicates  $p < .05$ ; \*\* indicates  $p < .01$ .  $N = 128$

Table 8: *Regression results based on sub-sample that spontaneously generated NVIs.*

Predictor	<i>Model 9.1</i>	<i>Model 9.2</i>	<i>Model 9.3</i>	<i>Model 9.4</i>
Age	0.01	0.01	0.01	0.01
Gender	-0.09	-0.03	0.01	0.06
Openness to Experience	0.01	-0.01	-0.02	-0.05
Highest Education	0.08	0.07	0.07	0.07
No. of Business Classes	0.15	0.12	0.11	0.12
Ever Started a Business	-0.28	-0.18	-0.19	-0.12
Years of Supervising or Management Experience	-0.03	-0.03 <sup>†</sup>	-0.03 <sup>†</sup>	-0.03 <sup>†</sup>
Prior Industry Experience	-0.11*	-0.12**	-0.16**	-0.19**
Prospective Thinking		0.40*	0.36 <sup>†</sup>	0.47*
Counterfactual Thinking		0.18	0.16	0.28
Perspective Taking		0.50**	0.51**	0.69**
Prior Knowledge of Market			0.00	0.10
Prior Knowledge of Technology			0.05	-0.19
Prior Knowledge Market x Prospective Thinking				-0.06
Prior Knowledge Market x Counterfactual Thinking				-0.13
Prior Knowledge Market x Perspective Taking				-0.11
Prior Knowledge Technology x Prospective Thinking				0.26 <sup>†</sup>
Prior Knowledge Technology x Counterfactual Thinking				0.28 <sup>†</sup>
Prior Knowledge Technology x Perspective Taking				0.31*
$R^2$	.106*	.163**	.178**	.218*
Log likelihood	-163.31	-158.34	-156.95	-153.18

Note. <sup>†</sup> indicates  $p < .10$ ; \* indicates  $p < .05$ ; \*\* indicates  $p < .01$ ;  $N = 151$ .

Table 9: Regression results based on sub-sample that was instructed to generate NVIs

	<b>Study 1</b>	<b>Study 2</b>		
		<i>Full sample</i>	<i>Sub sample: Spontaneous generation</i>	<i>Sub sample: Instructed generation</i>
Hypothesis 1: <i>The greater the use of prospective thinking, the higher the quality of NVIs.</i>	Supported	Supported	Unsupported	Supported
Hypothesis 2: <i>The greater the use of counterfactual thinking, the higher the quality of NVIs.</i>	Unsupported	Unsupported	Unsupported	Unsupported
Hypothesis 3: <i>The greater the use of perspective taking, the higher the quality of NVIs.</i>	Unsupported	Supported	Unsupported	Supported
Hypothesis 4a: <i>Prospective thinking has a stronger effect on the quality of NVIs than counterfactual thinking.</i>	Supported	Supported		Unsupported
Hypothesis 4b: <i>Prospective thinking has a stronger effect on the quality of NVIs than perspective taking.</i>	Supported	Unsupported		Unsupported
Hypothesis 4c: <i>Perspective taking has a stronger effect on the quality of NVIs than counterfactual thinking.</i>	Unsupported	Marginally supported Unsupported		Marginally supported Unsupported
Hypothesis 5: <i>The relationship between (a) prospective thinking, (b) counterfactual thinking, (c) perspective taking and the quality of NVIs is positively moderated by the entrepreneur's prior knowledge of the market.</i>				
Hypothesis 6a: <i>The relationship between prospective thinking and the quality of NVIs is positively moderated by the entrepreneur's prior knowledge of the technology.</i>		Marginally supported		Marginally supported
Hypothesis 6b: <i>The relationship between counterfactual thinking and the quality of NVIs is positively moderated by the entrepreneur's prior knowledge of the technology.</i>		Supported		Marginally supported
Hypothesis 6c: <i>The relationship between perspective taking and the quality of NVIs is positively moderated by the entrepreneur's prior knowledge of the technology.</i>		Marginally supported		Supported

Table 10: *Overview of Support for Hypotheses in Each Study and Sample*