EASY DOES IT? THE EFFECTS OF PERCEIVED DIFFICULTY ON OVERCONFIDENCE

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Thesis submitted to the Office of Research and Graduate Studies in partial fulfillment of the requirements for the Degree of Master of Science in Engineering

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Santiago de Chile, (January, 2017)

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To my parents, girlfriend and friends who supported me through this process.
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RESUMEN

Es sabido que el exceso de confianza varía según la dificultad de la tarea a realizar. En esta investigación se propone que la percepción de dificultad tiene una influencia crucial en el exceso de confianza. Se propone también que la percepción de dificultad depende de, no sólo la dificultad de la tarea, sino que también de la experiencia, el feedback y de cómo la tarea es presentada. Dos experimentos apoyan el modelo propuesto. Los resultados sugieren que es posible modificar el exceso de confianza a través la experiencia, el feedback y la forma en que la tarea se presenta, incluso cuando la dificultad real de la tarea se mantiene constante. Esta investigación contribuye a alcanzar un mejor entendimiento de los mecanismos causales del exceso de confianza.
ABSTRACT

Overconfidence is known to vary depending on task difficulty. In this research, we propose that perceived difficulty has a crucial role in overconfidence. We propose that perceived difficulty depends on the actual difficulty of the task, but also on experience, feedback, and how the task is framed. Furthermore, perceived difficulty mediates the relationship between task difficulty and overconfidence and the relationship between experience and overconfidence. Two experiments support our model. Our results suggest that it is possible to modify overconfidence through framing, experience, and feedback; while keeping task difficulty constant. This research contributes to the understanding of the causal mechanisms of overconfidence.
1. INTRODUCTORY CHAPTER

1.1 Introduction

Scholars have been keen in the study of overconfidence. In the past years overconfidence have been used to explain many different phenomena, among which we can found: high rates of entrepreneurial entry (Camerer & Lovallo, 1999), high rates of corporate merger and acquisition (Malmendier & Tate, 2005), high rates of trading (Odean, 1998), speculative bubbles (Scheinkman & Xiong, 2003), leadership qualities (Shipman & Mumford, 2011), and even wars (Howard, 1983; Johnson, 2004). Overconfidence is usually linked to decision errors, which has led Nobel Laureate Daniel Kahneman to state “What would I eliminate if I had a magic wand? Overconfidence” (Shariatmadari, July 15, 2015).

Overconfidence occurs when there is a difference between estimated and actual performance. People can experience overconfidence in three different ways, for their results (overestimation), their results relative to others (overplacement), and the accuracy of their estimations (overprecision) (Moore & Healy, 2008). In this research we consider overconfidence as overestimation, which denotes the difference between estimated performance and actual performance. Estimated performance is how individuals forecast their performance, and actual performance is how they actually perform.

There are many known predictors for overconfidence, for example, amount of information available (Tsai, Klayman, & Hastie, 2008), difficulty of the task (Moore & Healy, 2008), nature of information (Zacharakis & Shepherd, 2001), gender (Hügelschäfer & Achtziger, 2014), early life-experiences (Malmendier, Tate, & Yan, 2011), past success (Hilary & Menzly, 2006), sense of power (Fast, Sivanathan, Mayer, & Galinsky, 2012), emotion (Lofy, 1998), affect (Emich, 2014), among others.
Among all the known predictors for overconfidence, difficulty is perhaps one of the most studied (Moore & Small, 2007; Moore & Cain, 2007; Pulford & Colman, 1997). Previous research has found that in difficult tasks, people tend to overestimate their performance. For example, entrepreneurs often are 100% certain that their pioneering products and new ventures will prosper (Shrader & Simon, 1997; Simon & Houghton, 2003), despite that they face many difficult decisions in starting a new venture (McMullen & Shepherd, 2006) or introducing an innovative product (Lumpkin & Dess, 1996). Still, in a sample of 3,000 entrepreneurs, 81% believed that their chance of success was 70% or higher, and 33% estimated their chance of success to be 100% (Cooper, Woo, & Dunkelberg, 1988), despite of the five-year new venture survival rate being merely 25% (Bernardo & Welch, 2001). In contrast, in easy tasks, people tend to underestimate their performance. Lichtenstein & Fischhoff (1977) found that overconfidence declined as the percentage of correct answers increased, which has been called the ‘hard-easy effect.’ In sum, with easy tasks, people exhibit underconfidence and with difficult tasks people exhibit overconfidence (Moore & Small, 2007).

The hard-easy effect indicates that task difficulty might not be properly incorporated in the decision making process. While identifying whether a task is easier or harder than other is in general simple, it seems we often have problems establishing the actual level of difficulty of a task. In fact, in experiments, task difficulty is typically unknown to individuals during the task but instead it is calculated post task (Wright, Hollenbeck, Wolf, & McMahan, 1995). Therefore, despite task difficulty being a predictor of overconfidence, the causal mechanisms of overestimation remains unclear.

From the basis that task difficulty might not be properly incorporated in the decision making process, it is natural to wonder if there is a difference between
how people perceive difficulty and the actual difficulty of a task. And if so, what are the consequences of such difference and what are its drivers.

We already know task difficulty influences overconfidence, but it is compulsory to ask if the same applies to perceived difficulty. This would help explain the influence of task difficulty on overconfidence and the hard-easy effect. Despite the multiple studies on task difficulty and overconfidence, so far, we have no knowledge of studies about the influence of perceived difficulty on overconfidence.

We believe perceived task difficulty influences estimated performance, and as overconfidence is the difference between performance and estimated performance, we also believe that perceived difficulty influences overconfidence. Perception, in general, influences beliefs (Saberwal, 1996; Smith, 2001; Swartz, 1965) and therefore estimations. Furthermore, there is evidence of an influence of some forms of perception, such as perception of risk and competence on estimated performance, and therefore, overconfidence (Fast et al., 2012)

Perception in general, and perceived difficulty in particular, do not depend only on the object that is being perceived, but also on the context and the individual perceiving it (Swartz, 1965) In the case of the perceived difficulty of a task, we consider the object of perception to be the task itself, the individual to be the participant, and the context or framing, the external conditions or information available.

1.2 Hypotheses

We hypothesize that perceived difficulty should be influenced by task difficulty, framing, and individual characteristics. Perception, in general, depends on not only the object or task that is perceived, but also on the context in which it is perceived (room characteristics, environmental noises, the attitude society has
towards a task, etc.), and the individual who perceives it (age, gender, academic/career background, etc.) (Fast et al., 2012; Gustafson, 1998; Swartz, 1965; Wei, Chia, & Lo, 2011), and we believe that perceived difficulty, in particular, is not an exception.

Finally, adding together the mentioned relationships between task difficulty, perceived difficulty, estimated performance, and overconfidence, we propose a mediating role of perceived difficulty on the relationship between task difficulty and overconfidence.

1.3 Procedure

We test our hypotheses using two studies. We conducted experiments in which participants perform a 20-item task in different conditions. We externally manipulate framing and feedback conditions. In order to manipulate framing, we give participants information about the task, before they start performing it, regarding the difficulty of the task: we randomly communicate them that the task is easy or hard. In order to manipulate feedback, in the second study, we randomly assigned participants into the feedback and no-feedback conditions. Participants in the feedback condition received the correct answer of an item just after they answered it. Participants answered questionnaires about perceived difficulty and overconfidence on different instances of the experiment: before performing the task, between different items of the task, and after finalizing the task.

All participants perform the same 20-items, in a random order, and in consequence, task difficulty is kept constant between conditions. However, difficulty varies across different items, which allows us to isolate the influence of task difficulty. We also analyze the influence of experience, as a personal trait, on perceived difficulty and overconfidence. To do so, we consider the marginal experience with the task gained after answering each item.
1.4 Results

The experiments showed that perceived difficulty not only predicts but also causes overconfidence. The two studies tested and confirmed that overconfidence depends on perceived difficulty, which in turn depends on experience, framing, and task difficulty. First, we find that participants that perceived the task as more difficult, had lower levels of overconfidence than the ones which perceived the task as easier. Second, we find a higher perceived difficulty for participants on the hard framing condition (those that were told that the task was hard), than for participants on the easy framing condition (those that were told that the task was easy). Third, we find a positive influence of task difficulty on perceived difficulty, within individuals. Finally, we find that experience, understood as the number of items a participant has already answered on a given time, has a U-shaped influence on perceived difficulty. Up to a certain point, experience decreases perceived difficulty and consequently increases overconfidence. Nevertheless, after experience reaches a threshold, perceived difficulty increases, and thus, the mediation effect of experience on overconfidence through perceived difficulty also decreases.

When feedback is available, the influence of framing on perceived difficulty tends to disappear. We find a second grade influence of the interaction between experience and feedback on overconfidence; when feedback is present and experience increases, overconfidence decreases, but up to a certain threshold of experience, after which overconfidence increases again.

1.5 Discussion

By studying the influence of framing, task, experience, and feedback, on perceived difficulty and overconfidence, our research helps to better understand the mechanisms that influence overconfidence. Additionally, these findings advance the understanding on the hard-and-easy effect in overconfidence on
many fronts. First, our results show the critical role of perceived difficulty in overconfidence. Perceived difficulty influences overconfidence above and beyond task difficulty does and mediates the effect of task difficulty on overconfidence. Consequently, the influence of task difficulty (Klayman & Soll, 1999; Moore & Cain, 2007) can be partially counteracted by modifying perceived difficulty. Even more interestingly, the effect of perceived difficulty on overconfidence is opposite to the direct effect of task difficulty on overconfidence. While a high task difficulty increases overconfidence, a high perceived difficulty decreases overconfidence. On the other hand, while a low task difficulty decreases overconfidence, a low perceived difficulty increases overconfidence.

Also, our study highlights the multiple connections and non-linear relations between the different variables involved in the overconfidence process. Moreover, we believe the understanding of contextual and individual factors that lead to overconfidence can generate new directions of theoretical development.

Finally, this research helps to explain how experience influences overconfidence. We show that not all increase in experience carries the same effect on overconfidence. We extend previous literature by showing that adding experiences not always increase overconfidence (Gloede & Menkhoff, 2009; Lambert, Bessière, & N’Goala, 2012; Menkhoff, Schmeling, & Schmidt, 2013; Menkhoff, Schmidt, & Brozynski, 2006). In fact, adding experiences to an already experienced individual tends to decrease overconfidence.

1.6 Practical Implications

Managers and entrepreneurs often hear from mentors, employees, and people in their network about the difficulty of different tasks. Current results show that framing a task as easy or difficult serves not only as an encouraging or warning note about the particular task, but may also change the levels of overconfidence.
Overconfidence can be a plus or a disadvantage (c.f. Anderson & Brion, 2012; Camerer & Lovallo, 1999; Ko & Huang, 2007), and framing provides an alternative option to alter the level of overconfidence.

1.7 Limitations and Future Work

Experience was not manipulated in our experiments. Thus, experience may not have been the only factor that changed through the realization of the experiments. For example, after a few trials, participant’s interest can decrease, or participants’ might have a decreasing concentration. This means that our conclusions regarding experience are not necessarily causal.

1.8 Conclusions

One of the basic questions for management researchers is how perception influences overconfidence. Building upon the literature of overconfidence and task difficulty, we proposed and tested the mediating role of perceived difficulty on the influence of task difficulty on overconfidence. Perceived difficulty plays a prominent role on overconfidence and it is not so a simple (closely related to difficulty) variable, but rather a complex one, influenced (beside task difficulty) by framing, experience and feedback.
2. THESIS

2.1 Introduction

Overconfidence, perhaps the most studied decision-making biases, has been used to explain many key phenomena in applied psychology and management, such as high rates of entrepreneurial entry (Cain, Moore, & Haran, 2015), leadership qualities (Shipman & Mumford, 2011), investment decisions (Dittrich, Güth, & Maciejovsky, 2005), and management forecasting (Hribar & Yang, 2015). Overconfidence is usually linked to decision errors, which has led Nobel Laureate Daniel Kahneman to state “What would I eliminate if I had a magic wand? Overconfidence” (Shariatmadari, July 15, 2015).

A key predictor of overconfidence is task difficulty (Moore & Small, 2007; Moore & Cain, 2007; Pulford & Colman, 1997). Previous research has found the ‘hard-easy effect’ (Moore & Small, 2007): people tend to be overconfident in difficult tasks, and underconfident on easy tasks. Yet, the construct of task difficulty fails to explain individual differences in overconfidence found in previous studies (Benoît & Moore, 2009; Moore & Healy, 2008). Moreover, task difficulty is typically unknown by the performer, and in consequence, a mediator is needed on the influence of task difficulty on overconfidence.

In the present paper, we argue that the literature on overconfidence and the hard-easy effect can be greatly enhanced by a key construct: perceived task difficulty. Perceived task difficulty is an important construct in self-efficacy theory (Bandura 1997; Pajares, 2011) and the theory of planned behavior (Ajzen, 1991; Trafimow, Sheeran, Conner, Finlay, 2002). On the other hand, perceived easiness, or fluency has proved to influence estimated performance (Alter, Oppenheimer, Epley, & Eyre, 2007). Yet, judgment and choice researchers have ignored perceived difficulty when studying overconfidence and the hard-easy effect.
We test the counterintuitive hypothesis, in light of the hard-easy effect, that perceived difficulty is negatively related to overconfidence. Said differently, we argue that decision makers who perceive a task as easy are more likely to be overconfident than those who perceive a task as difficult. We also argue that perceptions of task difficulty are affected not only by the task at hand but also by other factors such as the framing of the task, task experience, and whether feedback is provided. We develop a theoretical model that seeks to examine the role of perceived difficulty in overconfidence, but also examine antecedents of perceived difficulty. Overall, we study how factors such as framing, task difficulty, task experience, and feedback, have an indirect effect on overconfidence through perceived task difficulty.

The incorporation of perceived difficulty to the model for overconfidence allows us to uncover two underlying and opposite paths through which task difficulty influence overconfidence. On one hand, and as previous literature indicates, the direct influence of task difficulty on overconfidence leads to higher overconfidence. On the other hand, the indirect influence of task difficulty on overconfidence through perceived difficulty leads to lower overconfidence. A consequence of our results is that the hard-easy effect does not depend only on how hard or easy is the task, but also on how it is perceived.

2.1.1 Theoretical Background and Hypotheses

Overconfidence plays a key role in managerial and entrepreneurial behaviors and outcomes. A previous study on high-technology firms indicates that overconfidence is positively related to the riskiness of product introductions (Simon & Houghton, 2003). Moreover, it has been found that realistically confident subjects exhibit more concessionary behaviors and successful performances than subjects who are overconfident (Neale & Bazerman, 1985). Furthermore, there is evidence of a negative relationship between entrepreneurs’...
overconfidence and the performance (revenue and employment growth) of their new ventures (Hmieleski & Baron, 2009).

The most popular form of overconfidence is most often defined as the difference between the estimated performance (confidence) and the actual performance of an individual, also known as overestimation (Moore & Healy, 2008).¹ Task difficulty influences both estimated performance and actual performance in a way that in easy tasks people exhibit overconfidence and in hard tasks underconfidence (Moore & Small, 2007). Stated differently, in easy tasks people estimate their performance to be better than their actual performance, and in hard tasks people estimate their performance to be worse than their actual performance.

When performing most tasks, people do not have access to objective measures of difficulty. For example, how difficult is to merge two companies, to close a deal successfully, or even to organize a business meeting over skype? People do not have access to objective difficulty but instead perceive how difficult a task is (Bratfisch, Borg, & Dornic, 1971, 1972; Delignieres, 1993). Similarly, in earlier experimental research on overconfidence, individuals did not have access to measures of the actual difficulty of tasks (c.f. Emich, 2014; Jain, Mukherjee, Bearden, & Gaba, 2013; Lambert, Bessière, & N’Goala, 2012; McKenzie, Liersch, & Yaniv, 2008), instead they perceived the difficulty of the tasks. Perception varies depending on the person, and the circumstances. In the words of the philosopher Robert Swartz: “Things that exist in the world can appear different to different people, or to the same person, under dissimilar conditions, even though the objects do not change at all” (1965, p. xv).

¹ Moore and Healy (2008) made a distinction among types of overconfidence. The present article focuses on the most popular type, known as ‘overestimation’ in their taxonomy: when subjective confidence is greater than objective accuracy.
2.1.2 The role of perceived difficulty

Prior research shows that perceptions influence attitudes (Wei et al., 2011), behaviors (Chartrand & Bargh, 1999), decision-making (Sitkin & Weingart, 1995), and overconfidence (Fast et al., 2012). Perception influences beliefs (Saberwal, 1996; Smith, 2001; Swartz, 1965), and thus, estimations. We theorize perceived difficulty also influences overconfidence. We draw on studies on perceived easiness, also known as fluency, which show perceived easiness increases estimated performance (Alter et al., 2007). In consequence, perceived difficulty, should decrease estimated performance, and thus, overconfidence.

We hypothesize that when a task is perceived as more difficult, people exhibit less overconfidence. The rationale is the following. A decision maker who perceive a given task as easy (A) will to make accurate predictions (or will expect to perform well) and thus be highly confident. In contrast, decision makers who believe a task to be difficult (B) will expect to make less accurate predictions (or will expect to perform poorly) and thus be less confident. If the actual accuracy levels of both decision makers are similar, decision maker A will be more overconfident than decision maker B. For example, consider the prototypical entrepreneur who often finds ventures easy but tend to be unhappy with their performance. We argue that what lead them to be overconfident are their perceptions of how difficult the tasks are.

2.1.3 Antecedents of perceived difficulty

Task difficulty is the natural antecedent for perceived difficulty: hard tasks are typically perceived as harder than easy tasks. Nevertheless, task difficulty does not totally determine perceived difficulty. As we mentioned before, perception in general, and perceived difficulty in particular, depends on not only what is being perceived, but also the individual perceiving it and the framing in which it is perceived (Swartz, 1965).
There are many differences between individuals, but due its relationship with overconfidence, we focus on experience. Prior research indicates that experience tends to increase performance and also overconfidence (Menkhoff et al., 2013). Yet, a higher performance, if everything else stays the same, should lead to a lower overconfidence. In other words, the positive influence of experience on performance cannot explain the influence of experience on overconfidence. It is well known that experience influences perceptions (Gruber, Fink, & Damm, 1957; Kuhl, 2000), and we believe experience decreases perceived difficulty: after a couple of trials, it is not rare to find a task easier than the first time.

Finally, framing, which includes external conditions or information, has a relevant influence on perceived difficulty (Hargreaves, Rojo, & Sugden, 2014). Different studies have shown that what people do, and what people is told, before performing a task influences their perceptions of the same tasks (Emich, 2014). In particular, when a particular framing makes participants believe the task to be more difficult or more stressful, the framing increases perceived difficulty, and when a framing relaxes participants or let them believe the task to be less difficult, the framing decreases perceived difficulty (Hargreaves et al., 2014).

We propose a 3-factor model that takes into account the influence of perceived difficulty on overconfidence, and also considers the influence of task difficulty, framing, and experience on perceived difficulty. Our model is described in Figure 2-1:

![3 factor model for the influence of perceived difficulty on overconfidence.](image-url)
a) Task difficulty

Three definitions of task difficulty have appeared in the literature. It can be understood as a task characteristic, where a certain parameter of the task determines its difficulty (e.g., number of digits on a division) (Cheng, Luckett, & Mahama, 2007; Diehl & Sterman, 1995). It can be related to performance, where a lower average performance indicates a higher difficulty (Moore & Small, 2007; Moore & Cain, 2007; Wright et al., 1995). Alternatively, it can be defined as the difference between expectations of performance and performance (Moore & Healy, 2008). As experience is a variable of our model, and it has an influence on performance, we discard the definitions that relate task difficulty with performance and choose to use the one that considers task difficulty as a task characteristic (Cheng et al., 2007; Diehl & Sterman, 1995).

b) Experience

Experience has been found to be highly relevant to management (Cassar, 2014; Malmendier et al., 2011; Menkhoff et al., 2006; Tyler & Steensma, 1998) and has been also related to biases (Hilary & Menzly, 2006; Kaustia, Alho, & Puttonen, 2008; Lambert et al., 2012), in particular, to overconfidence. For example, that experienced investors’ and fund managers’ become more overconfident with experience (Menkhoff et al., 2013), and that experienced VCs tend to be more overconfident (Zacharakis & Shepherd, 2001).

In studies of judgment and decision-making, people generally operationalize experience as the number of items or repetitions performed on a given task (Gino, Argote, Miron-Spektor, & Todorova, 2010; Moore & Cain, 2007; Moore, Carter, & Yang, 2015; Rakow, Demes, & Newell, 2008).

Experience influence estimated performance (Cassar, 2014; Hilary & Menzly, 2006; Menkhoff et al., 2013; Parker, 2013), perception (Forlani & Mullins, 2000; Kuhl, 2000; Saberwal, 1996) and beliefs (Saberwal, 1996; Smith, 2001; Swartz,
We hypothesize that experience with the task decreases perceived difficulty, or in other words, that when someone performs a task several times, after a few trials, he will tend to find the task easier than the first time.

c) Framing

Framing temporarily modifies, among other things, people’s mindsets, their affects, and their sense of power (Fast et al., 2012; Hügelschäfer & Achtziger, 2014; Johnson & Tversky, 1983). For example, the framing of recalling or reading a negative situation would make us think with a negative mindset (Hilbig, 2009), and adopting a determinate posture can influence our sense of power (Carney, Cuddy, & Yap, 2010; Wilmuth, 2016).

Framing is present not only in experiments, but also in everyday life. A football coach motivating his team, a mother smiling at his son, a happy family on a TV add, those are all examples of framing on everyday life.

We theorize that framing influences perceived difficulty. For example, when someone tells you that a task is difficult, you will be inclined to believe that it is difficult, and the opposite will happen if someone tells you the same task is easy.

2.1.4 The mediating role of perceived difficulty

As we mentioned, we propose that task difficulty influences perceived difficulty, which in time influences overconfidence. This, together with the influence of task difficulty on overconfidence, leads us to hypothesize a partial mediating role of perceived difficulty on the relationship between task difficulty and overconfidence.

Previous studies have documented the influence of experience on overconfidence (Cassar, 2014; Hilary & Menzly, 2006; Menkhoff et al., 2013; Parker, 2013). As we mentioned, we hypothesize that experience decreases perceived difficulty which in turn decreases overconfidence. In consequence, we also hypothesize a
partial mediation of perceived difficulty on the effect of experience on overconfidence.

Overall, we expect perceived difficulty to decrease overconfidence (H1); we also expect that the significant antecedents of perceived difficulty will be actual task difficulty (H2), experience with the task (H3), and the framing of the task (H4). And, we expect task difficulty, and experience with the task to have an indirect effect on overconfidence through perceived difficulty (H5).

2.2 Experiments

We conducted two studies, both of which followed a similar design. In both studies we manipulated the framing and then asked participants to perform a 20-item task with items of varying levels of difficulty. In both studies we measured overconfidence and perceived difficulty on different stages of the experiments. This gives us the possibility to study the influence of perceived difficulty on overconfidence not only across different conditions of framing, but also across different levels of experience and item difficulty.

In study 1 we investigated the effect of perceived difficulty on overconfidence, and the effect of task difficulty, experience, and framing on perceived difficulty. Measures for overconfidence and perceived difficulty are adapted from previous experiments (Moore & Small, 2007; Seegers, van Putten, & de Brabander, 2002; Tsai, Klayman, & Hastie, 2008; Xiao et al., 2014).

Study 2 elaborates over study 1 and incorporates a new manipulation: feedback. Half the participants receive feedback after each item of the experiment, and the other half do not.
2.2.1 Study 1

a) Method

i) Participants

Participants were 62 working professionals who were completing a management degree at a private university. They were on average 31.97 years old, and 35.7% of participants were female. Participants were offered course credits for participating. Also, with the purpose to homogenize participants’ effort, participants were eligible to win a lottery for extra credits based on the accuracy of their predictions. The experiment lasted approximately 20 minutes.

ii) Design

The experiment had a 2 (easy framing vs. hard framing) x 20 (difficulty levels) x 20 (experience levels) mixed factorial design.

iii) Procedure

Each participant received by email an invitation to participate, which included a link that directed to a website that led them through the experiment\(^2\).

In order to manipulate participants’ perceived difficulty about the task, an introduction message providing framing for the task was delivered. Participants were randomly assigned to the two conditions of framing. Those on the hard framing condition received on their screens a message

\(^2\) The website was designed with the software Jspsych, which is commonly used to develop experiments for behavior research (de Leeuw, 2014).

\(^3\) Participants performed the experiment online. Pilot experiments were conducted in which participants performed the activities both online from their homes and in person from classrooms, and no substantial differences were observed.
that framed the task as hard. Those on the easy condition received on their screens a message that framed the task as easy.

After the manipulation, participants were asked to estimate their performance and to answer a questionnaire about their perception of difficulty, both related to the complete task they were about to perform.

Subsequently, all participants performed the same 20-item task. Twenty individual items were presented in a random order to each participant. In each item participants had 8 seconds to estimate the number of words in the given passage of text. The 20 items of the task were the same for each participant, and in consequence, the overall task difficulty was identical for the two groups. Still, the difficulty of each item and the order they were presented were not the same. After estimating the number of words of each item, participants had to answer a short questionnaire about perceived difficulty and expected performance for that particular item. Finally, participants were thanked and debriefed after they finished the 20 items of the task.

iv) Task

Based on previous research we used an estimation task, which has an objective criteria of correctness, but provides participants with little sense of how they have performed (Moore & Small, 2007). By doing this we reduced the importance of the order in which task items were presented. Also, as we prefer participants not to have previous experience with the task, we selected an uncommon task: estimating the number of words in a passage. As it was unlikely for participants to have prior expectations for their performance, the selected task allowed us to easily manipulate framing.
Each item consisted only on one passage. All passages were taken from the Spanish version of the book titled “The Little Prince” without modifications. In order to have a correct answer, the estimation had to be less than 50 words apart from the real number of words that the passage actually had. Passages had between 100 and 350 words, with an average of around 225 words. As mentioned before, participants had 8 seconds to look at each of these passages.

v) Independent Variables

- Experience

We consider experience as the number of items of the task a participant has performed at a certain moment. Hence, the value for experience can go from 1 to 20.

Given the design of our study, there are two types of variables. Some variables are at a participant level (level 1), and others are at an item level (level 2). Experience, as it varies between items, is a level 2 variable.

- Difficulty

We consider the total number of words in each passage as an objective measure of its difficulty. Since the acceptable margin for a correct answer decreases proportionally with the total number of words in the passage, we use this criteria to classify the passages with fewest words as easy and the passages with most words as hard. As we mentioned, items had passages of between 100 and 350 words, so the possible values of difficulty are between 100 and 350. Item difficulty is a level 2 variable (item level).
Framing

With the purpose of modifying the perception of difficulty about the task, we manipulate participants’ framing by giving them different information about the task they were about to perform. In order to give the impression that the task is either easy or difficult, both groups are provided the same message except for five words that are different.

Treatment text instructions can be translated as below. Sections in bold indicate words that differed across the two conditions. Participants also see such words in bold. The words in parenthesis are for the easy framing condition.

“Please read carefully the following instructions twice:
You will be required to perform an activity that you probably have never performed before.
The task consists in estimating as accurately as possible the number of words in a given text, which will appear on the screen. In total, there will be 20 passages taken from the book titled “The Little Prince”.
Given your profile as a class, it is expected that your ability to perform this task will be bad (good) compared to the rest of the population.
The human mind is able to estimate big amounts of data with a big (small) margin of error. Each question has been assigned one point, and to consider a question as correct an error margin of 50 words around the real number of words will be accepted, a number with which participants have obtained a low (high) amount of correct answers in previous studies.
Usually participants have 20 (5) seconds to look at each passage, but in this occasion you will have 8.

As additional information, which should help you to better estimate the difficulty of this activity, consider that in previous occasions participants have been highly surprised by the bad (good) results they obtained once they got to know their scores.”

We assign a value of 1 to framing for participants on the hard framing condition and a value of 0 to framing for those on the easy framing condition. Framing is constant during the experiment, hence, it is a level 1 variable (participant level).

vi) Mediator Variable

- Perceived difficulty

Perceived difficulty is measured after each item of the task with the question. “How do you consider the difficulty of estimating the number of words of the previous passage?” Which is answered as a 7 levels Likert scale, from very easy to very difficult. Perceived difficulty varies between items and in consequence it is a level 2 variable (item level).

vii) Dependent Variables

- Estimated performance

Estimated performance is measured after each item of the task with the question “From 0 to 100%, what are the chances that your answer will be on the range -50,+50 from the actual number of words in the previous passage?”. We use a scale with possible answers from 0% to 100%, in 1% increments, to measure the answer for this question. Estimated performance is relative to each item, so it is a level 2 variable.
- Actual performance

Actual performance is measured as binary accuracy variable, in which 0 means ‘miss’ and 1 means ‘hit’. More specifically, for each item, a score of 0 is assigned to participants whose answer is more than 50 words away from the actual number of words on the passage of such item, and 1 for participants whose answer is less than 50 words away from the actual number of words on the passage. Actual performance is relative to each item, so it is a level 2 variable.

- Overconfidence.

Following previous research on overconfidence (Fast et al., 2012; Klayman & Soll, 1999; Pulford & Colman, 1997), we calculate overconfidence as the difference between estimated performance and actual performance. Overconfidence is relative to each item, so it is a level 2 variable.

b) Results

i) Analytical Strategy

We chose to use multi-level modeling in order to analyze the data (Strohminger, Lewis, & Meyer, 2011; Waldman & Yammarino, 1999). In our experiment participants are nested in framing conditions. In consequence, some measures are between participants and others are within participants. Nested data violate the independence assumption required by traditional statistical techniques (Peugh, 2010).

Multilevel modelling allows to analyze data that have a hierarchical structure (Field, 2009). In other words, by using multi-level modeling, we make sure that the structure of our experiment is taken into consideration when determining the relationships between the different
variables. We also used Preacher and Hayes’ (2008) bootstrapping procedure to examine indirect effects.

ii) Manipulation check

As a manipulation check, we asked participants “How difficult you consider the task you are about to perform?” prior they started the task. We conducted an independent-samples $t$-test for the answer of such question between participants on the hard framing condition ($hf$) and those on the easy framing condition ($ef$). Results show a significant difference for hard framing ($M_{hf} = 4.8, SD_{hf} = 0.79$) and easy framing ($M_{ef} = 4.4, SD_{ef} = 0.75$) conditions; $t(60) = -1.95, p = 0.0282$. These results confirm that framing does have an effect on perceived difficulty and that the manipulation was successful.

iii) Hypothesis testing

- Influence of perceived difficulty on overconfidence.

We tested the influence of perceived difficulty on overconfidence (H1) through mixed-effect multi-level regression analysis with overconfidence as the dependent variable. Independent variables were difficulty, perceived difficulty, experience with the task and framing. We also included as an independent variable the second power of experience. Results from this regression are presented in Table 2-I.

Table 2-I: Mixed-effect multi-level regression for overconfidence. Ind. variables: difficulty, perceived difficulty, experience, framing, and experience x experience

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>.3277</td>
<td>$p = .009$</td>
</tr>
<tr>
<td>Level 1, trial specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item difficulty</td>
<td>.0015</td>
<td>$p &lt; .001$</td>
</tr>
</tbody>
</table>
Results from a variation of previous regression that do not include perceived difficulty are presented in Table 2-II.

Table 2-II: Mixed-effect multi-level regression for overconfidence. Ind. variables: difficulty, experience, framing, and experience x experience.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>.1749</td>
<td>p = .172</td>
</tr>
<tr>
<td>Level 1, trial specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item difficulty</td>
<td>.0014</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Experience</td>
<td>-.0140</td>
<td>p = .141</td>
</tr>
<tr>
<td>Experience x Experience</td>
<td>.0005</td>
<td>p = .263</td>
</tr>
<tr>
<td>Level 2, participant specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing</td>
<td>-.2009</td>
<td>p &lt; .001</td>
</tr>
</tbody>
</table>

The significant negative effect of perceived difficulty on overconfidence supports our hypothesis. Additionally, results show that item difficulty increases overconfidence.

Influence of item difficulty, experience and framing on perceived difficulty.

We tested the influence of item difficulty, experience and framing on perceived difficulty (H2, H3, and H4) also through mixed-effect multi-level regression analysis, but with perceived
difficulty as the dependent variable. Independent variables were item difficulty, experience with the task, and framing. We also included as an independent variable the second power of experience. Results of this regression are presented in Table 2-III.

Table 2-III: Mixed-effect multi-level regression for perceived difficulty. Ind. variables: difficulty, experience, framing, and experience x experience.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>3.7966</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td><strong>Level 1, trial specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item difficulty</td>
<td>.0031</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Experience</td>
<td>-.0563</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Experience x Experience</td>
<td>.0022</td>
<td>p = .001</td>
</tr>
<tr>
<td><strong>Level 2, participant specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing</td>
<td>.5314</td>
<td>p &lt; .007</td>
</tr>
</tbody>
</table>

The significant positive effect of item difficulty on perceived difficulty supports hypothesis 2. As expected, results show that when an item is more difficult, it tends to be perceived as such.

On the other hand, the significant negative effect of experience on perceived difficulty supports hypothesis 3. Results show that as participants increase their experience with the task, they tend to perceive it as easier. Also, the influence of the second power of experience on perceived difficulty indicates that after a certain point, the marginal influence of experience on perceived
difficulty diminishes. This relationship can be represented by equation 1, formulated with the coefficients from Table 2-III.

Equation 1: U shaped influence of Experience on Perceived difficulty

\[
\text{Perceived Difficulty} = 3.7907 - 0.0602 \times \text{Experience} + \text{Experience}^2 \times 0.0023 + \text{Framing} \times 0.5420
\]

Figure 2-2 below plots the equation 1 this U-shaped relationship (keeping all other variables constant).

![Perceived difficulty vs Experience](image)

**Figure 2-2: Influence of experience on perceived difficulty**

Finally, the significant positive effect of framing on perceived difficulty supports hypothesis 4. Results show that when participants are told that a task is difficult, they tend to perceive it as more difficult that when they are told the same task is easy.

Framing’s influence on perceived difficulty is significant despite the presence of experience in the regression. In order to test if framing’s influence on perceived difficulty is persistent after
participants finished the task, we asked them “How difficult did you find the task you just performed?” after the finished the task. An independent t-test for the answer of participants to such question between the two framing conditions was conducted. Results validate that the difference on perceived difficulty was persistent and significant even after participants completed the whole task ($M_{hf} = 5.94, SD_{hf} = 0.68$; $M_{hf} = 5.18, SD_{hf} = 0.96$; $t(60) = -3.62, p < 0.001$).

Mediating role of perceived difficulty on the influence of experience and difficulty on overconfidence.

In order to test the mediating role of perceived difficulty on the influence of both difficulty and experience on overconfidence (hypothesis 5), we conducted Preacher and Hayes’ (2008) bootstrapping analysis procedure to test the mediation effect of perceived difficulty on the effect that task difficulty and experience have on overconfidence.

Results show a partial mediation of perceived difficulty on the effect that difficulty has on overconfidence, as the 95% bias-corrected confidence interval for the indirect effect and for the direct effect did not include zero. Table 2-IV below show the results of the bootstrapping test.

Table 2-IV: Bootstrapping analysis: the mediation effect of perceived difficulty on the effect of task difficulty on overconfidence.

<table>
<thead>
<tr>
<th></th>
<th>Observed Coef.</th>
<th>Bias</th>
<th>Bootstrap Std. Err.</th>
<th>[95% Bias-corrected Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect effect</td>
<td>-.00022</td>
<td>2.83E-07</td>
<td>.00005</td>
<td>-.00034 - .00013</td>
</tr>
<tr>
<td>Direct effect</td>
<td>.00159</td>
<td>4.31E-06</td>
<td>.00018</td>
<td>.00122 - .00192</td>
</tr>
</tbody>
</table>
Finally, we were also able to prove a full mediation of perceived difficulty on the effect of experience on overconfidence. As the 95% bias-corrected confidence interval for the indirect effect did not included zero and the one for the direct effect did included zero. Table 2-V below show the results of the bootstrapping test.

Table 2-V: Bootstrapping analysis: the mediation effect of perceived difficulty on the effect of experience on overconfidence.

<table>
<thead>
<tr>
<th>Observed Coef.</th>
<th>Bias</th>
<th>Bootstrap Std. Err.</th>
<th>[95% Bias-corrected Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect effect</td>
<td>0.00054</td>
<td>-5.10E-06</td>
<td>0.00029</td>
</tr>
<tr>
<td></td>
<td>0.00128</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct effect</td>
<td>-0.00496</td>
<td>-0.00013</td>
<td>0.00252</td>
</tr>
<tr>
<td></td>
<td>-0.00971</td>
<td></td>
<td>0.00065</td>
</tr>
</tbody>
</table>

2.3 The Role of Feedback

Experience should help participants gain information about the task. Nonetheless experience by itself does not necessarily give concrete information about their actual performance. In consequence, a higher level of experience by itself does not grant more realistic expectations of own performance. A proof of this is the fact that experience has been found in previous studies to increase overconfidence (Menkhoff et al., 2013, 2006).

Feedback, on the other hand, if accurate, gives concrete information about both the task and the participant’s performance.

We believe, in line with the feedback-overconfidence literature (Arkes, Christensen, Lai, & Blumer, 1987; Russo & Schoemaker, 1992), that accurate information about actual performance helps participants adjust their expectations of performance to a more realistic ones. Prior research has found that feedback helps reduce overconfidence (Arkes et al., 1987; Russo & Schoemaker, 1992),
and as overconfidence is calculated as the difference between expected and actual performance, this means feedback helps achieve more realistic expectations of own performance.

Despite the known influence of feedback on overconfidence, little has been said on the influence of feedback on perceived difficulty. We hypothesize that feedback helps reach more realistic expectations of performance, at least partially by helping reach a more accurate perception of the task’s actual difficulty. To address this, we analyze the role of feedback in our proposed model.

First, we expect feedback to moderate the influence of framing on overconfidence. Feedback grants access to unbiased information about own performance on a certain task. Unbiased information of own performance will likely influence perceived difficulty. Stated differently, if such unbiased information is properly assimilated, it can replace previously conceived beliefs of task difficulty, acquired, for example, from framing. As framing influence overconfidence through perceived difficulty, we hypothesize that when feedback is available, the influence of framing on overconfidence will decrease. In other words, for participants on the hard framing condition, feedback should increase overconfidence; and for participants on the easy framing condition, feedback should decrease overconfidence.

Second, we believe that the first feedbacks received by participants will have a greater influence on perceived difficulty than posterior ones. Additional information helps update prior beliefs, but if those prior beliefs are not so different from the additional information, the update will not be so significant. In other words, when people with wrong beliefs receive feedback, this feedback will have a significant influence on perceived difficulty; however, when people have more accurate beliefs such influence will decrease and become marginal since feedback will add less new information. In concrete, we hypothesize the
interaction between experience and feedback has a non-linear influence on perceived difficulty.

Overall, we expect feedback to moderate the effect of framing on perceived difficulty (H6); we also expect the interaction between experience and feedback to have a non-linear, U-shaped, influence on overconfidence (H7).

2.3.1 Study 2

a) Method

i) Participants.
Participants were 160 working professionals who were completing a management degree at a private university. The mean age was 31.54 years and 37.8% of them were women. As in study 1, participants were offered course credits for participating and an extra bonus conditional on their performance.

ii) Design.
Experiment 2 had a 2 (easy framing vs. hard framing) x 2 (feedback vs. no feedback) x 20 (difficulty levels) x 20 (experience levels) mixed factorial design.

iii) Procedure.
As we mentioned before, study 2 is similar to study 1 except that study 2 contained feedback. Feedback was provided by displaying on participant’s screens, after they answer each item, the actual number of words the relevant passage had. Besides such difference, participants, task, questionnaires, and framing manipulation were the same than in study 1.
a) Results

i) Analytical Strategy

As in study 1, we used multi-level regressions and Preacher and Hayes’ bootstrapping method to analyze the data (Strohminger et al., 2011; Waldman & Yammarino, 1999; Preacher & Hayes, 2008).

ii) Manipulation check

Analog to study 1, as a manipulation check we asked participants “How difficult you consider the task you are about to perform?” prior to participants started the task. We conducted an independent-samples t-test for the answer of such question between participants on the hard framing condition (hf) and those on the easy framing condition (ef).

Manipulation was successful both for the participants on the non-feedback condition and for those on the feedback condition. For participants on the non-feedback condition, results show a significant difference between hard framing ($M_{hf} = 5.1, SD_{hf} = 0.94$) and easy framing ($M_{ef} = 4.4, SD_{ef} = 1.04$) conditions; $t(76) = −3.14, p = 0.001$. These results validate that the framing manipulation was successful for the no feedback condition. For participants on the feedback condition, results also show a significant difference in the perceived difficulty for hard framing ($M_{hf} = 4.8, SD_{hf} = 0.81$) and easy framing ($M_{ef} = 4.5, SD_{ef} = 0.99$) conditions; $t(76) = −1.72, p = 0.05$.

iii) Hypothesis testing

- Influence of perceived difficulty on overconfidence.

We tested again the influence of perceived difficulty on overconfidence (H1) through mixed-effect multi-level regression
analysis with overconfidence as the dependent variable. Independent variables were difficulty, perceived difficulty, experience, the second power of experience, framing, and feedback. Results from this regression are presented in Table 2-VI.

Table 2-VI: Mixed-effect multi-level regression for overconfidence. Ind. variables: difficulty, perceived difficulty, experience, framing, feedback, and experience x experience.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>.1187</td>
<td>p = .125</td>
</tr>
<tr>
<td>Level 1, trial specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item difficulty</td>
<td>.0019</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Item perceived difficulty</td>
<td>-.0588</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Experience</td>
<td>-.0227</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Experience x Experience</td>
<td>.0001</td>
<td>p = .006</td>
</tr>
<tr>
<td>Level 2, participant specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing</td>
<td>-.0294</td>
<td>p = .359</td>
</tr>
<tr>
<td>Feedback</td>
<td>-.1534</td>
<td>p &lt; .001</td>
</tr>
</tbody>
</table>

Results from a variation of previous regression that do not include perceived difficulty are presented in Table 2-VII.

Table 2-VII: Mixed-effect multi-level regression for overconfidence. Ind. variables: difficulty, experience, framing, feedback, and experience x experience.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-.1418</td>
<td>p = .037</td>
</tr>
<tr>
<td>Level 1, trial specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item difficulty</td>
<td>.0018</td>
<td>p &lt; .001</td>
</tr>
</tbody>
</table>
As in study 1, the significant negative effect of perceived difficulty on overconfidence supports our hypothesis that perceived difficulty influences overconfidence.

Influence of feedback, experience, item difficulty and framing on perceived difficulty.

In order to test the influence of feedback on perceived difficulty, and to test again the influence of item difficulty, experience and framing on perceived difficulty (H2, H3, and H4), we conducted a mixed-effect multi-level regression analysis, with perceived difficulty as the dependent variable. Independent variables were difficulty, experience, feedback and framing. We also included the second power of experience as an independent variable. Results of this regression are presented in Table 2-VIII.

Table 2-VIII: Mixed-effect multi-level regression for perceived difficulty. Ind. variables: difficulty, experience, framing, feedback and experience x experience.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>4.2704</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Level 1, trial specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item difficulty</td>
<td>.0027</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Experience</td>
<td>-.0676</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Experience x Experience</td>
<td>.0021</td>
<td>p &lt; .001</td>
</tr>
</tbody>
</table>
Level 2, participant specific

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Framing</td>
<td>.3757</td>
<td>.008</td>
</tr>
<tr>
<td>Feedback</td>
<td>-.3743</td>
<td>.008</td>
</tr>
</tbody>
</table>

In line with H2, H3 and H4, and with results from study 1, we also find that item difficulty, framing and experience have a significant influence on perceived difficulty.

Results also show, in line with hypothesis 6, that the effect of feedback is of opposite sign and relatively the same magnitude that the effect of framing on perceived difficulty. In other words, feedback seems to counteract the influence of framing on perceived difficulty.

- Moderating effect of feedback on influence of framing on perceived difficulty.

In order to test the moderating effect of feedback on the influence of framing on perceived difficulty (H6), we conducted a mixed-effect multi-level regression analysis, with perceived difficulty as the dependent variable. Independent variables were difficulty, experience, feedback and framing. We also included the second power of experience, the interaction between experience and framing, the interaction between feedback and framing, the first and second grade interactions between experience and feedback, and the triple interaction between feedback, experience and feedback as independent variables. Results of this regression are presented in Table 2-IX.

Table 2-IX: Mixed-effect multi-level regression for perceived difficulty. Ind. variables: difficulty, experience, framing, feedback, experience x experience, experience x
feedback, feedback x experience x experience, feedback x framing, experience x framing, and feedback x experience x framing.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>3.7526</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td><strong>Level 1, trial specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item difficulty</td>
<td>.0027</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Experience</td>
<td>-.0380</td>
<td>p = .017</td>
</tr>
<tr>
<td>Experience x Experience</td>
<td>.0010</td>
<td>p = .108</td>
</tr>
<tr>
<td><strong>Level 2, participant specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing</td>
<td>.7447</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Feedback</td>
<td>1.0931</td>
<td>p = .018</td>
</tr>
<tr>
<td>Interactions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback x Experience</td>
<td>-.0728</td>
<td>p = .001</td>
</tr>
<tr>
<td>Feedback x Experience$^2$</td>
<td>.0022</td>
<td>p = .008</td>
</tr>
<tr>
<td>Feedback x Experience x Framing</td>
<td>.0148</td>
<td>p = .085</td>
</tr>
<tr>
<td>Feedback x Framing</td>
<td>-.8376</td>
<td>p = .004</td>
</tr>
<tr>
<td>Experience x Framing</td>
<td>-.0027</td>
<td>p = .659</td>
</tr>
</tbody>
</table>

In order to illustrate the results of the previous regression, we plotted in Figure 2-3, perceived difficulty for the 4 treatment groups considering the coefficients from Table 2-IX. Equation 2, formulated with the coefficients form Table 2-IX, describe perceived difficulty for the different conditions:

Equation 2: $3.7526 + Experience x - .0380 + Framing x .7447 + Feedback x 1.0931 + Feedback x Experience x - .0728 + Feedback x Experience$ $^2$ x .0022 + Feedback x Experience x Framing x .0148 + Feedback x Framing x $- .8376$
Figure 2-3: Moderating influence of feedback on framing.

- Mediating role of perceived difficulty on the influence of experience and difficulty on overconfidence.

In order to corroborate the results obtained in study 1 regarding the mediation role of perceived difficulty on the influences of experience and difficulty on overconfidence (H5), we conducted Preacher and Hayes’ (2008) bootstrapping analysis procedure.

Similar to study 1, we were able to prove a partial mediation of perceived difficulty on the effect of difficulty on overconfidence, as the 95% bias-corrected confidence interval for the indirect effect and for the direct effect did not include zero. Table 2-X below show the results of the bootstrapping test.

Table 2-X: Bootstrapping analysis, the mediation effect of perceived difficulty on the effect of task difficulty on overconfidence.

<table>
<thead>
<tr>
<th>Perceived difficulty</th>
<th>Observed Coef.</th>
<th>Bias</th>
<th>Bootstrap Std. Err.</th>
<th>[95% Bias-corrected Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>easy framing, no feedback</td>
<td>3.5</td>
<td>3.7</td>
<td>3.9</td>
<td>4.1</td>
</tr>
<tr>
<td>hard framing, no feedback</td>
<td>3.5</td>
<td>3.7</td>
<td>3.9</td>
<td>4.1</td>
</tr>
<tr>
<td>easy framing, feedback</td>
<td>3.5</td>
<td>3.7</td>
<td>3.9</td>
<td>4.1</td>
</tr>
<tr>
<td>hard framing, feedback</td>
<td>3.5</td>
<td>3.7</td>
<td>3.9</td>
<td>4.1</td>
</tr>
</tbody>
</table>
Also similar to study 1, we were able to prove a partial mediation of perceived difficulty on the effect of experience on overconfidence, as the 95% bias-corrected confidence interval for the indirect effect and for the direct effect did not include zero. Table 2-XI below show the results of the bootstrapping test.

Table 2-XI: Bootstrapping analysis, the mediation effect of perceived difficulty on the effect of experience on overconfidence.

<table>
<thead>
<tr>
<th>Observed Coef.</th>
<th>Bias</th>
<th>Bootstrap Std. Err.</th>
<th>[95% Bias-corrected Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect effect</td>
<td>-.00018</td>
<td>-1.08E-06</td>
<td>2.76E-05</td>
</tr>
<tr>
<td>Direct effect</td>
<td>.00196</td>
<td>1.28E-06</td>
<td>1.01E-04</td>
</tr>
</tbody>
</table>

- Moderating role of experience on the influence of feedback on overconfidence.

We tested the moderating role of experience on the influence of feedback on overconfidence (H7) through mixed-effect multi-level regression analysis with overconfidence as dependent variable. Independent variables were difficulty, perceived difficulty, experience, framing, feedback, and the first and second grade interactions between experience and feedback. Results of this regression are presented in Table 2-XII.
Table 2-XII: Mixed-effect multi-level regression for overconfidence. Ind. variables: difficulty, perceived difficulty, experience, framing, feedback, experience x experience, feedback x experience and feedback x experience x experience.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>.0378</td>
<td>(p = .570)</td>
</tr>
<tr>
<td><strong>Level 1, trial specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item difficulty</td>
<td>.0019</td>
<td>(p &lt; .001)</td>
</tr>
<tr>
<td>Item perceived difficulty</td>
<td>-.0601</td>
<td>(p &lt; .001)</td>
</tr>
<tr>
<td>Experience</td>
<td>-.0064</td>
<td>(p = .442)</td>
</tr>
<tr>
<td>Experience x Experience</td>
<td>.0001</td>
<td>(p = .790)</td>
</tr>
<tr>
<td><strong>Level 2, participant specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing</td>
<td>-.0290</td>
<td>(p = .366)</td>
</tr>
<tr>
<td>Feedback</td>
<td>.0030</td>
<td>(p = .960)</td>
</tr>
<tr>
<td><strong>Interactions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback x Experience</td>
<td>-.0327</td>
<td>(p &lt; .005)</td>
</tr>
<tr>
<td>Feedback x Experience(^2)</td>
<td>.0013</td>
<td>(p &lt; .017)</td>
</tr>
</tbody>
</table>

Regarding H7, we find that the influence of feedback on overconfidence is moderated by experience. When participants have little experience with the task the negative effect of the first degree interaction between feedback and experience on overconfidence overruns the positive effect of the second degree interaction between feedback and experience on overconfidence. On the other hand, as experience increases, the positive effect of the second degree interaction grows bigger, and the marginal effect of feedback on overconfidence decreases. To illustrate this effect, Figure 2-4 below shows overconfidence estimated with the parameters of the first and second level interaction between feedback and experience, while keeping all other variables.
constant. Equation 3, formulated with the coefficients form Table 2-XII, describe overconfidence for the different conditions:

Equation 3: \(0.0378 + \text{Experience} \times -0.0064 + \text{Feedback} \times 0.003 + \text{Feedback} \times \text{Experience} \times -0.0327 + \text{Feedback} \times \text{Experience}^2 \times 0.0013 + \text{Experience}^2 \times 0.0001\)

Figure 2-4: Influence of the interaction between feedback and experience on overconfidence.

- Mediating role of perceived difficulty on the influence of the interaction between feedback and experience on overconfidence.

In order to test a possible mediation of perceived difficulty on the influence of the interaction between feedback and experience on overconfidence, we conducted Preacher and Hayes’ (2008) bootstrapping analysis procedure.

We were able to prove a partial mediation of perceived difficulty on the effect of the interaction of feedback and experience on
overconfidence, as the 95% bias-corrected confidence interval for the indirect effect and for the direct effect did not include zero.

Table 2-XIII below show the results of the bootstrapping test.

Table 2-XIII: Bootstrapping analysis: the mediation effect of perceived difficulty on the effect of the interaction between feedback and experience on overconfidence.

<table>
<thead>
<tr>
<th></th>
<th>Observed Coef.</th>
<th>Bias</th>
<th>Bootstrap Std. Err.</th>
<th>[95% Bias-corrected Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect effect</td>
<td>.00187</td>
<td>3.40E-06</td>
<td>.0003</td>
<td>.00128 - .00258</td>
</tr>
<tr>
<td>Direct effect</td>
<td>- .01251</td>
<td>-1.67E-05</td>
<td>.0014</td>
<td>-.01522 - -.00978</td>
</tr>
</tbody>
</table>
2.4 Discussion

This study examined the effect of perceived difficulty on overconfidence. The experiments showed that perceived difficulty not only predicts but also causes overconfidence. The two studies tested and confirmed that overconfidence depends on perceived difficulty, which in turn depends on experience, framing, and task difficulty. Perceived difficulty mediates the influence of experience on overconfidence and the influence of task difficulty on overconfidence.

When feedback is available, the influence of framing on perceived difficulty tends to disappear. Also, we find a second grade influence of the interaction between experience and feedback on overconfidence; when feedback is present and experience increases, overconfidence decreases, but up to a certain threshold of experience, after which overconfidence increases again.

2.4.1 Theoretical Contributions

a) On the role of difficulty in overconfidence.

By studying the influence of framing, task, experience and feedback, on perceived difficulty and overconfidence, our research helps to better understand the mechanisms that influence overconfidence. The findings advances the research on the hard-and-easy effect in overconfidence on many fronts. First, our results show the critical role of perceived difficulty in overconfidence research. Perceived difficulty influences overconfidence. Also, perceived difficulty depends not only on the task difficulty, but also framing and experience, which change perceived difficulty even when task difficulty is kept constant. Thus, perceived difficulty influences overconfidence above and beyond task difficulty does. Perceived difficulty mediates the effect of task difficulty on overconfidence. Consequently, the influence of task difficulty (Klayman & Soll, 1999; Moore & Cain, 2007) can be partially counteracted by modifying perceived difficulty, thus this research helps to understand why and how task difficulty influences estimated
performance and overconfidence. Even more interestingly, the effect of perceived difficulty on overconfidence is opposite to the direct effect of task difficulty on overconfidence. While a high task difficulty increases overconfidence, a high perceived difficulty decreases overconfidence. And while a low task difficulty decreases overconfidence, a low perceived difficulty increases overconfidence.

As a consequence, research on overconfidence needs to clearly differentiate task difficulty and perceived difficulty. This is important because previous studies on the “hard easy” effect had attributed results of perceived difficulty to task difficulty (cf. Rose and Windschitl, 2008). On their study, participants had the same chances of success on “easy” and “hard” tasks. Therefore, objective difficulty was the same for “easy” and “hard” tasks and in consequence, objective difficulty cannot explain their results. Moreover, our results can help explain why people exhibit different levels of overconfidence when performing the same task in the literatures (Anderson & Brion, 2012; Jakobsson, Levin, & Kotsadam, 2013; Lambert et al., 2012; Malmendier et al., 2011).

b) On the role of framing in overconfidence.

Our study shows that framing influences overconfidence through perceived difficulty. While the previous research has already found the effect of framing on overconfidence (Hügelschäfer & Achtziger, 2014; Johnson & Tversky, 1983), we help to uncover the mechanism of such effect by including perceived difficulty as a mediator. Moreover, our finding that feedback moderates the effect of framing on perceived difficulty gives important boundary conditions. In particular, when feedback is available, the effects of framing on perceived difficulty and subsequently on overconfidence disappear (Hügelschäfer & Achtziger, 2014; Johnson & Tversky, 1983).
c) On the role of experience in overconfidence.

Our results contribute in explaining how experience affects overconfidence. We show that the influence of experience on overconfidence is partially mediated by perceived difficulty. The mediation relationship helps us to better understand how experience influences overconfidence. Experience has a U-shaped influence on perceived difficulty, and as perceived difficulty partially. Up to certain point, experience decreases perceived difficulty and consequently increases overconfidence. This is in line with findings that investors and fund managers overconfidence is more pronounced with experience (Menkhoff et al., 2013, 2006). Nevertheless, after experience reaches a threshold, perceived difficulty increases, and thus, the mediation effect of experience on overconfidence through perceived difficulty decreases. This is highly relevant as shows that not all increase in experience carries the same effect on overconfidence. We extend previous literature by showing that adding experiences not always increase overconfidence (Gloede & Menkhoff, 2009; Lambert et al., 2012; Menkhoff et al., 2013, 2006). In fact, adding experiences to an already experienced individual tend to decrease overconfidence.

d) On the role of feedback in overconfidence.

While it is well-known that feedback reduces overconfidence (Pulford & Colman, 1997), we found that the effect of feedback on overconfidence is moderated by experience. The interaction between feedback and experience has a U-shaped influence on overconfidence. Feedback decreases overconfidence in the first few trials, but after a certain number of trials, additional feedback increases overconfidence. We extend previous literature by showing that adding feedback do not always reduce overconfidence (Arkes et al., 1987; Eberlein, Ludwig, & Nafziger, 2011; Pulford & Colman, 1997). In fact, form a certain threshold, more feedback tend to increase overconfidence.
2.4.2 Practical Implications

Managers and entrepreneurs should not forget how their ventures are perceived. Our research shows that perceived difficulty is as relevant as actual difficulty in overconfidence. Overconfidence is known as a driver for investors decisions (Chen, Kim, & Nofsinger, 2007; Chuang & Lee, 2006; Kliger & Levy, 2010). As overconfidence is influenced by perceived difficulty, entrepreneurs and managers should take into account how their business difficulty is perceived by possible investors.

Experience can increase overconfidence (Gloede & Menkhoff, 2009; Lambert et al., 2012; Menkhoff et al., 2013, 2006). From another point of view, experience can produce a mismatch between expected performance and actual performance. Our research shows that the influence of experience on perceived difficulty, and thus in overconfidence, is not linear but U-shaped. This means that there is a maximum mismatch between expected performance and actual performance that experience can originate. One path to correct such mismatch is by gaining more experience. In other words, a solution for experience generated overconfidence is additional experience.

Managers and entrepreneurs often hear from mentors, employees, and people in their network about the difficulty of different tasks. Current results show that framing a task as easy or difficult serves not only as an encouraging or warning note about the particular task, but may also change levels of overconfidence. Overconfidence can be a plus or a disadvantage (c.f. Anderson & Brion, 2012; Camerer & Lovallo, 1999; Ko & Huang, 2007), and framing provides an alternative option to alter the level of overconfidence.

Our research also have interesting practical implications on feedback. Feedback do not always contribute to decrease overconfidence. In fact, it can even contribute to increase it. Our study show than feedback is better than no feedback.
when the goal is to decrease overconfidence, but it also shows that there is an optimal amount of feedback to be provided in order to reduce overconfidence. And that there is a limit on how much feedback can decrease overconfidence.

2.4.3 Limitations and Future Work

One limitation of our study is that experience was not manipulated in the experiments. Thus, experience may not have been the only factor that changed through the realization of the experiments. For example, after a few trials, participant’s interest can have decreased, or participants’ concentration can have been lower. Consequently, we are able to prove the existing correlation between experience and perceived difficulty, but not the causality of such relationship. Therefore, in order to gain a better understanding of the influence of experience on perceived difficulty, it is important to further examine this issue in future studies.

Another limitation of our study is that as the experiments were performed online, we were not able to control for the engagement of participants. Some participants might have answered randomly just to conclude the task. Given the random assignment of participants on each group, the percentage of people doing so should be the same on each group, and so the obtained results are valid and significant. Nevertheless, the magnitude of the effects might have been affected by this behavior.

2.4.4 Conclusions

One of the basic questions for management researchers is how perception influences overconfidence. Building upon the literature of overconfidence and task difficulty, we proposed and tested the mediating role of perceived difficulty on the influence of task difficulty on overconfidence. Perceived difficulty plays a prominent role on overconfidence and it is not so closely related to difficulty, but
rather a complex variable, influenced, beside task difficulty, by framing, experience and feedback.

The fact that framing, experience and feedback can influence perceived difficulty and subsequently overconfidence gives new understanding of the causal mechanisms of overconfidence. Managerial decision-making does not happen in vacuum. There are multiple connections and non-linear relations between the different variables involved in the overconfidence process, and we believe the understanding of contextual and individual factors that lead to overconfidence can generate new directions of theoretical development.
REFERENCES


Gloede, O., & Menkhoff, L. 2009. Financial professionals’ overconfidence: Is it experience, job, or attitude?


Menkhoff, L., Schmidt, U., & Brozynski, T. 2006. The impact of experience on risk


Nicholls, J., & Miller, A. 1983. The differentiation of the concepts of difficulty and ability. *Child Development*.


Rai, R., Mitchell, P., Kadar, T., & Mackenzie, L. 2014. Adolescent Egocentrism and
the Illusion of Transparency: Are Adolescents as Egocentric as we Might Think?

*Current Psychology.*


Management Journal, 46(2): 139–149.


Wright, P. M., Hollenbeck, J. R., Wolf, S., & McMahan, G. C. 1995. The Effects of


APENDIX A: DEFINITIONS OF DIFFICULTY

In order to study the influence of difficulty on perceived difficulty, it is important to clearly define what difficulty is, so we can establish levels of difficulty of different tasks. The common definitions of difficulty are usually tautological, for example, difficult is something that is not easy to do or accomplish, or difficult is a task in which it is hard to succeed. In the literature we can find a few concepts as well, such as normative difficulty, objective difficulty and egocentric difficulty, each of which is measured in a different way.

Normative difficulty is related to performance. Task A is more difficult than task B when people perform in average worse in A than B, and so, the relative difficulty of two different tasks can be measured by comparing the performance of a reference group (Wright et al., 1995). However, the relationship between the difficulty of tasks A and B stablished by the performance of the reference group will only be valid for individuals or groups of individuals statistically similar to the ones of the reference group (Juslin, 1994).

Objective difficulty, in the other hand, is not directly related to performance, but to the characteristics and parameters of a task itself (Cheng et al., 2007; Diehl & Sterman, 1995). For example, if I ask someone to estimate the amount of words in a text with a 10% margin of error, it will be easier than to ask the same question but with a 5% margin of error. This allows to stablish a difference in the difficulty of two tasks independently of the people that is performing them. Yet, this concept has a problem too, it doesn’t allow to compare the difficulty of two tasks of a different nature, for example solving a math problem and writing an essay.

Egocentric difficulty is less commonly used in literature, and it is mostly used in child development (Müller, Seiler, Perren, & Simoni, 2015; Rai,
Mitchell, Kadar, & Mackenzie, 2014). According to this concept of difficulty tasks are discriminated on the basis of subjective certainty of being able to complete them. In other words, a task would be judged as difficult if one is certain of failure on it, and easy if success appear certain (Nicholls & Miller, 1983). We consider that this concept is more closely related to perceived difficulty than to the previous concepts of difficulty.

From these definitions, we choose to consider difficulty as objective difficulty. In other words, we consider difficulty as a characteristic of the task. This definition, contrasting normative difficulty, establishes a clear difference between difficulty and performance, which is highly relevant for the model, as it implies that difficulty is something that exist before performance, and thus, it can be perceived. Also, from an operational point of view, it allow us to vary the difficulty without having to test the task with a reference group every time, but just maintaining a similar format. Finally, we believe that this definition will help improve the understanding of the difference between difficulty, perceived difficulty and expected performance.
APENDIX B: ADDITIONAL EXPERIMENTS

Additional Experiment N°1

a) Method

i) Participants.

Participants were undergraduate students from engineering at Pontificia Universidad Catolica de Chile. In the first experiment participated 49 students with a mean age of 22.4 years and a percentage of women of 24.5%. Participants were offered course credits for participating and the possibility to receive a bonus if their answers were accurate.

ii) Design

Participants were randomly assigned into two different conditions of perceived difficulty. Dependent variables were overconfidence, and perceived difficulty. In order to isolate the effect of perceived difficulty, all participants performed the same task.

iii) Procedure

The experiment was run as a pen-and-paper study. We measured overconfidence after participants completed the task.

We divided participants randomly in two groups, and separated them into two different rooms. In order to manipulate participants’ perceived difficulty about the task, a verbal message providing framing for the task was delivered. Participants were randomly assigned to the two conditions of framing. Those on the hard framing condition received a message that framed the task as hard. Those on the easy condition received a message that framed the task as easy.
Subsequently, all participants performed the same 10-item task. Ten individual items were presented in the same order to each participant. In each item participants had 8 seconds to estimate the number of words in the given passage of text. The 10 items of the task were the same for each participant, and in consequence, the overall task difficulty was identical for the two groups. After completing the task, participants were asked to estimate their performance on the complete task they had performed. Finally, participants were thanked and debriefed after they finished the 10 items of the task.

iv) Task

Based on previous research we used an estimation task, which has an objective criteria of correctness, but provides participants with little sense of how they have performed (Moore & Small, 2007). By doing this we reduced the importance of the order in which task items were presented. Also, as we prefer participants not to have previous experience with the task, we selected an uncommon task: estimating the number of words in a passage. As it was unlikely for participants to have prior expectations for their performance, the selected task allowed us to easily manipulate framing.

Each item consisted only on one passage. All passages were taken from the Spanish version of the book titled “The Little Prince” without modifications. In order to have a correct answer, the estimation had to be less than 10 words apart from the real number of words that the passage actually had. The texts had between 100 and 316 words, with a standard deviation of 64.6 words. As mentioned before, participants had 8 seconds to look at each of these passages.
v) Independent Variables

- Framing

With the purpose of modifying the perception of difficulty about the task, we manipulate participants’ framing by giving them different information about the task they were about to perform. In order to give the impression that the task is either easy or difficult, we verbally describe the task as easy for one group and as hard for the other. One group received messages like “usually participants do well in this kind of task” or “in general participants have only 5 seconds to answer but you will have 8”. The other group received messages like “usually participants do badly in this kind of task” or “in general participants have 15 seconds to answer but you will have just 8”.

vi) Dependent Variables

- Estimated performance

Estimated performance is measured after the complete task with the question “How many items do you think you will have right?”. We use a scale with possible answers from 0 to 10 to measure the answer for this question.

- Actual performance

Actual performance is measured as the number of items each participant got right. More specifically, for each item, a score of 0 is assigned to participants whose answer is more than 10 words away from the actual number of words on the passage of such item, and 1 for participants whose answer is less than 10 words away from the actual number of words on the passage.
Overconfidence.

Following previous research (Moore & Small, 2007), we calculate overconfidence as the difference between estimated performance and actual performance.

b) Results

We conducted an independent-samples *t*-test for overconfidence between participants on the hard framing condition (*hf*) and those on the easy framing condition (*ef*). Results show no significant difference between hard framing (*M*$_{hf}$ = −1.04, *SD*$_{hf}$ = 7.43) and easy framing (*M*$_{ef}$ = −0.92, *SD*$_{ef}$ = 12.74) conditions; *t*(45) = −0.13, *p* = 0.4468. These results are probably cause of a bad framing manipulation.
Additional Experiment N°2

a) Method

i) Participants

Participants were undergraduate students from engineering at Pontificia Universidad Católica de Chile. In the first experiment participated 64 students with a mean age of 22.8 years and a percentage of women of 21.9%. Participants were offered course credits for participating and the possibility to receive a bonus if they answers were accurate.

ii) Design

Participants were randomly assigned into two different conditions of perceived difficulty. Dependent variables were overconfidence, and perceived difficulty. In order to isolate the effect of perceived difficulty, all participants performed the same task.

iii) Procedure

The experiment was run as a pen-and-paper study, with measures of perceived difficulty and overconfidence both before and after participants completing the task.

As context can influence perceived difficulty, we intended to maintain it constant for the two groups, so we kept all of them in the same room. This way context was, on average, the same for both groups.

In order to manipulate participants’ perceived difficulty about the task, a written message providing framing for the task was delivered. Participants were randomly assigned to the two conditions of framing. Those on the hard framing condition received a message that framed the task as hard. Those on the easy condition received a message that framed the task as easy.
After the manipulation, participants were asked to estimate their performance and to answer a questionnaire about their perception of difficulty, both related to the complete task they were about to perform.

Subsequently, all participants performed the same 10-item task. Ten individual items were presented in the same order to each participant. In each item participants had 8 seconds to estimate the number of words in the given passage of text. The 10 items of the task were the same for each participant, and in consequence, the overall task difficulty was identical for the two groups. After completing the task, participants were asked to estimate their performance and to answer a questionnaire about their perception of difficulty, both related to the complete task they had performed. Finally, participants were thanked and debriefed after they finished the 20 items of the task.

iv) Task

Based on previous research we used an estimation task, which has an objective criteria of correctness, but provides participants with little sense of how they have performed (Moore & Small, 2007). By doing this we reduced the importance of the order in which task items were presented. Also, as we prefer participants not to have previous experience with the task, we selected an uncommon task: estimating the number of words in a passage. As it was unlikely for participants to have prior expectations for their performance, the selected task allowed us to easily manipulate framing.

Each item consisted only on one passage. All passages were taken from the Spanish version of the book titled “The Little Prince” without modifications. In order to have a correct answer, the estimation had to be less than 10 words apart from the real number of words that the passage actually had. The texts had between 100 and 316 words, with a standard
deviation of 64.6 words. As mentioned before, participants had 8 seconds to look at each of these passages.

v) Independent Variables

- Framing

With the purpose of modifying the perception of difficulty about the task, we manipulate participants’ framing by giving them different information about the task they were about to perform. In order to give the impression that the task is either easy or difficult, both groups are provided the same message except for five words that are different.

Treatment text instructions can be translated as below. Sections in bold indicate words that differed across the two conditions. Participants also see such words in bold. The words in parenthesis are for the easy framing condition.

“Please read carefully the following instructions twice:
You will be required to perform an activity that you probably have never performed before.
The task consists in estimating as accurately as possible the number of words in a given text, which will appear on the screen. In total, there will be 20 passages taken from the book titled “The Little Prince”.
Given your profile as a class, it is expected that your ability to perform this task will be bad (good) compared to the rest of the population.
The human mind is able to estimate big amounts of data with a big (small) margin of error. Each question has been assigned one point, and to consider a question as correct an error margin
of 25 words around the real number of words will be accepted, a number with which participants have obtained a low (high) amount of correct answers in previous studies.

Usually participants have 20 (5) seconds to look at each passage, but in this occasion you will have 8.

As additional information, which should help you to better estimate the difficulty of this activity, consider that in previous occasions participants have been highly surprised by the bad (good) results they obtained once they got to know their scores.”

vi) Mediator Variable

- Perceived difficulty

Perceived difficulty is measured both before and after the complete task with the question “How do you consider the difficulty of the task you will (had to) perform?” Which is answered as a 7 levels Likert scale, from very easy to very difficult.

vii) Dependent Variables

- Estimated performance

Estimated performance is measured both before and after the complete task with the question “How many items do you think you will have right?”. We use a scale with possible answers from 0 to 10 to measure the answer for this question.

- Actual performance

Actual performance is measured as the number of items each participant got right. More specifically, for each item, a score of 0 is assigned to participants whose answer is more than 10 words away from the actual number of words on the passage of such
item, and 1 for participants whose answer is less than 10 words away from the actual number of words on the passage.

- Overconfidence

Following previous research on overconfidence (Fast et al., 2012; Klayman & Soll, 1999; Pulford & Colman, 1997), we calculate overconfidence as the difference between estimated performance and actual performance.

b) Results

The two groups doesn’t present significant differences in terms of age, gender or self-stem.

The first step is to determine if the manipulation on perceived difficulty was successful, and if its effect lasted after the participants performed the task. Analyzing perceived difficulty before and after the participants performing the task, we can see in the image that the stimulus produced a difference in the perception between the two groups, and that this difference remained even after performing the task.
Figure 3-1: Perceived difficulty before and after the task.

On average all participants changed their perceptions after performing the task, as it was expected because the object of perception is important in Perception Theory. And although the difference in perception was reduced between the two groups, there is a clear effect of the description of the task changing their beliefs. The same effect can be seen by looking at the expected results for oneself and others before and after performing the task. And also, we can see there is a correlation between perceived difficulty and expected scores.
On the other hand, the average score of the two groups is not significantly different. Since the task they were performing was the same, and they present only small differences in their level of motivation, this is the result we were expecting.

Considering Overconfidence as the difference of perceived score and actual score (this apply to both oneself and average scores), it is expectable analyzing the previous results that both groups will present a difference in their level of overconfidence (the expected scores are different, but on average their scores are the same).

Both overestimation and overplacement between the two groups are significantly different and in the direction that was expected. In other words, the easy task perception group had on average more overestimation and more overplacement than the difficult perception group. The levels of overconfidence indicates that the hard group difficulty perception of the task is more accurate than the one of the easy group, this can be seen in the next image.
As we define overestimation as the difference between the expected score for oneself and the actual score, and those two are influenced by perception of difficulty and actual difficulty, and using a proxy of actual difficulty with the score obtained by the participants in the task, we can see that a regression of the score and perception as explicative variables is a better predictor of overconfidence than one that only considers the score. This implies that when trying to identify tasks or ventures in which people will have higher levels of overconfidence, one should try to identify both difficulty and perceived difficulty of the people about that task.

Moore and Healy found in 2008 a strange relationship between the expected scores of oneself and others depending on the difficulty of a task (Moore & Healy, 2008). Their founding can be summarized in Figure 3-4.

Figure 3-3: Overestimation and overplacement.

![Figure 3-3: Overestimation and overplacement.](image-url)
Figure 3-4 show that there is a systematic difference in the appreciation of oneself and others sore depending on the task difficulty. We are able to replicate the relationship founded by Moore and Healy between expectative and score, but with perception instead of score, and it was done both before and after the participants performing the task.
As we said before, we believe that the difficulty of a task will mediate the perceived difficulty, but it’s not the only factor that influences it, as for example, a different description of the task. And as in this experiment all participants had to do the same task, we are certain about this point.
Additional Experiment N°3

a) Method

i) Participants

Participants were 37 undergraduate students. They were on average 22.97 years old, and 22.7% of participants were female. Participants were offered course credits for participating. Also, with the purpose to homogenize participants’ effort, participants were eligible to win a lottery for extra credits based on the accuracy of their predictions. The experiment lasted approximately 20 minutes.

ii) Design

The experiment had a 2 (easy framing vs. hard framing) x 20 (difficulty levels) x 20 (experience levels) mixed factorial design.

iii) Procedure

The experiment was run in computers. All 37 participants went to the same room for the experiment. When participants arrived, they were thanked and asked to sit down. Afterwards, they were told to initiate the experiment through a website previously designed with the software Jspsych (de Leeuw, 2014). In order to manipulate participants’ perceived difficulty about the task, an introduction message providing framing for the task was delivered. Participants were randomly assigned to the two conditions of framing. Those on the hard framing condition received on their screens a message

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4 The website was designed with the software Jspsych, which is commonly used to develop experiments for behavior research (de Leeuw, 2014).
5 Participants performed the experiment online. Pilot experiments were conducted in which participants performed the activities both online from their homes and in person from classrooms, and no substantial differences were observed.
that framed the task as hard. Those on the easy condition received on their screens a message that framed the task as easy.

After the manipulation, participants were asked to estimate their performance and to answer a questionnaire about their perception of difficulty, both related to the complete task they were about to perform.

Subsequently, all participants performed the same 20-item task. Twenty individual items were presented in a random order to each participant. In each item participants had 8 seconds to estimate the number of words in the given passage of text. The 20 items of the task were the same for each participant, and in consequence, the overall task difficulty was identical for the two groups. Still, the difficulty of each item and the order they were presented were not the same. After estimating the number of words of each item, participants had to answer a short questionnaire about perceived difficulty and expected performance for that particular item. Finally, participants were thanked and debriefed after they finished the 20 items of the task.

iv) Task

Based on previous research we used an estimation task, which has an objective criteria of correctness, but provides participants with little sense of how they have performed (Moore & Small, 2007). By doing this we reduced the importance of the order in which task items were presented. Also, as we prefer participants not to have previous experience with the task, we selected an uncommon task: estimating the number of words in a passage. As it was unlikely for participants to have prior expectations for their performance, the selected task allowed us to easily manipulate framing.
Each item consisted only on one passage. All passages were taken from the Spanish version of the book titled “The Little Prince” without modifications. In order to have a correct answer, the estimation had to be less than 25 words apart from the real number of words that the passage actually had. The texts had between 100 and 316 words, with a standard deviation of 64.6 words. As mentioned before, participants had 8 seconds to look at each of these passages.

v) Independent Variables

- Experience

We consider experience as the number of items of the task a participant has performed at a certain moment. Hence, the value for experience can go from 1 to 20.

Given the design of our study, there are two types of variables. Some variables are at a participant level (level 1), and others are at an item level (level 2). Experience, as it varies between items, is a level 2 variable.

- Difficulty

We consider the total number of words in each passage as an objective measure of its difficulty. Since the acceptable margin for a correct answer decreases proportionally with the total number of words in the passage, we use this criteria to classify the passages with fewest words as easy and the passages with most words as hard. As we mentioned, items had passages of between 100 and 350 words, so the possible values of difficulty are between 100 and 350. Item difficulty is a level 2 variable (item level).
- Framing

With the purpose of modifying the perception of difficulty about the task, we manipulate participants’ framing by giving them different information about the task they were about to perform. In order to give the impression that the task is either easy or difficult, both groups are provided the same message except for five words that are different.

Treatment text instructions can be translated as below. Sections in bold indicate words that differed across the two conditions. Participants also see such words in bold. The words in parenthesis are for the easy framing condition.

“Please read carefully the following instructions twice:
You will be required to perform an activity that you probably have never performed before.
The task consists in estimating as accurately as possible the number of words in a given text, which will appear on the screen. In total, there will be 20 passages taken from the book titled “The Little Prince”.
Given your profile as a class, it is expected that your ability to perform this task will be bad (good) compared to the rest of the population.
The human mind is able to estimate big amounts of data with a big (small) margin of error. Each question has been assigned one point, and to consider a question as correct an error margin of 25 words around the real number of words will be accepted, a number with which participants have obtained a low (high) amount of correct answers in previous studies.
Usually participants have 20 (5) seconds to look at each passage, but in this occasion you will have 8.

As additional information, which should help you to better estimate the difficulty of this activity, consider that in previous occasions participants have been highly surprised by the bad (good) results they obtained once they got to know their scores.”

We assign a value of 1 to framing for participants on the hard framing condition and a value of 0 to framing for those on the easy framing condition. Framing is constant during the experiment, hence, it is a level 1 variable (participant level).

vi) Mediator Variable
- Perceived difficulty

Perceived difficulty is measured after each item of the task with the question “How do you consider the difficulty of estimating the number of words of the previous passage?”. Which is answered as a 7 levels Likert scale, from very easy to very difficult. Perceived difficulty varies between items and in consequence it is a level 2 variable (item level).

vii) Dependent Variables
- Estimated performance

Estimated performance is measured after each item of the task with the question “From 0 to 100%, what are the chances that your answer will be on the range -25,+25 from the actual number of words in the previous passage?”. We use a scale with possible answers from 0% to 100%, in 1% increments, to measure the answer for this question. Estimated performance is relative to each item, so it is a level 2 variable.
- Actual performance

Actual performance is measured as binary accuracy variable, in which 0 means ‘miss’ and 1 means ‘hit’. More specifically, for each item, a score of 0 is assigned to participants whose answer is more than 25 words away from the actual number of words on the passage of such item, and 1 for participants whose answer is less than 25 words away from the actual number of words on the passage. Actual performance is relative to each item, so it is a level 2 variable.

- Overconfidence

Following previous research on overconfidence (Fast et al., 2012; Klayman & Soll, 1999; Pulford & Colman, 1997), we calculate overconfidence as the difference between estimated performance and actual performance. Overconfidence is relative to each item, so it is a level 2 variable.

b) Results

The two groups do not present significant differences in terms of age or gender. First we conducted a T test for manipulation check, and we find a significant higher perceived difficulty for the hard treatment participants (p = 0.047). The effect of the manipulation is also significant when the participants were performing the task (p < 0.01) and it lasted after they finished the task (p < 0.01).
Figure 3-6: Perceived difficulty before, during and after the task.

In the same sense, the expected results of the participants are significantly higher for the ones in the easy treatment than for the ones in the hard treatment in all the measures: before the task (p < 0.01), during the task (p < 0.01) and after the task (p = 0.0267).

As expected, and similar to the results of Additional experiment N°2, overestimation is significantly higher (p = 0.0416) for the participants in the easy perception treatment (M=3.85, SD= 2.64) than for the participants in the hard perception treatment (M=2.23, SD= 2.86).

Despite the difference in perceived difficulty produced by the stimulus, there is a significant difference in the perceived difficulty of the two easiest and the two most difficult tasks. We used the total amount of words as a proxy of difficulty, where more words in a text would make it more difficult, as the acceptable margin is proportionally smaller. There is a significant difference in the scores obtained in the “easy” tasks (average 0.2824) and the “difficult” tasks (average 0.162).
We conducted a 2x2 ANOVA analysis with difficulty and treatment as independent variables. Both variables included two levels, easy and difficult for difficulty and easy perception and hard perception for perceived difficulty. All effects were statistically significant at the .05 significance level, except for the interaction effect. The main effect for task difficulty yielded an F ratio of $F(1,144) = 5.64, p = 0.018$ and the effect for treatment yielded an F ratio of $F(1,144) = 23.67, p < 0.01$. As expected, difficult tasks are perceived as significantly more difficult than easy task, and thus, task difficulty is relevant in determining perceived difficulty.

![Perceived difficulty graph](image)

**Figure 3-7: Perceived difficulty on easy and hard tasks.**

In order to identify if perceived difficulty changed with more experience in the task, we measured the perceived difficulty in the first three texts and in the last three texts for both groups. We conducted a 2x2 ANOVA analysis with “experience” and treatment as independent variables. Both variables included two levels, firsts and lasts questions for “experience” and easy perception and hard perception for the treatment. All effects were statistically significant at the
.05 significance level, except for the interaction effect. The main effect for “experience” yielded an F ratio of $F(1,218) = 13.14, p < 0.01$ and the effect for treatment yielded an F ratio of $F(1,218) = 6.33, p = 0.0126$. We found that when people have more experience in the task, they perceive it as significantly less difficult, even though nor the experience nor the treatment have a significant effect on score: easy perception treatment firsts’ questions (M=0.288, SD=0.208), easy perception treatment lasts’ questions (M=0.233, SD=0.181), hard perception treatment firsts’ questions (M=0.254, SD=0.194), hard perception treatment lasts’ questions (M=0.294, SD=0.211).
Additional Experiment N°4

a) Method

i) Participants

Participants were 48 working professionals who were completing a management degree at a private university. They were on average 32.53 years old, and 34.4% of participants were female. Participants were offered course credits for participating. Also, with the purpose to homogenize participants’ effort, participants were eligible to win a lottery for extra credits based on the accuracy of their predictions. The experiment lasted approximately 20 minutes.

ii) Design

The experiment had a 2 (easy framing vs. hard framing) x 20 (difficulty levels) x 20 (experience levels) mixed factorial design.

iii) Procedure

Each participant received by email an invitation to participate, which included a link that directed to a website that led them through the experiment.\(^6\)

In order to manipulate participants’ perceived difficulty about the task, an introduction message providing framing for the task was delivered. Participants were randomly assigned to the two conditions of framing. Those on the hard framing condition received on their screens a message

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\(^6\) The website was designed with the software Jspsych, which is commonly used to develop experiments for behavior research (de Leeuw, 2014).

\(^7\) Participants performed the experiment online. Pilot experiments were conducted in which participants performed the activities both online from their homes and in person from classrooms, and no substantial differences were observed.
that framed the task as hard. Those on the easy condition received on their screens a message that framed the task as easy.

After the manipulation, participants were asked to estimate their performance and to answer a questionnaire about their perception of difficulty, both related to the complete task they were about to perform.

Subsequently, all participants performed the same 20-item task. Twenty individual items were presented in a random order to each participant. In each item participants had 8 seconds to estimate value of a time series on a specific time in the future. The 20 items of the task were the same for each participant, and in consequence, the overall task difficulty was identical for the two groups. Still, the difficulty of each item and the order they were presented were not the same. After estimating the value of the series of each item, participants had to answer a short questionnaire about perceived difficulty and expected performance for that particular item. Finally, participants were thanked and debriefed after they finished the 20 items of the task.

iv) Task

Based on previous research we used an estimation task, which has an objective criteria of correctness, but provides participants with little sense of how they have performed (Moore & Small, 2007). By doing this we reduced the importance of the order in which task items were presented. Also, as we prefer participants not to have previous experience with the task, we selected an uncommon task: estimating value of a time series in a specific time in the future. As it was unlikely for participants to have prior expectations for their performance, the selected task allowed us to easily manipulate framing.
Each item consisted only on one time series. All time series are random samples of a random walk with an initial value of 100 and a standard deviation of 1.2. In order to have a correct answer, the estimation had to be less than 50 units apart from the real value of the time series in the specified time. As mentioned before, participants had 8 seconds to look at each of these passages.

v) Independent Variables

- Experience

We consider experience as the number of items of the task a participant has performed at a certain moment. Hence, the value for experience can go from 1 to 20.

Given the design of our study, there are two types of variables. Some variables are at a participant level (level 1), and others are at an item level (level 2). Experience, as it varies between items, is a level 2 variable.

- Difficulty

We consider the time of the prediction as an objective measure of its difficulty. Since more iterations have passed, the possible values of the series have a broader distribution. We use this criteria to classify the items with shortest time frame as easy and the time series with the longest time frames as hard. Item difficulty is a level 2 variable (item level).

- Framing

With the purpose of modifying the perception of difficulty about the task, we manipulate participants’ framing by giving them different information about the task they were about to perform. In order to give the impression that the task is either easy or
difficult, both groups are provided the same message except for five words that are different.

Treatment text instructions can be translated as below. Sections in bold indicate words that differed across the two conditions. Participants also see such words in bold. The words in parenthesis are for the easy framing condition.

“Please read carefully the following instructions twice:
You will be required to perform an activity that you probably have never performed before.
The task consists in estimating as accurately as possible the value of a time series in an specific time in the future. Time series will appear on the screen. In total, there will be 20 time series.
Given your profile as a class, it is expected that your ability to perform this task will be bad (good) compared to the rest of the population.
The human mind is able to estimate big amounts of data with a big (small) margin of error. Each question has been assigned one point, and to consider a question as correct an error margin of 50 around the real value of the time series in the specified time will be accepted, a number with which participants have obtained a low (high) amount of correct answers in previous studies.
Usually participants have 20 (5) seconds to look at each series, but in this occasion you will have 8.
As additional information, which should help you to better estimate the difficulty of this activity, consider that in previous occasions participants have been highly surprised by the bad (good) results they obtained once they got to know their scores.”
We assign a value of 1 to framing for participants on the hard framing condition and a value of 0 to framing for those on the easy framing condition. Framing is constant during the experiment, hence, it is a level 1 variable (participant level).

vi) Mediator Variable
- Perceived difficulty

Perceived difficulty is measured after each item of the task with the question. “How do you consider the difficulty of estimating the number of words of the previous passage?” Which is answered as a 7 levels Likert scale, from very easy to very difficult. Perceived difficulty varies between items and in consequence it is a level 2 variable (item level).

vii) Dependent Variables
- Estimated performance

Estimated performance is measured after each item of the task with the question “From 0 to 100%, what are the chances that your answer will be on the range -50,+50 from the actual number value of the time series in the specified time?”. We use a scale with possible answers from 0% to 100%, in 1% increments, to measure the answer for this question. Estimated performance is relative to each item, so it is a level 2 variable.

- Actual performance

Actual performance is measured as binary accuracy variable, in which 0 means ‘miss’ and 1 means ‘hit’. More specifically, for each item, a score of 0 is assigned to participants whose answer is more than 50 away from the actual value of the time series in the specified time of such item, and 1 for participants whose
answer is less than 50 away from the actual value of the time series in the specified time. Actual performance is relative to each item, so it is a level 2 variable.  

- Overconfidence

Following previous research on overconfidence (Fast et al., 2012; Klayman & Soll, 1999; Pulford & Colman, 1997), we calculate overconfidence as the difference between estimated performance and actual performance. Overconfidence is relative to each item, so it is a level 2 variable.

b) Results

i) Analytical Strategy

We chose to use multi-level modeling in order to analyze the data (Strohminger et al., 2011; Waldman & Yammarino, 1999). In our experiment participants are nested in framing conditions. In consequence, some measures are between participants and others are within participants. Nested data violate the independence assumption required by traditional statistical techniques (Peugh, 2010).

Multilevel modelling allows to analyze data that have a hierarchical structure (Field, 2009). In other words, by using multi-level modeling, we make sure that the structure of our experiment is taken into consideration when determining the relationships between the different variables. We also used Preacher and Hayes’ (2008) bootstrapping procedure to examine indirect effects.

ii) Manipulation check

As a manipulation check, we asked participants “How difficult you consider the task you are about to perform?” prior they started the task. We conducted an independent-samples t-test for the answer of such
question between participants on the hard framing condition \((hf)\) and those on the easy framing condition \((ef)\). Results show a significant difference for hard framing \((M_{hf} = 5, SD_{hf} = 1.13)\) and easy framing \((M_{ef} = 4.28, SD_{ef} = 0.74)\) conditions; \(t(46) = -2.64, p = 0.0057\). These results confirm that framing does have an effect on perceived difficulty and that the manipulation was successful.

iii) Hypothesis testing

- Influence of perceived difficulty on overconfidence

We tested the influence of perceived difficulty on overconfidence (H1) through mixed-effect multi-level regression analysis with overconfidence as the dependent variable. Independent variables were difficulty, perceived difficulty, experience with the task and framing. We also included as an independent variable the second power of experience. Results from this regression are presented in Table 3-I.

Table 3-I: Mixed-effect multi-level regression for overconfidence. Ind. variables: difficulty, perceived difficulty, experience, framing, and experience x experience.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>.3938</td>
<td>(p = .005)</td>
</tr>
<tr>
<td>Level 1, trial specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item difficulty</td>
<td>.0899</td>
<td>(p &lt; .001)</td>
</tr>
<tr>
<td>Item perceived difficulty</td>
<td>-.0958</td>
<td>(p &lt; .001)</td>
</tr>
<tr>
<td>Experience</td>
<td>-.0028</td>
<td>(p = .811)</td>
</tr>
<tr>
<td>Experience (x) Experience</td>
<td>-.0000</td>
<td>(p = .945)</td>
</tr>
<tr>
<td>Level 2, participant specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing</td>
<td>-.0349</td>
<td>(p = .624)</td>
</tr>
</tbody>
</table>
Results from a variation of previous regression that do not include perceived difficulty are presented in Table 3-II.

Table 3-II: Mixed-effect multi-level regression for overconfidence. Ind. variables: difficulty, experience, framing, and experience x experience.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>.0654</td>
<td><em>p</em> = .633</td>
</tr>
<tr>
<td>Level 1, trial specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item difficulty</td>
<td>.0777</td>
<td><em>p</em> &lt; .001</td>
</tr>
<tr>
<td>Experience</td>
<td>-.0008</td>
<td><em>p</em> = .943</td>
</tr>
<tr>
<td>Experience x Experience</td>
<td>.0001</td>
<td><em>p</em> = .793</td>
</tr>
<tr>
<td>Level 2, participant specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing</td>
<td>-.2009</td>
<td><em>p</em> &lt; .001</td>
</tr>
</tbody>
</table>

Results show a significant negative effect of perceived difficulty on overconfidence. Additionally, results show that item difficulty increases overconfidence.

- Influence of item difficulty, experience and framing on perceived difficulty

We tested the influence of item difficulty, experience and framing on perceived also through mixed-effect multi-level regression analysis, but with perceived difficulty as the dependent variable. Independent variables were item difficulty, experience with the task, and framing. We also included as an independent variable the second power of experience. Results of this regression are presented in Table 3-III.

Table 3-III: Mixed-effect multi-level regression for perceived difficulty. Ind. variables: difficulty, experience, framing, and experience x experience.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>3.4266</td>
<td><em>p</em> &lt; .001</td>
</tr>
<tr>
<td><strong>Level 1, trial specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item difficulty</td>
<td>.1270</td>
<td><em>p</em> &lt; .001</td>
</tr>
<tr>
<td>Experience</td>
<td>-.0201</td>
<td><em>p</em> = .275</td>
</tr>
<tr>
<td>Experience x Experience</td>
<td>.0011</td>
<td><em>p</em> = .203</td>
</tr>
<tr>
<td><strong>Level 2, participant specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Framing</td>
<td>.6775</td>
<td><em>p</em> = .003</td>
</tr>
</tbody>
</table>

We found a significant positive effect of item difficulty on perceived difficulty. As expected, results show that when an item is more difficult, it tends to be perceived as such.

On the other hand, we are unable to find a significant effect of experience on perceived difficulty.

Finally, we find a significant positive effect of framing on perceived difficulty. Results show that when participants are told that a task is difficult, they tend to perceive it as more difficult than when they are told the same task is easy.

Framing’s influence on perceived difficulty is significant despite the presence of experience in the regression. In order to test if framing’s influence on perceived difficulty is persistent after participants finished the task, we asked them “How difficult did you find the task you just performed?” after they finished the task. An independent t-test for the answer of participants to this question between the two framing conditions was conducted. Results validate that the difference on perceived difficulty was persistent and significant even after participants completed the
whole task ($M_{hf} = 5.74, SD_{hf} = 0.96; M_{hf} = 4.6, SD_{hf} = 1.04$; $t(46) = -3.92, p < 0.001$).

Mediating role of perceived difficulty on the influence of experience and difficulty on overconfidence

In order to test the mediating role of perceived difficulty on the influence of both difficulty and experience on overconfidence, we conducted Preacher and Hayes’ (2008) bootstrapping analysis procedure to test the mediation effect of perceived difficulty on the effect that task difficulty and experience have on overconfidence.

Results show a partial mediation of perceived difficulty on the effect that difficulty has on overconfidence, as the 95% bias-corrected confidence interval for the indirect effect and for the direct effect did not include zero. Table 3-IV below show the results of the bootstrapping test.

Table 3-IV: Bootstrapping analysis: the mediation effect of perceived difficulty on the effect of task difficulty on overconfidence.

<table>
<thead>
<tr>
<th></th>
<th>Observed Coef.</th>
<th>Bias</th>
<th>Bootstrap Std. Err.</th>
<th>[95% Bias-corrected Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect effect</td>
<td>-.01666</td>
<td>6.05E-04</td>
<td>.00483</td>
<td>-.02714</td>
</tr>
<tr>
<td>Direct effect</td>
<td>.09295</td>
<td>1.05E-03</td>
<td>.01590</td>
<td>.05931</td>
</tr>
</tbody>
</table>