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The Impact of Failure and Success Experience on Drug Development

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It is unclear whether the common belief that experience benefits new product development is driven by decision-makers allocating more attention to success experience or more attention to failure experience. This article differentiates between the two aforementioned types of experience in order to explore their separate effects on new product development. We find that only late-stage failure experience improves new product development, that success experience is more beneficial than late-stage failure experience and that, while others' related failure experience increases the likelihood of failure, others' related success experience decreases it. We conducted our research in the context of drug development in the biotech industry and obtained our data from Pharma Projects. We employ logistic regression analysis to model the likelihood that a drug development project results in failure.

Practitioner Points

- Our findings suggest that firms do not pay enough attention to less salient failures. Therefore, we believe that managers should increase their efforts to study less costly failures, since doing so might help their organizations from incurring a more expensive backlash further down the line.
- Our findings suggest that firms put more effort into extracting value from failure than success and that they do not extract as much value from their own successes as their competitors do. Consequently, organizations experiencing success need to put in place processes to make sure they extract more value from their successes.
- Our results show organizations' efforts to extract value from competitor salient failures are not sufficient enough to improve firms' outlooks. Therefore, we suggest that managers dedicate greater time to understanding the implications of others' salient failures.

Introduction

On December 2, 2006, Pfizer discovered during phase III clinical trials that one of the most promising projects in its pipeline, torcetrapib—a drug developed to combat heart disease—had in fact increased the risk of death and heart problems. Having already invested U.S.$800 million in the development of this cholesteryl ester transfer protein (CETP), Pfizer was on the cusp of producing one of the best-selling drugs in history, with expected annual sales of around U.S.$20 billion. When the adverse discovery was made, Pfizer rapidly stopped development of torcetrapib and immediately suffered a series of drops in its share price (FiercePharma, 2010). The failure of torcetrapib, which had been expected to replace Pfizer's top seller at the time, Lipitor, came as a major shock to the pharmaceutical giant. The event also had an instantaneous effect on other pharmaceutical companies with similar CETP projects in development. Several companies, such as AstraZeneca, followed Pfizer and terminated their CETP projects. Others, such as Roche and Merck, reacted to Pfizer's failure by improving their own CETP programs. Merck, for example, set about understanding basic CETP biology and slowed down its development plans. Even months after Pfizer's failure, the positive effects could be seen in Merck's own developed drug, which showed no increase in blood pressure (Economist, 2006). For Pfizer, the failure was not able to benefit other drugs in its development pipeline, since it did not have any other CETP developments planned. Instead, the company attempted to regroup by taking drastic cost-cutting measures and through the strategic acquisition of smaller firms.

In industries with high levels of uncertainty, such as the biotech industry, more often than not firms face situations similar to that of torcetrapib. In fact,

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research shows that, in the biotech industry, where our research is conducted, 85% of all projects entering phase I of drug development fail before reaching the market (Hay, Thomas, Craighead, Economides, and Rosenthal, 2014). New product development (NPD) failure is also widespread in other industries, with rates never dropping below 35% (Castellion and Markham, 2013). With such high rates of NPD failure, and the threat they represent for a firm's survival, understanding the impact they have on future NPDs has become a central issue for both practitioners (Barczak, 2014; Collins, 2015) and scholars (Hu, McNamara, and Piaskowska, 2016; Markovitch, Steckel, Michaut, Philip, and Tracy, 2015; Shepherd, Haynie, and Patzelt, 2013).

Scholars have long held the belief that firms primarily adapt their behavior from a problemistic search arising from the experience of failure (Cyert and March, 1963; Madsen and Desai, 2010; March and Shapira, 1992). According to the attention-based view (ABV), this is due to the fact that what firms focus on and the decisions they make depend on the particular characteristics of the events they experience (Ocasio, 1997, 2011). In particular, events with a clear connection to a firm's aspirations are more likely to have a greater impact on its attention and decisions (Greve, 2003). Therefore, not only failures but also successes are bound to attract a firm's attention and ultimately affect its future decisions (Gavetti, Greve, Levinthal, and Ocasio, 2012). This is why some scholars argue that we cannot fully understand the implications of failure experience and success experience for the organization without studying them together (KC, Staats, and Gino, 2013; Madsen and Desai, 2010). Despite the work done in this area, important questions remain unanswered in the ABV literature regarding the role of success and failure experience. This article makes three core contributions to this literature.

First, some studies have found that extracting value from failure experience is not always straightforward and, under certain circumstances, nonproblemistic searches arising from success can even lead to better outcomes (Deichmann and van den Ende, 2013). Meanwhile, other studies have found evidence that failure attracts more attention than success and is, therefore, more beneficial for firms (Madsen and Desai, 2010). Given these contradictory findings, generalizing whether organizations benefit more from failure than from success, or vice versa, is not possible without more research dedicated to the topic. This article contributes to this gap in the literature by directly comparing the impact of failure and success experience on firms' NPD.

Second, our study expands our insight into the ways that failure experience affects future NPD by showing that it is also important to differentiate among different saliences of failure. Based on this, our study shows that the salience of failure, be it early stage (phase I), medium stage (phase II), or late stage (phase III) in our context of clinical trials, affects decision-makers' attention differently and is therefore relevant for understanding its impact on future NPD. This is an important contribution given that the theoretical mechanism behind the role that different saliences of failure have on firms has received little attention (Gong, Zhang, and Xia, 2017).

Third, as the torcetrapib example shows, organizations pay attention and can also benefit from the NPD experiences of others (Srinivasan, Haunschild, and Grewal, 2007; Talay, Calantone, and Voorhees, 2014).

BIOGRAPHICAL SKETCHES

Dr. Antonio Garzón-Vico is an assistant professor of business of biotech in the School of Biomolecular and Biomedical Science at University College Dublin. Originally a philosophy and business graduate, he currently conducts research on topics of business of biotech (cognitive biases, learning from success, and failure) and teach business skills to science students (business planning, strategy, and organizational behavior). He also advise science-based startups on business planning and organizational behavior.

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Observing others' failures and successes is crucial for NPD, as organizations have limited resources and time to experiment with all possible outcomes in order to increase their likelihood of success. Therefore, we look at whether others' experiences of failure and success have greater impact on future NPD than first-hand experience of failure and success.

Similar to other studies in the related field, this article employs a logit model to explore the impact that failure and success experiences have on the probability of future drug development projects being ceased (Madsen and Desai, 2010).

Theory and Hypotheses

According to the ABV of the firm (Ocasio, 1997, 2011), firms' behavior—and, by extension, their outcomes—depends on what their decision-makers pay attention to. The ABV of the firm adopts Herbert Simon's (1947) idea that decision-makers' cognition is limited, meaning they cannot attend to all the stimuli available to them. Given the large amount of information available in a firm's environment and the limits of human cognition, decision-makers must be selective in what they attend to at any one time. The ABV of the firm starts from this assumption of human nature and suggests that firms' decision-makers make decisions using only those experiences that attract their attention.

A major tenet in the ABV of the firm is that individual decision-maker's attention is situated in the context of the firm's activities and procedures. Firms are history-dependent systems and, as such, a firm's experience acts as the basis for the way in which its environment is represented (Daft and Weick, 1984). Consequently, a firm's history affects what its decision-makers pay attention to, what they do, and thus the future of their NPDs (Garzón-Vico, Gibbons, McNamara, and Rosier, 2016; Kraaijenbrink, 2012; Paladino, 2007; Wei, Yi, and Guo, 2014). A firm's experience can affect its future by directing decision-makers' attention in various ways. For example, a firm's experience can result in decision-makers discriminating against irrelevant external information; a process that has the potential to lead to a reduction in project uncertainty (Olivera and Argote, 1999) or improve a firm's problem-solving capabilities (Grant, 1996; Leonard-Barton, 1992; Nelson and Winter, 1982). By directing decision-makers' attention, a firm's experience can also facilitate their ability to recognize, assimilate, and exploit new external knowledge (March, 1991) or direct them to the right partners more efficiently (Mayer and Salomon, 2006).

But not all experiences have the same impact on firms' attention (Argote and Miron-Spektor, 2011; Darr and Argote, 1995; Ingram and Baum, 1997), and this is because different types of experiences have different saliences and may not attract decision-makers' attention to the same extent. The salience of an experience is crucial to understanding whether decision-makers will act upon it, as more salient experiences are more likely to attract attention and therefore play a bigger role in a firm's behavior (Gavetti et al., 2012).

Paramount examples of salience are failure and success experiences, which largely derive from the fact that decision-makers' attention is outcome oriented: decision-makers are more likely to focus on outcomes relevant to the firm's performance (Greve, 2003). This is why failures such as torcetrapib attract a great deal of attention and determine the firm's subsequent decisions; they suppose a major setback to the performance of the firm in question. It therefore comes as no surprise that numerous scholars have attempted to understand the roles of failure and success in firms' future (e.g., Baum and Ingram, 1998; Deichmann and van den Ende, 2013; Desai, 2014a, 2014b; Haunschild and Sullivan, 2002; KC et al., 2013; Kim and Miner, 2007; Madsen and Desai, 2010; Meschi and Métais, 2015; Shepherd, Patzelt, and Wolfe, 2011, Su and McNamara, 2012). Figure 1 presents the hypotheses we study in order to contribute to the ABV literature.

Failure Experience

NPD failure occurs when initial aspirations regarding the potential of a project are not met by the outcome (Cyert and March, 1963; Madsen and Desai, 2010; Shepherd and Cardon, 2009; Shepherd, Patzelt, Williams, and Warnecke, 2014). As a result, firms direct their attention to the failure, and initiate a process of reflection and action with the intention of bringing outcomes and aspirations in line for better performance (Argyris and Schon, 1996). In order to do achieve this, firms' decision-makers analyze failures to find information that might indicate problems with current NPD projects (Hu et al., 2016) and ultimately help them predict future risks (Miner, Kim, Holzinger, and Haunschild, 1999). Based on this notion, many successful firms admit that part of their success is due to their readiness to react to failures (Gardiner, 2008).

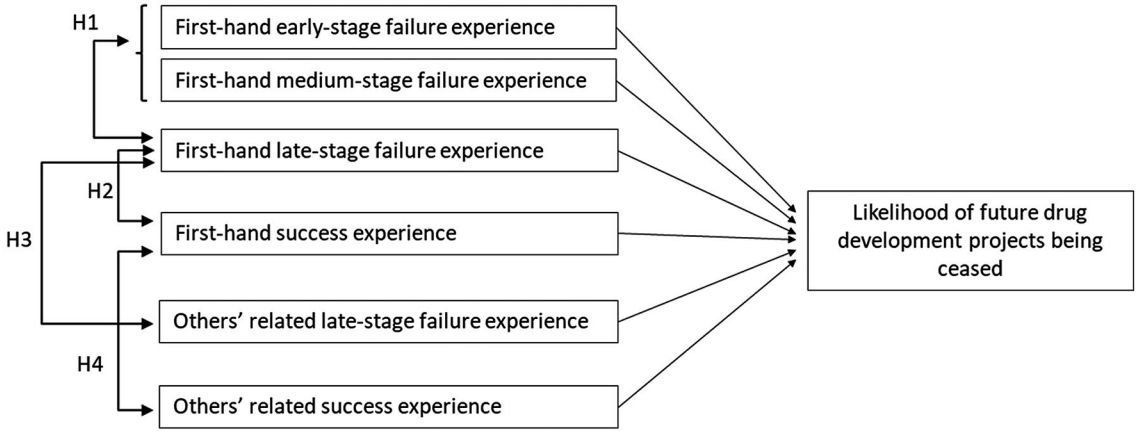

Figure 1. Hypotheses Comparing Different Types of Experience Impact on the Likelihood of NPD Being Ceased

This view of how firms react to failures lines up well with Pfizer's actions after torcetrapib's failure. Pfizer investigated the reasons behind the failure, with the intention of predicting possible risks in other existing drug development projects in its pipeline. This process concluded with different relevant actions, including the termination of other existing projects currently in earlier development stages.

Failure experience can also negatively affect a decision-maker's ability to gather the correct information due to the emotions they cause (Disterer, 2002). Not meeting aspirations regarding a project can trigger and stir negative emotions in organizations (Huy, 2002; Kiefer, 2005; Shepherd et al., 2011), which can in turn lead members of the firm to overestimate the possibility of new failures (Nygren, Isen, Taylor, and Dulin, 1996), become more inclined to leave the organization (Shepherd et al., 2013), or neglect to analyze the failure (Kiefer, 2005). The importance of emotions lies in the fact they might lead to firm members focusing their attention on explaining the failure away (KC et al., 2013) or determining accountability (Sitkin and Weingart, 1995). If this occurs, it is likely that time is diverted away from understanding the event itself. Additionally, after a failure, an organizations' members might be less inclined to disclose all the relevant information surrounding the failure due to fears of retribution (Mantere, Aula, Schildt, & Vaara, 2013; Shepherd and Cardon, 2009).

Failure Experience Salience

Although decision-makers in a firm tend to pay attention to, be affected by, and act following failures, not all failures attract the same level of attention or have the same impact on them. There is evidence in the literature suggesting that different failure experiences with variations in salience affect firms differently. Some scholars argue that failures have different saliences based on the cost they represent for the firm and the degree of their rarity, meaning decision-makers' behavior, and the firm's future, are affected differently (Gong et al., 2017; Hayward, 2002; Lampel, Shamsie, and Shapira, 2009; Madsen and Desai, 2010). In this respect, the ABV of the firm posits that differences in cost and rarity affect the level of attention that failure experiences receive and, consequently, the impact they will have on future organizational actions (Ocasio, 1997). In particular, the more costly and rarer an experience is, the greater attention it will receive, and the greater its impact on the firm's future will be (Lampel et al., 2009).

In the context of the biotech industry, the salience of a failure, and therefore the attention it receives, depends on the stage of development at which it takes place, since failures at different stages of development carry different cost implications for the firm and are different in how rare they are. As a result, drug development projects increase their salience, and cost, as they progress through phases I, II, and III. According to the latest estimates, out-of-pocket costs are U.S.$25.3 million for phase I, U.S.$58.6 million for phase II, and U.S.$255.4 million for phase III (DiMasi, Grabowski, and Hansen, 2016). These estimates, together with the cost of preclinical research, can bring the total investment needed for a compound to reach phase III up to U.S.$2 billion; an amount more difficult to ignore than the smaller loses at phases I and II. Similarly,

failures are rarer at phase III than at phases I and II. According to our data, only 14% of all drugs that enter development fail at phase III, while 38% fail in phase I and 32% do so in phase II. Therefore, failures that take place at phase III of development, such as torcetrapib, gain more attention from managers, shareholders, and the public than failures at phase I or II of development due to the higher cost implications and the increased rarity. Thus, failures at phase III are more salient, difficult to ignore by organizations, and more likely to affect future decisions made on ongoing and possible new projects.

As we have already argued, failures have the potential to affect firms not only in a positive sense by attracting the attention of decision-makers and directing future actions but also negatively through bad emotions (Huy, 2002; Kiefer, 2005; Shepherd et al., 2011, 2013) and accountability (Sitkin and Weingart, 1995). It is then natural to assume that the adverse impact of negative emotions on firms would increase with the cost implications of the failure; that is, phase III failures are more likely to lead to overstating the likelihood of future drug development projects being ceased or make it less likely for a firm's members to disclose relevant information regarding the failure than if this occurred during phase II or I.

Even though we acknowledge accountability and negative emotions as powerful factors affecting how organizations react to failure, we find stronger evidence in the ABV literature and the industry to suggest that organizations benefit more from rarer failures with greater cost impact on the firm. First, prior studies suggest that firms are more likely to allocate time and resources to explore the more significant failures among them (Kim, Kim, and Miner, 2009; Madsen and Desai, 2010). This is because failures with more severe consequences, like that of torcetrapib, lead to significant public debate and scrutiny from regulators, affected communities, concerned stakeholders, and the media (Hoffman and Ocasio, 2001; Hudson, 2008; Yu, Sengul, and Lester, 2008). This is particularly true in the biotech industry, where more salient failures lead to investigations and discussions inside and outside the organization, as affected parties and regulators work to understand what went wrong. On the other hand, less salient failures might be easier to turn into successes (Sitkin and Pablo, 1992) and ignore (Dillon and Tinsley, 2008). In fact, in the biotech industry, failures at phases I and II do spark considerably less attention and discussion from different stakeholders due to their less consequential nature.

Second, the high rate of failure in the biotech industry might have led to a greater acceptance of failure than in those industries where bad emotions had a negative impact on the organization (Huy, 2002; Kiefer, 2005; Shepherd et al., 2011, 2013). This normalization of failure in the biotech industry might lead to a lower negative impact of emotions after failure and, therefore, focus organizational attention on extracting value from the experience of salient failures rather than on accountability. Following the above discussion, we propose the following hypothesis:

H1: First-hand experience of late-stage NPD failure reduces the likelihood of future NPD being ceased more than first-hand experience of early- and medium-stage NPD failure.

Success versus Failure Experience

According to the ABV of the firm, failure and success experiences affect the attention of decision-makers differently. This is because, contrary to what happens with experience of failure, experience of success can be seen as evidence that organizational knowledge is adequate and that further knowledge development is not necessary (Lant, Milliken, and Batra, 1992; March and Shapira, 1992). Although success experience does not lead firms to stop seeking new knowledge, it can lead to excessive trust in existing knowledge (Gino and Pisano, 2011; Louis and Sutton, 1991) and inertia (Miller, 1994), in addition to directing a firm's attention toward a "local search" for knowledge—a process that is unchallenged (Lant et al., 1992)—and away from a "non-local search" (Cyert and March, 1963; Levinthal and March, 1981). In certain industries, directing your attention toward a local search is not necessarily bad for firms, as local searches can facilitate the refinement of successful routines and lead to better outcomes (Muehlfeld, Rao Sahib, and Van Witteloostuijn, 2012). But in contexts such as the biotech industry, where firms rely on innovation, local searches might not be enough to guarantee acceptable outcomes; decision-makers might be tempted to deviate their attention from relevant nonlocal information (Audia, Locke, and Smith, 2000; Hayward, Rindova, and Pollock, 2004) and

make flawed inputs (Markovitch et al., 2015), resulting in poor decision-making approaches and ultimately poorer outcomes (Audia and Goncalo, 2007). We find an example of the possible negative impacts of success experiences in a study of the hard disk drive industry by Audia and Goncalo (2007), in which they discovered that greater success experience led to fewer innovative ideas from employees, who preferred to rely on familiar knowledge instead.

The idea that experience of success might be less beneficial to future outcomes than experience of failure in highly innovative industries is supported by Madsen and Desai (2010), who carried out the only direct comparison of these two experiences at the organizational level. Their study focused on the global orbital launch vehicle industry, where success is more common than failure. Their findings support the idea that organizations pay more attention to and benefit more from prior failure than from prior success, resulting in a decrease in the probability of future failure. They argue that failure leads to improvements because it directs an organization's attention toward the search for new knowledge; a process that success, as previously argued, does not necessarily do.

We also find strong evidence in the psychology literature that failures are more likely to attract attention than successes. Studies looking at how individuals react to either a loss or a gain show that, when compared, the former looms larger and has greater salience, and is thus more likely to condition the attention and future decisions of the individual (Kahneman and Tversky, 2013). This asymmetry between losses and gains has an evolutionary explanation: you are more likely to survive if you treat threats as more urgent (Kahneman, 2011). Therefore, and following the above discussion, we assume that decision-makers will pay more attention to failures than successes in the biotech industry due to the negative implications that such failures have for the firm's survival. As we have already argued, phase III failures in the biotech industry are more likely to attract attention and affect future NPD than phase I and II failures; as such, we only make a comparison between failure experiences and success experiences found in phase III developments.

H2: First-hand experience of late-stage NPD failure reduces the likelihood of future NPD being ceased more than first-hand experience of NPD success.

First-Hand versus Others' Experience of Failure and Success

Torcetrapib's failure and the consequences it had for other firms represents an example of how organizations can benefit vicariously from others' related failure experiences (e.g., Beckman and Haunschild, 2002; Bresman, 2013; Haunschild and Sullivan, 2002; Ingram and Baum, 1997; Miner and Haunschild, 1995; Yang, Li, and Delios, 2015). Research in this area suggests that the likelihood of organizational failure decreases when the number of other organizations experiencing failures increases. This indicates that organizations pay attention to failure when it takes place in their own environment, as doing so has the potential to reveal the presence of possible future failures in their own organizations (Baum and Dahlin, 2007; Haunschild and Sullivan, 2002; Ingram and Baum, 1997; Kim and Miner, 2007). In some industries, the information regarding a failure is made available to the public, making it more likely to attract the attention and condition the behavior of other firms. The orbital launch vehicle industry is an example whereby the disclosure of information following a failure seems to explain why other organizations might benefit from the experience of others (Madsen and Desai, 2010). Similarly, in the biotech industry, organizations are obliged by law to disclose designs and the results of all clinical studies for treatments within a given period, which in turn facilitates the ability of other firms to inform their decisions from observing others' failures.

Despite there being plenty of evidence to suggest that organizations do pay attention to, and benefit from, the experiences of others (Baum and Dahlin, 2007; Haunschild and Sullivan, 2002; Ingram and Baum, 1997; Kim and Miner, 2007; Scarbrough, Robertson, and Swan, 2015), it is not yet clear in the literature whether organizations benefit more from their own failures or more from others'. We propose that organizations benefit more from observing others' failures than from their own because, as previously argued, the experience of failing can affect their ability to extract relevant lessons from the experience. Furthermore, the observing firm will not be affected by all the financial and emotional implications of the failure, which, as previously mentioned, can affect the organization's ability to extract valuable information.

Pfizer's failure exemplifies the situation described above. The fact that Pfizer was involved in the failure created a sense of panic, as the firm's current

market leader was set to expire five years down the line. Most of the efforts after the failure were concentrated on developing drastic measures that could prevent an immediate catastrophe. One such measure was the immediate task of cutting 10,000 jobs. During the time in which Pfizer was concentrating on these measures, other competitors could sit back and begin the process of analyzing torcetrapib's failure. This explains why, contrary to what happened to Pfizer, the outlook for companies such as AstraZeneca, Roche, and Merck improved at the news of the termination of torcetrapib's development. As argued above, the fact that these firms were not directly involved in the failure gave them the financial and emotional security needed to make better decisions.

Additionally, the fact that AstraZeneca, Merck, and Roche had similar projects to torcetrapib in their pipelines allowed them to review and evaluate the consequences of the torcetrapib failure for their own projects, which were still in the early stages of development. This is in line with findings in the literature that support the idea that organizations pay more attention and benefit more from others' experiences if they are related to their own past and present experience (Bresman, 2013; Nesta and Saviotti, 2005). Additionally, when an organization is familiar with the experience of another company, it will be more likely to employ and use this known experience more appropriately, without having to translate it to an unrelated context (Hora and Klassen, 2013; Ingram and Baum, 1997). Based on the above discussion, we propose the following hypothesis:

H3: Others' related experience of late-stage NPD failure reduces the likelihood of future NPD being ceased more than first-hand experience of late-stage NPD failure.

Organizations not only pay attention to and make decisions based on others' failures, they also closely follow and benefit from others' successes (Madsen and Desai, 2010). In a context of shared knowledge bases, observing others' success might prompt an organization to copy the practices of the succeeding organization (Carroll and Hannan, 1995; Miner et al., 1999). This is why firms that operate in a common domain typically employ similar practices. In the biotech industry, it is common that an initial success in combating a certain illness prompts other competitors to adopt similar approaches.

We previously argued that first-hand success experience can be self-limiting and affect the organization negatively, often resulting in firms implementing a local search and becoming overconfident (Audia et al., 2000; Hayward et al., 2004). This is not the case when a firm observes others' successes. It is, in fact, the contrary: watching others' successes might create a sense of urgency in the observing firm, pushing it to imitate as a way of replicating a similar successful outcome and maintain a competitive advantage (Posen, Lee, and Yi, 2013). Following the above discussion, we propose the following hypothesis:

H4: Others' related experience of NPD success reduces the likelihood of future NPD being ceased more than first-hand experience of NPD success.

Methodology

Research Setting

The biotech industry offers fertile ground through which to answer our research question. Efficiently responding to new advances and developments is crucial, since companies face tremendous pressure to innovate. In the last 10 years, the number of drugs in development has increased by 62%, while research and development (R&D) expenditure has doubled. Although the number of new medicines reaching the market picked up in 2015, annual output has effectively flatlined over the same period; developing new medicines is becoming an increasingly expensive business (the average cost per molecule is anything from U.S.$75 million to U.S.$4 billion), and the regulatory context of drug development is also becoming more rigorous (e.g., the Food and Drug Administration is building an active surveillance system called Sentinel to oversee the safety of all medicines on the U.S. market). Virtually all firms in the biotech industry have multiple product candidates in their development pipelines. Given the low probability of a product reaching the market, ranging between 10% and 15% (Hay et al., 2014), a critical factor for managers is to allocate R&D resources wisely. In this context, maximizing the use of first-hand and others' experiences for drug development is of vital importance in the biotech industry, as doing so informs decisions regarding costly project development.

Sample and Data

We obtained the data with which to conduct our research from *Pharma Projects*, a database containing information on pharmaceutical and biotech drug development projects. The source data are based on company questionnaires, and the filings, journals, annual reports, industry conferences, and press releases of the U.S. Securities and Exchange Commission and U.S. Food and Drug Administration. *Pharma Projects* includes data from more than 600 biotech and biopharmaceutical companies, with detailed profiles showing joint ventures, licensing agreements, and over 29,000 detailed drug profiles, including 217 therapy profiles. The information in the database is regularly updated and includes all historical information on every compound ever recorded.

We focused our search only on those drugs that had a biological origin; these included biological cells, cellular structural components, and macromolecules (including DNA/RNA, peptides, proteins, and structural polysaccharides/lipids) from natural sources. Like similar studies that use data on drug development for their analysis, we believe that focusing on biologic drugs (large molecules) ensures homogeneous sampling and controls for variance that exists within the broader group of pharma/biotech/life sciences products (e.g., Hoang and Rothaermel, 2005, 2010). We focused only on drugs that were either fully launched or ceased between January 2000 and March 2015, and that had entered clinical trials. It is only when drugs enter clinical trials involving humans that information on failures becomes widely available. Also, it is only when humans are involved in trials that failures have a significant impact on firms, both financially and socially.

For all projects, an event date (either for full launch or cessation) was identified. This resulted in a total sample of 1749 drugs, of which 264 (15.09%) were fully launched, and 1485 (84.91%) were ceased during the 15-year period. A total of 904 organizations participated in the development of the 1749 drugs as either originators or licensees. Because we wanted to explore the impact of failure and success experiences on future NPD and because, in some cases, more than one organization was involved in the development of one drug, we organized our data as unbalanced panel data. We ended up with a total of 2981 observations for all 904 organizations and 1749 drugs. Some of the organizations in our sample only took part in a very small number of drug development projects and were subsequently left out of our fixed effects analysis. Fixed effects analysis controls for firm heterogeneity and, as such, does not consider those firms with all drug development projects as either failures or successes. This subsample, which contained a total of 1145 observations developed by a total of 79 organizations, was employed to build our model. Nonetheless, we used the full 2981 observations to construct our variables for others' organizational experiences.

Dependent Variable

Our dependent variable represents whether a given drug development project has been fully launched or ceased. All the projects are either clear launches or ceased projects. In the biotech industry, it is widely assumed that drugs that are fully launched are those that have reached the market and have therefore completed all clinical trials successfully and passed the necessary regulatory approvals. We define "ceased" as those drug development projects that have been stopped before reaching the market. A drug development project can either be ceased after phase I, II, or III trials, or at the time of assessment by the regulatory agency. Each phase of development involves a larger number of patients and greater overall costs. In our sample, the reasons for ceasing a project are always scientific, meaning that the results of the clinical trials did not prove the efficacy of the drug in question. Thus, *ceased* is a dichotomous dummy variable, coded 1 for ceased projects and 0 for fully launched.

Independent Variables

The variable measuring *first-hand early-stage failure* experience represents the number of failed projects at phase I of development in which an organization was involved as either an originator or a licensee. The variable measuring *first-hand medium-stage failure experience* represents the number of failed projects at phase II of development in which an organization was involved as either an originator or a licensee. The variable measuring *first-hand late-stage failure experience* represents the number of failed projects at phase III of development in which an organization was involved as either an originator or a licensee. The *first-hand success experience* variable is the number of successful prior projects in which an organization was involved as either an originator or a licensee. The

variable measuring *others' related success experience* is the number of fully launched projects in the same therapeutic area as the project in question by other organizations. The variable measuring *others' related late-stage failure experience* is the number of projects ceased in phase III in the same therapeutic area as the project in question by other organizations.

During the time covered by the sample, several organizations in our sample merged with others or were acquired by others. In these cases, the above experience variables were constructed so as to account for all the prior experience possessed by the merged or acquired organization.

Experience discount factor. Some researchers suggests that the value of experience depreciates over time (Kim and Miner, 2007; Olivera and Argote, 1999). Extracting value from distant experience can lead organizations to adopt routines that worked well in the past but that are no longer useful (Levinthal and March, 1993). Because there is often no theoretical basis for a specific functional form of the depreciation of experience, previous researchers have often used a prespecified model of experience devaluation (Darr and Argote, 1995; Ingram and Baum, 1997; Kim and Miner, 2007; Madsen and Desai, 2010). In order to account for the depreciation of past experience over time and as a robustness test, we employed a series of arbitrarily selected discount factors by which prior experiences are divided before being added into a cumulative past experience variable. First, we used a discount factor equal to 1, assuming no depreciation in the value of past experience. Second, we set the depreciation factor to the square root of the age of the experience, assuming that experience initially depreciates more slowly than linearly and slows further with time. Third, we used a discount factor equal to the age of the experience, assuming that experience depreciates in linear fashion. Fourth, we set the discount factor equal to the experience age squared, assuming that the value of past experience depreciates faster than linearly at first and then accelerates further with time. We employed the discount that yielded a better fit for the model.

Control Variables

Based on prior research in drug development projects, which shows that the scientific characteristics of the drugs may affect the outcome of the project (Danzon, Nicholson, and Pereira, 2005; Macher and Boerner, 2006), we created various variables covering scientific aspects of the drug development projects. *Therapeutic area risk* measures the percentage of prior failed projects within the therapeutic area of the focal drug at the time of the event. Similarly, the variable *biological origin risk* measures the percentage of prior failed drug development projects within the biological origin group of the focal drug at the time of the event. Both of these variables control for the difference of scientific complexity behind each drug development project. We also controlled for whether the drug development project targeted a rare disease. Rare diseases are less likely to be the subject of scientific research, that is, there may be less interest, resources, and political drive behind their development. We employed a dummy variable (*rare disease*) with 1 indicating those drugs listed as rare diseases by the Genetic and Rare Diseases Association.

Whether a project is conducted solo or in collaboration with other firms can affect support for a project. We created a dummy variable (*R&D alliance*), where 0 denotes a solo project and 1 denotes a project conducted in collaboration with another firm. As a way to control for unobservable year effects, such as the introduction of new technologies in drug development, and for correct truncation, the variable *year* indicates the year in which the project was initiated. We also controlled for the organization's size, as this may affect its ability to extract value from both failure and success. Following several prior studies that have used R&D expenditure as a proxy to an organization's size (e.g., Lee and Chen, 2009), we created the variable *R&D investment,* which measures the total amount invested in the years prior to the date of observation. We also controlled for the role that the organization plays in the development of the drug in question. The dummy variable *organization's role* is coded 1 for companies that are the originator of the compound and 0 for companies that act as licensees. The experience and expertise an organization has in terms of its drug development project is relevant to its future (Macher and Boerner, 2012). By employing the number of previous drugs developed by the same organization in that particular therapeutic area, we thus created the variable *therapeutic area experience* to capture the level of expertise held by the organization. We also measured the percentage of total failed projects per organization (*percentage failed*) to control for the relationship between failed and successful projects.

Analysis

Similar to previous studies on failure experience (e.g., Madsen and Desai, 2010), we used logistic regression analysis to model the likelihood that a drug development project resulted in failure. This is common for binary-response models, such as ours, where the dependent variable has only two possible values. We included firm-specific fixed effects to control for unobserved heterogeneity (Hosmer, Lemeshow, and Sturdivant, 2013). The inclusion of organizations' fixed effects was necessary because many characteristics of the firms were unobservable during the period of the study. The fixed effects regression model takes the form:

$$\log\left(\frac{P_j}{1-P_j}\right)=\alpha_i+x'_{ij}\beta+e_{ij}$$

where P_j is the probability that drug development project j will fail and α_i is a firm-specific parameter representing the effect of unobserved firm characteristics. β signifies the regression coefficients representing the effects of the observed covariates and e_{ij} independent error terms.

Results

Table 1 presents descriptive statistics and correlations for the variables included in this study. The experience variables used in this study were depreciated using their best-fitting depreciation value. The different values are reported in brackets below each variable. There are some moderate correlations. The reason for the moderate correlation between *R&D alliance* and *organization's role* (r = .67) is that all those organizations that were the solo developers of a drug (value of 1 for *governance*) were also the originators (value of 1 for *organization's role*). There is also a moderate correlation between *first-hand late-stage failure experience* and *R&D investment* (r = .66). We ran the analysis without the control variables for *R&D alliance* and *R&D investment*, and the results followed the same pattern.

There is also a moderate correlation between *first-hand success experience* and *others' related success experience* (r = .58). One reason for the correlation could be that experience variables increase as organizations gain overall experience. One reason for multicollinearity in panel data such as those employed in this work is that the regressors included in the model share a common trend; that is, they all increase or decrease over time. Thus, the moderate degree of correlation between some of the experiences may be because they grow at more or less the same rate (Gujarati, 1988). To alleviate concerns about multicollinearity, we report nested models across the analysis. Since model fit is not affected by multicollinearity, we compared model fit across sets of nested models and verified the results with likelihood ratio tests.

Table 2 reports maximum-likelihood estimates for the fixed effects logit regression analysis of drug failures. Model 1 contains only control variables that can be used for comparison against the models containing experience variables. In Model 1, we see that the coefficient for calendar year is positive and significant, suggesting that since 2000, the likelihood of failure has increased. This finding is in line with recent studies in the industry showing that the likelihood of failure has increased over the last decade due to regulatory changes (Hay et al., 2014). We also find that, as the percentage of failed drug development projects increases, the likelihood of future drug development projects being ceased decreases. Our results also show that increasing the complexity of the science, both for the therapeutic area and biological origin, increases the likelihood of future drug development projects being ceased. Furthermore, Model 1 also shows that more R&D investment reduces the likelihood of future drug development project being ceased. In particular, a marginal effects analysis at mean values for all other variables shows that increasing R&D investment by U.S.$1 billion would decrease the likelihood of failure by 11 percentage points.

Models 2–6 look at the impact of first-hand early-stage failure experience, first-hand medium-stage failure experience, first-hand late-stage failure experience, and first-hand success experience on the likelihood of drug failure. H1 suggested that the probability of drug failure is lower with first-hand experience of late-stage failure than with first-hand experience of early- and medium-stage failures. In Model 4, the first-hand late-stage failure experience coefficient is negative and significant (p < .05), indicating that the probability of failure decreases as organizations gain experience of late-stage failure. We also conducted a marginal effects analysis for first-hand late-stage failure experience with all other variables calculated at their mean

Table 1. Descriptive Statistics

	Mean	Std. Dv.	Min.	Max.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Ceased	.84	.36	.00	1.00	1.00															
2. R&D alliance	.41	.49	.00	1.00	−.02	1.00														
3. Year	2008	4	2000	2015	.00	−.06**	1.00													
4. Organization's role	.76	.43	.00	1.00	.05*	−.67***	.05**	1.00												
5. Percentage failed	55.32	44.05	.00	100.00	.20***	.08***	.04*	−.06**	1.00											
6. Therapeutic area experience	5.43	10.08	.00	57.00	−.10***	−.10***	−.00	.06***	.13***	1.00										
7. Rare disease	.04	.19	.00	1.00	.01	.01	−.01	−.01	.01	−.04	1.00									
8. Therapeutic area risk	81.19	24.93	.00	100.00	.41***	.07***	.03	−.03	.19***	−.03	.03	1.00								
9. Biological origin risk	84.14	16.02	.00	100.00	.29***	.04*	−.02	−.00	.05*	−.00	.05**	.38***	1.00							
10. R&D investment (in million $)	1325	2331	.43	9877.73	.01	.06**	.08***	−.09***	.33***	.02	.00	.03	−.12***	1.00						
11. First-hand success experience (age square disc.)	.03	.17	.00	1.55	−.34***	−.04*	.07***	.00	−.14***	.48***	−.02	−.20***	−.09***	−.05**	1.00					
12. First-hand early-stage failure experience (age disc.)	.04	.17	.00	2.28	.07***	−.06**	.02	.05**	.18***	.40***	−.02	.04*	.00	.09***	−.03	1.00				
13. First-hand medium-stage failure experience (age disc.)	.02	.13	.00	1.50	.05**	−.03	−.01	.02	.15***	.31***	−.01	.05*	−.00	.10***	−.03	.04*	1.00			
14. First-hand late-stage failure experience (no disc.)	2.35	4.35	.00	21.00	.03	−.02	.07***	−.00	.35***	.02	.00	.00	−.10***	.66***	−.06**	.06***	.09***	1.00		
15. Others' related success experience (age disc.)	.21	.77	.00	10.51	−.25***	.05*	−.03	−.07***	−.05*	.31***	−.03	−.16***	−.18***	−.01	.58***	−.01	−.01	.00	1.00	
16. Others' related late-stage failure experience (age square root disc.)	98.87	86.57	.00	268.00	.27***	.03	.16***	−.01	.17***	.04*	.01	.51***	.27***	.06***	−.14***	.04*	.08***	.05**	−.09***	1.00

*$p < .05$, **$p < .01$, ***$p < .001$.

Table 2. Logistic Models Predicting Drug Development Projects Being Ceased

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
R&D alliance	−.33 (.27)	−.30 (.27)	−.31 (.27)	−.36 (.27)	−.32 (.27)	−.32 (.27)	−.35 (.27)	−.38 (.27)	−.33 (.27)	−.33 (.27)
Year	.17*** (.03)	.17*** (.03)	.17*** (.03)	.23*** (.04)	.17*** (.03)	.22*** (.04)	.16*** (.03)	.22*** (.04)	.17*** (.03)	.17*** (.03)
Organization's role	−.12 (.28)	−.11 (.28)	−.11 (.28)	−.13 (.28)	−.19 (.28)	−.16 (.28)	−.15 (.28)	−.16 (.28)	−.19 (.28)	−.19 (.28)
Percentage failed	−.03*** (.01)	−.03*** (.01)	−.03*** (.01)	−.03*** (.01)	−.03*** (.01)	−.03*** (.01)	−.03*** (.01)	−.03*** (.01)	−.03*** (.01)	−.03*** (.01)
Therapeutic area experience	.04 (.32)	−.13 (.34)	−.09 (.34)	.05 (.33)	.94 (.55)	.45 (.58)	−.04 (.34)	−.04 (.34)	.62 (.44)	.89 (.56)
Rare disease	−.42 (.49)	−.40 (.48)	−.41 (.48)	−.41 (.49)	−.39 (.48)	−.37 (.48)	−.34 (.49)	−.33 (.49)	−.44 (.48)	−.43 (.48)
Therapeutic area risk	.03*** (.00)	.03*** (.00)	.03*** (.00)	.03*** (.00)	.02*** (.00)	.03*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)
Biological origin risk	.04*** (.01)	.04*** (.01)	.04*** (.01)	.04*** (.01)	.04*** (.01)	.04*** (.01)	.03*** (.01)	.04*** (.01)	.03*** (.01)	.03*** (.01)
R&D investment	−.00* (.00)	−.00* (.00)	−.00* (.00)	−.00 (.00)	−.00* (.00)	−.00 (.00)	−.00* (.00)	−.00 (.00)	−.00* (.00)	−.00* (.00)
First-hand early-stage failure experience (age disc.)		3.01 (1.92)				2.77 (2.05)				
First-hand medium-stage failure experience (age disc.)			2.27 (1.63)			1.83 (1.70)				
First-hand late-stage failure experience (no disc.)				−.12** (.05)		−.12** (.05)		−.12** (.05)		
First-hand success experience (age square disc.)					−2.21** (.83)	−1.72* (.84)				−.90 (.95)
Others' related late-stage failure experience (age square root disc.)							.13* (.05)	.13* (.05)		
Others' related success experience (age disc.)									−.73*** (.20)	−.68** (.21)
Wald chi square	217.12	221.31	220.45	224.64	226.19	237.19	222.61	230.17	237.24	238.18
Log likelihood	−334.09	−332.00	−332.42	−330.33	−329.55	−324.05	−331.34	−327.56	−324.03	−323.56
N	1145	1145	1145	1145	1145	1145	1145	1145	1145	1145
Clusters	79	79	79	79	79	79	79	79	79	79

Positive coefficients indicate that increases in the value of independent and control variables increase the probability of drug development failure and vice versa.
*$p < .05$, **$p < .01$, ***$p < .001$.

value and present the results in Figure 2. The *Y*-axis represents the probability of drug development failure, ranging from 0 to 1. The *X*-axis represents first-hand late-stage failure experience, ranging from 0 to 2 standard deviations. Increasing first-hand late-stage failure experience by one standard deviation, while keeping all other variables at mean values, decreases the probability of failure from .95 to .93. In Models 2 and 3, the coefficients for first-hand early- and medium-stage failure experiences are positive and nonsignificant. These results remain stable when included together in Model 6. These results support H1 and indicate that first-hand late-stage failure experience is more likely to reduce the likelihood of future drug development projects being ceased than first-hand experience of early- or medium-stage failure.

In H2, we suggested that the probability of drug failure is lower with first-hand experience of late-stage failure than with first-hand experience of success. In Model 5, we find that the first-hand success experience coefficient for the probability of failure rate is negative and significant ($p < .001$). This finding indicates that failures become less likely as organizations gain experience of success. To determine the net effect of first-hand success experience, we predicted probabilities of project failure against first-hand success experience, with all other variables calculated at their mean value. Figure 3 indicates that an organization's first-hand success experience has a negative impact on the likelihood of future drug development projects being ceased. In particular, our analysis shows that, keeping all other variables at mean values, increasing the first-hand success experience variable by one standard deviation reduces the probability of failure from .94 to .89. Model 6 includes both first-hand experience variables. In Model 6, we see how the coefficients for first-hand experience of late-stage failure and success remain stable. A Wald test ($p < .001$) suggests that the first-hand success experience coefficient in Model 6 is significantly more negative than the coefficient for first-hand late-stage failure experience. This is consistent with the argument that success

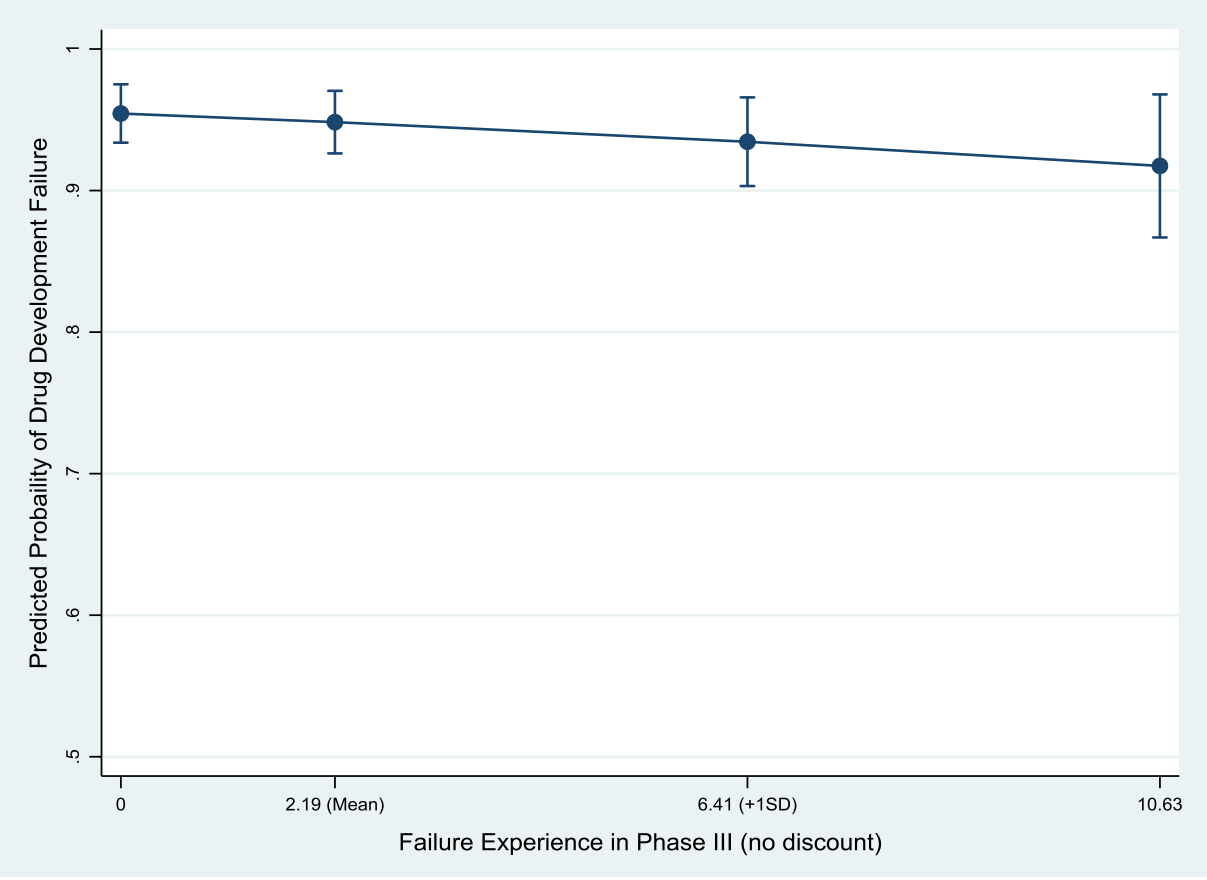

Figure 2. Effect of First-Hand Late-Stage Failure Experience on the Likelihood of Future Drug Development Projects Being Ceased

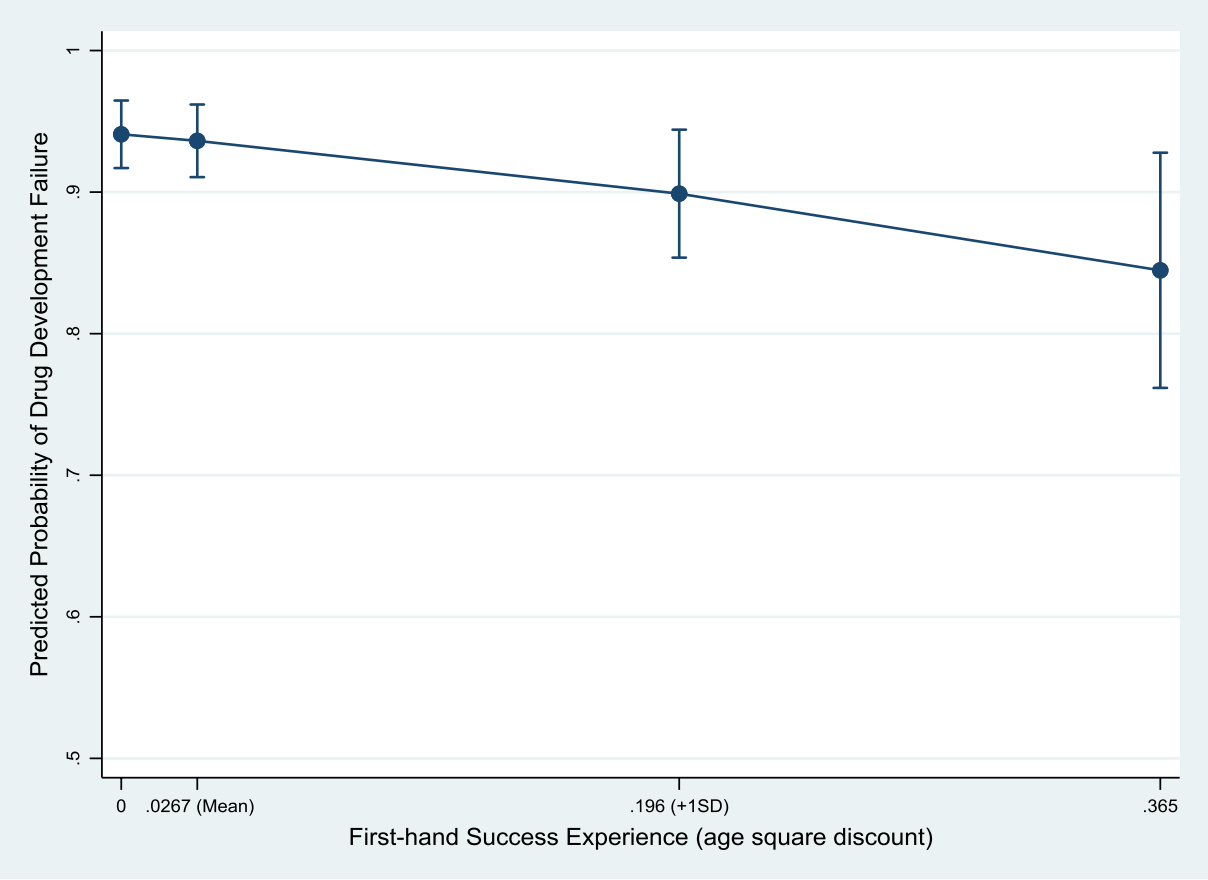

Figure 3. Effect of First-Hand Success Experience on the Likelihood of Future Drug Development Projects Being Ceased

experience is more likely to reduce the likelihood of future drug development projects being ceased than first-hand experience of late-stage failure. These findings do not support H2.

H3 suggested that the probability of drug failure is lower with others' related experience of late-stage failure than with first-hand experience of late-stage failure. In Model 7, we can see that the impact of others' related late-stage failure experience on the likelihood of future drug development projects being ceased is positive and significant ($p < .05$). This indicates that the likelihood of future drug development projects being ceased increases as the number of others' related late-stage failure increases. In Model 8, others' related late-stage failure experience and first-hand late-stage failure experience both remain unchanged. We also conducted marginal effects analysis for others' related late-stage failure experience and present them in Figure 4. Further analysis shows that increasing others' related late-stage failure experience by one standard deviation, while keeping all other variables at mean values, increases the probability of failure from .93 to .96. These results do not support H3, as the coefficient for first-hand late-stage failure experience is negative while the coefficient for others' related late-stage failure experience is positive.

In H4, we anticipated that others' related experience of success reduces the likelihood of failure more than first-hand experience of success. In Model 9, we can see how others' related success experience is negative and significant ($p < .001$). This value remains negative although it loses some significance ($p < .01$) when the others' related success experience variable is included with first-hand success experience in Model 10. We can also appreciate how first-hand success experience becomes nonsignificant, even though it remains negative, when combined with others' related success experience in Model 8. These results support H4 and suggest that others' related success experience is more likely to reduce the likelihood of future drug development projects being ceased than first-hand success experience. We also conducted a marginal effects analysis

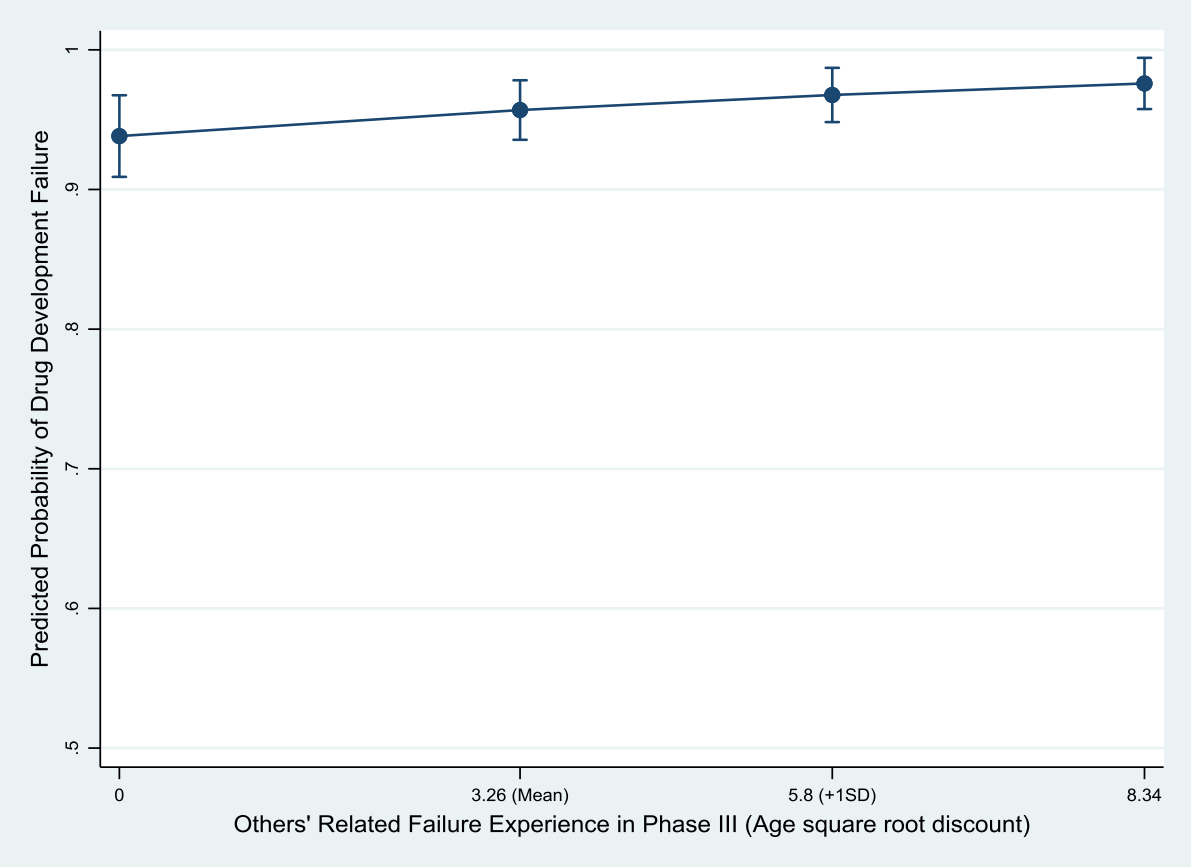

Figure 4. Effect of Others' Related Late-stage Failure Experience on the Likelihood of Future Drug Development Projects Being Ceased

for others' related success experience and present the results in Figure 5. Increasing others' related success experience by one standard deviation, while keeping all other variables at mean values, decreases the probability of failure from .95 to .92.

Robustness Tests

In addition to the main analyses reported above, we conducted supplementary analyses to assess whether our results were robust. First, while the use of fixed effects models is consistent with previous studies on failure (Madsen and Desai, 2010), there are other ways to model our data. Specifically, we used a probit random effects specification to address the nonindependence of observations within organizations (Wry, Lounsbury, and Jenni, 2014). A random effects specification divides the residual of each observation into organization-specific and other components to allow for organization-level changes through time. The advantage of random effects modeling is that it looks at the increase in the odds of failure averaged over all the organizations in the population and not just in the increase in the odds of failure in the organization the drug belongs to. Because the focus in random effects modeling is the whole population, these analyses included firms that had only successes or failures and that were left out of the fixed effects analysis. We used the "xtprobit" command in STATA 12, and present the results in Table 3. The pattern of results was similar to the fixed effects model with no changes in the signs of the experience variables. There was one difference in significance of the first-hand experience of success variable, which becomes significant in the robustness analysis.

We also conducted analyses using a theoretical rationale based on our interactions with practitioners in the industry. We assumed that phase I failure experiences, due to their smaller cost implications, depreciate the fastest; therefore, we used the square of their ages. For phase II failure experiences, we used an age

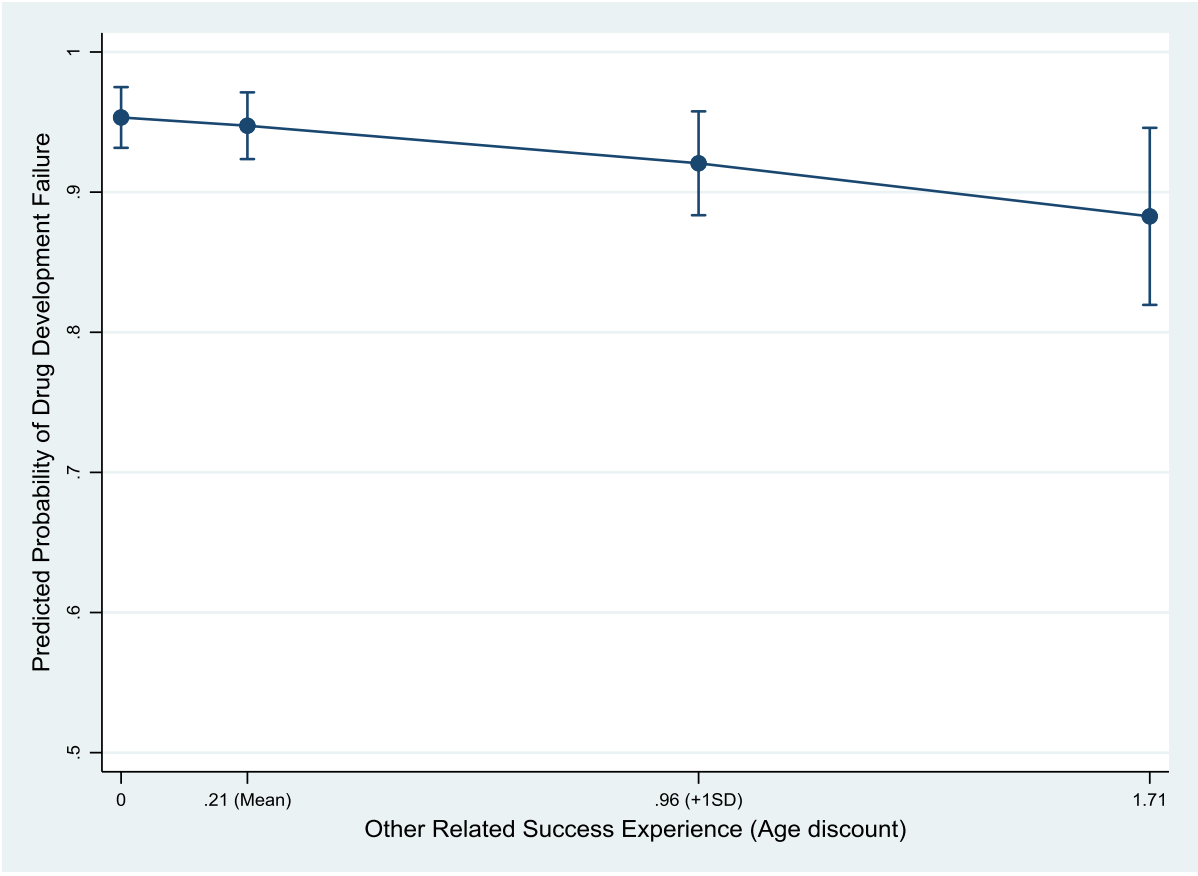

Figure 5. Effect of Others' Related Success Experience on the Likelihood of Future Drug Development Projects Being Ceased

discount to represent a slower depreciation of knowledge to that of phase I failure experiences. Last, we assumed that, due to the magnitude involved, both first-hand and others' phase III failure experiences would depreciate even more slowly than those experiences of phase II. Therefore, we employed a depreciation factor of the square root of their ages. The results yielded the same support to our hypotheses as the main models. We also followed other prior studies when using the same discount factor for different types and employed the age of the experience as a discount (Kim and Miner, 2009; Meschi and Métais, 2013). The direction of the predictions was the same as those in the main analysis.

One of the concerns when developing the ideas in this study was whether the explanatory variables employed added extra explanatory power. One of the aims of the research presented here was to suggest that breaking down first-hand total failure experience into early-, medium-, and late-stage phases is of interest when explaining drug failure. In order to test whether early-, medium-, and late-stage failure experiences added any value to the analysis, we reanalyzed the data with a total first-hand failure experience. The resulting model was significant, but the models that disaggregated total failure experience into first-hand early-, medium-, and late-stage failure experiences yielded a better fit.

Discussion

We examined whether experiences of NPD failure and success shape the outcome of a firm's subsequent NPD. In particular, we looked at failure experiences with different saliences, and at whether they took place inside or outside the firm. Using the ABV of the firm, we considered different mechanisms to explain whether a type of experience—failure or success—is more likely to attract the attention of decision-makers, and whether this affects the prospects of future NPD.

One major finding from our work is that failure experience reduces the likelihood of NPD being ceased

Table 3. Robustness Test: Probit Models Predicting Drug Development Projects Being Ceased

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
R&D alliance	−.25 (.13)	−.23 (.12)	−.24 (.13)	−.26* (.13)	−.25* (.13)	−.24 (.13)	−.25 (.13)	−.26* (.12)	−.26* (.13)	−.27* (.13)
Year	.04* (.02)	.03* (.01)	.04* (.02)	.05** (.02)	.02 (.02)	.03* (.02)	.03* (.02)	.03 (.01)	.04* (.02)	.05** (.02)
Organization's role	.04 (.14)	.05 (.14)	.04 (.14)	.04 (.14)	.03 (.14)	.04 (.14)	.02 (.14)	.03 (.14)	.03 (.14)	.03 (.14)
Percentage failed	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)
Therapeutic area experience	.00 (.01)	.00 (.01)	.00 (.01)	.01 (.01)	.00 (.01)	.01 (.01)	.00 (.01)	.00 (.01)	−.01 (.01)	.00 (.01)
Rare disease	−.16 (.24)	−.14 (.23)	−.15 (.24)	−.14 (.24)	−.16 (.24)	−.12 (.23)	−.18 (.23)	−.18 (.23)	−.17 (.24)	−.15 (.24)
Therapeutic area risk	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)
Biological origin risk	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)	.02*** (.00)
R&D investment	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)
First-hand early-stage failure experience (age disc.)		1.63 (.84)				1.74 (1.88)				
First-hand medium-stage failure experience (age disc.)			1.32 (.28)			1.20 (1.05)				
First-hand late-stage failure experience (no disc.)				−.06* (.02)		−.06* (.02)		−.04 (.03)		
First-hand success experience (age square disc.)					−1.59*** (.34)	−1.59*** (.34)				−1.21*** (.36)
Others' related late-stage failure experience (age square root disc.)							.08** (.03)	.07* (.03)		
Others' related success experience (age disc.)									−.42*** (.03)	−.32** (.11)
Wald chi square	226.99	249.93	226.94	226.90	226.02	247.11	226.75	245.80	228.81	228.07
Log likelihood	−831.94	−817.30	−828.27	−829.88	−829.32	−809.27	−818.71	−812.44	−827.74	−826.36
N	2750	2750	2750	2750	2750	2750	2750	2750	2750	2750
Clusters	848	848	848	848	848	848	848	848	848	848

Positive coefficients indicate that increases in the value of independent and control variables increase the probability of drug development failure and vice versa.
*$p < .05$, **$p < .01$, ***$p < .001$.

only if the failure experience is substantially salient in terms of its financial implications and rarity. We argue that when a failure has major financial consequences and is rare, as is the case with phase III failures, it will get more organizational attention and, therefore, be more likely to affect decisions regarding ongoing and future NPD. This goes some way in explaining our findings. Early and medium failures in the biotech industry have considerably smaller financial consequences and are more frequent than late-stage failures. We do not argue that the financial consequences of small- and medium-stage failures in the biotech industry are not considerable, only that in situations in which organizational attention is limited, it will be those rarer events with greater impact that become managers' primary focus of attention.

Our findings also show that experience of success attracts more attention and, therefore, is more beneficial to future NPD than experience of late-stage failure. Contrary to our findings, Madsen and Desai (2010) show that failure attracts the attention of decision-makers and promotes improvement more so than success; however, their study is in the orbital launch vehicle industry, where successes are the norm. In the biotech industry, successes are rare, with only 15% of all drugs successfully reaching the market. This difference in the rate of success in both industries might explain the fact that, in our study, success attracts more attention and leads to better outcomes. Furthermore, in the context of the biotech industry, successes not only indicate the success of a particular drug but also the success of a certain strategy to combat a disease. Therefore, in an industry in which successes are rare, an organization may be led to believe that their strategy—scanning the environment for new knowledge and translating it into a product—is adequate. We therefore posit that our results are more likely to be generalizable to other NPD industries that share similar rates of success, and to early-, medium-, and late-stage failures within the biotech industry.

Additionally our study indicates that an increase in others' related late-stage failure experience results in an increase in the likelihood of future drug development projects being ceased in the organization. We interpret these findings as indicating that the related late-stage failures of others do in fact attract the attention of decision-makers, but not because they are interested in extracting information to improve the prospects of their own similar drug development projects. Rather, such decision-makers, particularly those in the biotech industry, are more interested in the efficacy of a certain strategy in combating a certain disease. In other words, a drug failure might push observing firms to examine the evidence surrounding their own similar projects; a process that often results in the project being terminated. An example is bapineuzumab, a drug to combat Alzheimer's disease, that failed at phase III in 2012. This late-stage failure led to a sense of panic in observing firms with similar projects, resulting in many of them being terminated.

On the other hand, this study supports the claim that others' related success experience has a greater impact on future NPD than first-hand success experience. One possible reason for this might be that certain successes in the biotech industry have seen some decision-makers becoming overconfident (Gino and Pisano, 2011; Louis and Sutton, 1991). As argued previously, the financial implications of success might remove some of the urgency in looking for new innovative drugs, resulting in organizations becoming less inclined, or able, to reduce the likelihood of future drug development projects being ceased. The fact that observing organizations do not reap the financial rewards from the success, and are consequently not susceptible to overconfidence, might explain how they benefit more from others' experience of success.

We find an exception in the above rationale in our robustness analysis. Small organizations, those with only one or two drug development projects in their pipeline, seem to benefit from first-hand success experience. A possible reason for this finding is that first-hand successes have a slightly different meaning for smaller organizations. One isolated success for a small organization, without no prior history of drug development, would not be enough to remove the urgency in looking for new innovative drugs.

Theoretical Implications

Ocasio (2011) proposes that attentional engagement provides sources of variation in organizational sensemaking, thereby providing variation in organizational outcomes. However, he calls for more use of hypothesis-testing and quantitative methods in addressing attention. We contribute to this call in several ways. First, this study expands the ABV literature by developing our understanding of circumstances under which failure experience can improve organizations' future

NPD. Our study is the first one to show that NPD failures attract the attention of decision-makers differently, depending on the stage of development at which they take place. Our findings extend the idea that more salient failures are more difficult for organizations to ignore and are, consequently, more likely to affect any future decisions made (Madsen and Desai, 2010). In particular, our results add evidence to the literature indicating that organizations are less likely to benefit from failures that are not rare and/or have no major financial consequences relative to others' failure events.

Second, our findings run counter to some studies within the ABV suggesting that accountability and negative emotions after salient failures negatively affect organizations' attention toward improved outcomes. For example, our results are at odds with the small losses hypothesis in the ABV literature, which argues that, after salient failures, organizations are more likely to experience a decrease in their performance because they might dedicate more attention to determining accountability than to understanding the event and improving future outcomes (Gong et al., 2017; Hayward, 2002). Even though we do not measure accountability, our results suggest that even if companies in the biotech industry might dedicate some of their attention to accountability after a salient failure, their performance is, nonetheless, not affected by it. One reason that might explain this is that, in the biotech industry, there exists a stronger normalization of failure, which might reduce the need to blame others and see a reduced intensity of negative effects (Shepherd et al., 2011). We do not interpret this finding as evidence that negative emotions or accountability have no role to play in future actions that might affect the future of forthcoming NPD, but it does suggest that the salience of late-stage failures plays a bigger role in pushing the firm toward scrutinizing and extracting information relevant to the event in question.

Third, our results challenge the ABV assumption that organizations pay more attention to, and benefit more from, knowledge searches sparked by prior failure (Cyert and March, 1963; Lant et al., 1992; Madsen and Desai, 2010; March and Shapira, 1992). In fact, our findings support other prior studies claiming that rare successes are seen by managers as rich examples to follow and a way to excel during new projects (Deichmann and van den Ende, 2013; KC et al., 2013; Lampel et al., 2009). Our results indicate that organizational attention depends on the industry and the rarity of the events. This is an important contribution because, as our results show, whether organizations decide to pay more attention to failure or to success depends on the rarity and salience of these events in a specific industry. Comparing results across industries helps us draw some conclusions about the roles of failure and success experiences on NPD.

Fourth, our study also builds on the ABV of the firm by expanding our knowledge of the way that firms react to others' failures and successes. Our results are in contrast to certain scholastic claims that others' failures help improve the prospect of future projects (Baum and Dahlin, 2007; Madsen and Desai, 2010). In contrast to these studies, our results suggest that others' failures do attract the attention of the organization, but that this attention in fact leads to the termination of similar existing projects. Similarly, our study supports the well-established assumption that successes are of interest to organizations and result in improved prospects for their similar projects.

Implications for Practice

The results of this study have several implications for practice. First, as highlighted by Madsen and Desai (2010), how organizations deal with failure explains interorganizational variation in their outcomes. These authors suggest that managers should acknowledge failures in order to recognize the central role they play in organizational outcomes. According to their findings, organizations' leaders should not ignore failures; rather, they should treat them as invaluable opportunities. Our findings expand upon this assertion, suggesting that managers do not treat all types of failures equally; cost implications and rarity play a role in the level of attention they receive. In particular, our results indicate that, during the earlier stages of development, managers miss an opportunity by not paying enough attention to less salient failures, which have the potential to be quite valuable. As such, we believe that managers should increase their efforts to study less costly failures, since doing so might help their organizations from incurring a more expensive backlash further down the line. We do not suggest that paying more attention to less costly failures should be at the expense of those with higher cost; rather, managers should widen their scope, putting in place processes that

allow failures with lesser consequences—which potentially contain important lessons for the future—to be scrutinized more carefully.

Second, failure should still be acknowledged by organizations, but not at the expense of success experience. As our findings show, failure does not always have a greater impact on organizations than success and, consequently, it should not always be the primary focus of attention. As a result, we suggest that firms put equal effort into extracting value from successes as they do from failures. For example, the deployment and use of "after action reviews" (AARs) could be of considerable assistance in this regard (Garvin, 2000). AARs are useful for developing efficient but systematic reviews of both successes and failures. Moreover, they help provide a forum where norms of psychological safety can be established, which are important contributors to extracting value from experiences. Such norms can be developed more easily if managers and project participants gain experience in systematically discussing success and failure experiences, where openness and sharing of experience is more likely.

Third, managers are often unaware of the potential danger in not extracting as much value from their successes as their competitors. Positive feedback from success should not lead to believing that no extra effort is required to understand what led to that success. Indeed, our results indicate that even though organizations benefit from their own successes, observing organizations benefit even more. This suggests that organizations are not extracting as much value from their own successes as their competitors do. As we suggested in our discussion, this might be a result of overconfidence leading to organizations experiencing success putting less effort into understanding the implications of their success than their competitors. Therefore, organizations experiencing success need to put in place processes to avoid overconfidence that might prevent them from extracting as much value as their competitors.

Fourth, managers need to understand that others' failures may indicate problems for their own similar projects. In the biotech industry, managers are aware of the importance of other related failures, and most firms have well-established processes and protocols in place to scan and analyze related failure events in their environment. Every time a phase III failure takes place in the industry, firms start a process of analysis to try to understand the immediate consequences for their own related projects. Surprisingly, and despite managerial awareness of the importance of others' similar failures, our results show that these efforts are not sufficient enough to improve firms' outlooks. Therefore, we suggest that managers dedicate greater time to understanding the implications of others' salient failures. For example, processes such as competitive intelligence can be deployed to assess competitors' strategies and tactics before salient failures. More fine-grained intelligence projects can be deployed to review other firms' failures. Such intelligence enhances decision-makers' peripheral vision and thence their adaptability and agility (Schoemaker, Krupp, and Howland, 2013).

Limitations and Future Research

Based on the limitations of this study, we can propose a number of recommendations for future research on the topic of failure and success experiences. First, we focused on a specific setting, in the form of a single industry: biotech. Single-industry samples, while allowing control for exogenous industry effects, limit generalizability. This is particularly important when the rarity and financial implications of successes and failures vary according to industry conditions. Therefore, it would be advisable to probe generalizability to other sectors, including the development of small-molecule drugs. Similarly, research in other NPD industries with similar rates of failure and success to our sample might also help unearth other nuances not present in our work.

Second, considering prior work, we made several assumptions in order to explain the connection between experience and the probability of future failure (i.e., the likelihood of future drug development projects being ceased). Some of these assumptions exist at the micro level, while our analysis is conducted at the macro level. For example, we assume that failures and successes cause negative emotions that affect how decision-makers confront future decisions and, accordingly, future outcomes. This is an important limitation; we believe that future work should look into micro-level factors, such as emotions, motivations, or decision-making processes, and determine how these affect macro-level variables, such as the likelihood of future NPD failure.

The third limitation arises from the fact that we use a limited understanding of related failure and success experiences. In particular, we employ therapeutic areas to determine whether two drug development projects

are related. Despite using very well-established criteria for our chosen industry, this does not exhaust other relevant ways in which two projects might be similar. Specifically, firms could extract relevant information from projects that are similar in biological origin, mode of action, or delivery, even though they might be different in a therapeutic sense. We suggest that other studies use alternative methods to understand the concepts of "related" and "unrelated" to see if the findings hold. Changing the industry might also affect how the related/unrelated pair affects NPD.

Fourth, this study indicates that the mechanisms employed by firms to extract information from failures and successes are relevant and, in some cases, insufficient to improve organizations' outlooks. Nonetheless, we do not examine how these processes might work. This limitation constitutes an important opportunity for future work. More research on the particular processes that organizations employ to analyze failure and success events is needed. This work could then shed light upon the particular deficiencies that currently exist in the ways that organizations deal with failure and success experiences.

Fifth, this study uses logistic regression analysis to model the likelihood that a drug development project resulted in failure. Even though this approach has been widely employed by other similar studies in the literature (e.g., Madsen and Desai, 2010), it has its limitation. For example, it does not capture how success and failure experience affect different outcomes at different times in the future. Future research could look at this limitation and explore the impact that success and failure experience have on different specific outcomes at different specific times.

Sixth, this research only covers drug development projects from phase I to launch. In order to fully understand the role of success and failure experience in drug development, other studies could look at the preclinical stages where failure rates are even higher.

References

Argote, L., and E. Miron-Spektor. 2011. Organizational learning: From experience to knowledge. *Organization Science* 22 (5): 1123–37.

Argyris, C., and D. A. Schon. 1996. *Organizational theory II: Theory, method, and practice*. New York: Addison-Wesley.

Audia, P. G., and J. A. Goncalo. 2007. Past success and creativity over time: A study of inventors in the hard disk drive industry. *Management Science* 53 (1): 1–15.

Audia, P. G., E. A. Locke, and K. G. Smith. 2000. The paradox of success: An archival and a laboratory study of strategic persistence following radical environmental change. *Academy of Management Journal* 43 (5): 837–53.

Barczak, G. 2014. From the editor. *Journal of Product Innovation Management* 31 (4): 640–1.

Baum, J., and P. Ingram. 1998. Survival enhancing learning in the Mahattan hotel industry, 1998–1980. *Management Science* 44 (7): 996–1016.

Baum, J. A. C., and K. B. Dahlin. 2007. Aspiration performance and railroads' patterns of learning from train wrecks and crashes. *Organization Science* 18 (3): 368–85.

Beckman, C. M., and P. R. Haunschild. 2002. Network learning: The effects of partners' heterogeneity of experience on corporate acquisitions. *Administrative Science Quarterly* 47 (1): 92–124.

Bresman, H. 2013. Changing routines: A process model of vicarious group learning in pharmaceutical R&D. *Academy of Management Journal* 56 (1): 35–61.

Carroll, G. R., and M. T. Hannan. 1995. *Organizations in industry: Strategy, structure, and selection*. Oxford: Oxford University Press.

Castellion, G., and S. K. Markham. 2013. Perspective: New product failure rates: Influence of argumentum ad populum and self-interest. *Journal of Product Innovation Management* 30 (5): 976–9.

Collins, M. 2015. Reducing the failure rate of new products. *Forbes*. Available at https://www.forbes.com/sites/mikecollins/2015/04/30/reducing-the-failure-rate-of-new-products/#562711005318.

Cyert, R. M., and J. March. 1963. *A behavioral theory of the firm*. Englewood Cliffs, NJ: Prentice-Hall.

Daft, R. L., and K. E. Weick. 1984. Toward a model of organizations as interpretation systems. *Academy of management review* 9 (2): 284–95.

Danzon, P. M., S. Nicholson, and N. S. Pereira. 2005. Productivity in pharmaceutical-biotechnology R&D: The role of experience and alliances. *Journal of Health Economics* 24 (2): 317–39.

Darr, E. D., and L. Argote. 1995. The acquisition, transfer, and depreciation of knowledge in service organizations: Productivity in franchises. *Management Science* 41 (11): 1750–63.

Deichmann, D., and J. van den Ende. 2013. Rising from failure and learning from success: The role of past experience in radical initiative taking. *Organization Science* 25 (3): 670–90.

Desai, V. 2014a. Learning through the distribution of failures within an organization: Evidence from heart bypass surgery performance. *Academy of Management Journal* 58 (4): 1032–50.

Desai, V. M. 2014b. The impact of media information on issue salience following other organizations' failures. *Journal of Management* 40 (3): 893–918.

Dillon, R. L., and C. H. Tinsley. 2008. How near-misses influence decision making under risk: A missed opportunity for learning. *Management Science* 54 (8): 1425–40.

DiMasi, J. A., H. G. Grabowski, and R. W. Hansen. 2016. Innovation in the pharmaceutical industry: New estimates of R&D costs. *Journal of Health Economics* 47: 20–33.

Disterer, G. 2002. Management of project knowledge and experiences. *Journal of Knowledge Management* 6 (5): 512–23.

Economist. 2006. *When the drugs don't work: Pfizer gives a lesson in risk and reward*. London: Economist.

FiercePharma. 2010. *Torcetrapib—Pharma's Biggest Flops*. Available at https://www.fiercepharma.com/special-report/torcetrapib-pharma-s-biggest-flops.

Gardiner, B. 2008. *Bank failure in second life leads to calls for regulation*. Wired Magazine. Available at https://www.google.com/amp/s/www.wired.com/2007/08/bank-failure-in-second-life-leads-to-calls-for-regulation/amp.

Garvin, D. A. 2000. *Learning in action: A guide to putting the learning organization to work*. Boston, Massachusetts: Harvard Business Review press.

Garzón-Vico, A., P. Gibbons, P. McNamara, and J. Rosier. 2016. Technological area experience, experience diversity and innovation. *Technology Analysis & Strategic Management* 12 (9): 1–15.

Gavetti, G., H. R. Greve, D. A. Levinthal, and W. Ocasio. 2012. The behavioral theory of the firm: Assessment and prospects. *The Academy of Management Annals* 6 (1): 1–40.

Gino, F., and G. P. Pisano. 2011. Why leaders don't learn from success. *Harvard Business Review* 89 (4): 68–74.

Gong, Y., Y. Zhang, and J. Xia. 2017. Do firms learn more from small or big successes and failures? A test of the outcome-based feedback learning perspective. *Journal of Management* 45 (3): 1034–56.

Grant, R. M. 1996. Toward a knowledge-based theory of the firm. *Strategic Management Journal* 17: 109–22.

Greve, H. R. 2003. *Organizational learning from performance feedback: A behavioral perspective on innovation and change*. Cambridge: Cambridge University Press.

Gujarati, D. N. 1988. *Basic econometrics*. New York: McGraw-Hill.

Haunschild, P. R., and B. N. Sullivan. 2002. Learning from complexity: Effects of prior accidents and incidents on airlines' learning. *Administrative Science Quarterly* 47 (4): 609–43.

Hay, M., D. W. Thomas, J. L. Craighead, C. Economides, and J. Rosenthal. 2014. Clinical development success rates for investigational drugs. *Nature Biotechnology* 32 (1): 40–51.

Hayward, M. L. A. 2002. When do firms learn from their acquisition experience? Evidence from 1990 to 1995. *Strategic Management Journal* 23 (1): 21–39.

Hayward, M. L. A., V. P. Rindova, and T. G. Pollock. 2004. Believing one's own press: The causes and consequences of CEO celebrity. *Strategic Management Journal* 25 (7): 637–53.

Hoang, H., and F. T. Rothaermel. 2005. The effect of general and partner-specific alliance experience on joint R&D project performance. *Academy of Management Journal* 48 (2): 332–45.

Hoang, H., and F. T. Rothaermel. 2010. Leveraging internal and external experience: Exploration, exploitation, and R&D project performance. *Strategic Management Journal* 31 (7): 734–58.

Hoffman, A. J., and W. Ocasio. 2001. Not all events are attended equally: Toward a middle-range theory of industry attention to external events. *Organization Science* 12 (4): 414–34.

Hora, M., and R. D. Klassen. 2013. Learning from others' misfortune: Factors influencing knowledge acquisition to reduce operational risk. *Journal of Operations Management* 31 (1/2): 52–61.

Hosmer Jr, D. W., S. Lemeshow, and R. X. Sturdivant. 2013. *Applied logistic regression*. New York: John Wiley & Sons.

Hu, Y., P. McNamara, and D. Piaskowska. 2016. Project suspensions and failures in new product development: Returns for entrepreneurial firms in co-development alliances. *Journal of Product Innovation Management* 34 (1): 35–59.

Hudson, B. A. 2008. Against all odds: A consideration of core-stigmatized organizations. *Academy of Management Review* 33 (1): 252–66.

Huy, Q. N. 2002. Emotional balancing of organizational continuity and radical change: The contribution of middle managers. *Administrative Science Quarterly* 47 (1): 31–69.

Ingram, P., and J. A. C. Baum. 1997. Opportunity and constraint: Organizations' learning from the operating and competitive experience of industries. *Strategic Management Journal* 18: 75–98.

Kahneman, D. 2011. *Thinking, fast and slow*. New York: Macmillan.

Kahneman, D., and A. Tversky. 2013. Choices, values, and frames. In *Handbook of the fundamentals of financial decision making: Part I*, ed. L. C. MacLean and W. T. Ziemba, 269–78. Singapore: World Scientific.

KC, D., B. R. Staats, and F. Gino. 2013. Learning from my success and from others' failure: Evidence from minimally invasive cardiac surgery. *Management Science* 59 (11): 2435–49.

Kiefer, T. 2005. Feeling bad: Antecedents and consequences of negative emotions in ongoing change. *Journal of Organizational Behavior* 26 (8): 875–97.

Kim, J.-Y., J.-Y. Kim, and A. S. Miner. 2009. Organizational learning from extreme performance experience: The impact of success and recovery experience. *Organization Science* 20 (6): 958–78.

Kim, J.-Y. J., and A. S. Miner. 2007. Vicarious learning from the failures and near-failures of others: Evidence from the U.S. commercial banking industry. *Academy of Management Journal* 50 (2): 687–714.

Kim, J.-Y., and A. S. Miner. 2009. Organizational learning from extreme performance experience: The impact of success and recovery experience. *Organization Science* 20 (6): 958–78.

Kraaijenbrink, J. 2012. Integrating knowledge and knowledge processes: A critical incident study of product development projects. *Journal of Product Innovation Management* 29 (6): 1082–96.

Lampel, J., J. Shamsie, and Z. Shapira. 2009. Experiencing the improbable: Rare events and organizational learning. *Organization Science* 20 (5): 835–45.

Lant, T. K., F. J. Milliken, and B. Batra. 1992. The role of managerial learning and interpretation in strategic persistence and reorientation: An empirical exploration. *Strategic Management Journal* 13 (8): 585–608.

Lee, R. P., and Q. Chen. 2009. The immediate impact of new product introductions on stock price: The role of firm resources and size. *Journal of Product Innovation Management* 26 (1): 97–107.

Leonard-Barton, D. 1992. Core capabilities and core rigidities: A paradox in managing new product development. *Strategic Management Journal* 13 (S1): 111–25.

Levinthal, D., and J. G. March. 1981. A model of adaptive organizational search. *Journal of Economic Behavior & Organization* 2 (4): 307–33.

Levinthal, D. A., and J. G. March. 1993. The myopia of learning. *Strategic management journal* 14 (S2): 95–112.

Louis, M. R., and R. I. Sutton. 1991. Switching cognitive gears—From habits of mind to active thinking. *Human Relations* 44 (1): 55–76.

Macher, J. T., and C. S. Boerner. 2006. Experience and scale and scope economies: Trade-offs and performance in development. *Strategic Management Journal* 27 (9): 845–65.

Macher, J. T., and C. Boerner. 2012. Technological development at the boundaries of the firm: A knowledge-based examination in drug development. *Strategic Management Journal* 33 (9): 1016–36.

Madsen, P. M., and V. Desai. 2010. Failing to learn? The effects of failure and success on organizational learning in the global orbital launch vehicle industry. *Academy of Management Journal* 53 (3): 451–76.

Mantere, S., P. Aula, H. Schildt, and E. Vaara. 2013. Narrative attributions of entrepreneurial failure. *Journal of Business Venturing* 28 (4): 459–73.

March, J. G. 1991. Exploration and exploitation in organizational learning. *Organization Science* 2 (1): 71–87.

March, J. G., and Z. Shapira. 1992. Variable risk preferences and the focus of attention. *Psychological Review* 99 (1): 172–83.

Markovitch, D. G., J. H. Steckel, A. Michaut, D. Philip, and W. M. Tracy. 2015. Behavioral reasons for new product failure: Does overconfidence induce overforecasts? *Journal of Product Innovation Management* 32 (5): 825–41.

Mayer, K. J., and R. M. Salomon. 2006. Capabilities, contractual hazards, and governance: Integrating resource-based and transaction cost perspectives. *Academy of Management Journal* 49 (5): 942–59.

Meschi, P.-X., and E. Métais. 2013. Do firms forget about their past acquisitions? Evidence from French acquisitions in the United States (1988–2006). *Journal of Management* 39 (2): 469–95.

Meschi, P. X., and E. Métais. 2015. Too big to learn: The effects of major acquisition failures on subsequent acquisition divestment. *British Journal of Management* 26 (3): 408–23.

Miller, D. 1994. What happens after success: The perils of excellence. *Journal of Management Studies* 31 (3): 325–58.

Miner, A. S., and P. R. Haunschild. 1995. Population level learning. In *Research in organizational behavior: An annual series of analytical essays and critical reviews/1995*, ed. B. Staw and L. Cummings, 115–66. Greenwich, CT: Jai Press.

Miner, A. S., J. Y. Kim, I. W. Holzinger, and P. Haunschild. 1999. Fruits of failure: Organizational failure and population-level learning. *Advances in Strategic Management* 16: 187–220.

Muehlfeld, K., P. Rao Sahib, and A. Van Witteloostuijn. 2012. A contextual theory of organizational learning from failures and successes: A study of acquisition completion in the global newspaper industry, 1981–2008. *Strategic Management Journal* 33 (8): 938–64.

Nelson, R., and S. Winter. 1982. *An evolutionary theory of economic change*. Cambridge, MA: The Belknap Press of Harvard University Press.

Nesta, L., and P. P. Saviotti. 2005. Coherence of the knowledge base and the firm's innovative performance: Evidence from the U.S. pharmaceutical industry. *The Journal of Industrial Economics* 53 (1): 123–42.

Nygren, T. E., A. M. Isen, P. J. Taylor, and J. Dulin. 1996. The influence of positive affect on the decision rule in risk situations: Focus on outcome (and especially avoidance of loss) rather than probability. *Organizational Behavior and Human Decision Processes* 66 (1): 59–72.

Ocasio, W. 1997. Towards an attention-based view of the firm. *Psychology* 1: 403–4.

Ocasio, W. 2011. Attention to attention. *Organization Science* 22 (5): 1286–96.

Olivera, F., and L. Argote. 1999. Organizational learning and new product development: CORE processes. In *Shared cognition in organizations: The management of knowledge*, ed. J. M. Levine, L. Leigh, D. Thompson, and M. Messick, 297–325. Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Paladino, A. 2007. Investigating the drivers of innovation and new product success: A comparison of strategic orientations. *Journal of Product Innovation Management* 24 (6): 534–53.

Posen, H. E., J. Lee, and S. Yi. 2013. The power of imperfect imitation. *Strategic Management Journal* 34 (2): 149–64.

Scarbrough, H., M. Robertson, and J. Swan. 2015. Diffusion in the face of failure: The evolution of a management innovation. *British Journal of Management* 26 (3): 365–87.

Schoemaker, P. J., S. Krupp, and S. Howland. 2013. Strategic leadership: The essential skills. *Harvard Business Review* 91 (1): 131–4.

Shepherd, D. A., and M. S. Cardon. 2009. Negative emotional reactions to project failure and the self-compassion to learn from the experience. *Journal of Management Studies* 46 (6): 923–49.

Shepherd, D. A., J. M. Haynie, and H. Patzelt. 2013. Project failures arising from corporate entrepreneurship: Impact of multiple project failures on employees' accumulated emotions, learning, and motivation. *Journal of Product Innovation Management* 30 (5): 880–95.

Shepherd, D. A., H. Patzelt, T. A. Williams, and D. Warnecke. 2014. How does project termination impact project team members? Rapid termination, "creeping death," and learning from failure. *Journal of Management Studies* 51 (4): 513–46.

Shepherd, D. A., H. Patzelt, and M. Wolfe. 2011. Moving forward from project failure: Negative emotions, affective commitment, and learning from the experience. *Academy of Management Journal* 54 (6): 1229–59.

Simon, H. 1947. *Administrative behavior: A study of decision-making processes in administrative organizations*. Chicago: MacMillan.

Sitkin, S. B., and A. L. Pablo. 1992. Reconceptualizing the determinants of risk behavior. *The Academy of Management Review* 17 (1): 9–38.

Sitkin, S. B., and L. R. Weingart. 1995. Determinants of risky decision-making behavior: A test of the mediating role of risk perceptions and propensity. *Academy of Management Journal* 38 (6): 1573–92.

Srinivasan, R., P. Haunschild, and R. Grewal. 2007. Vicarious learning in new product introductions in the early years of a converging market. *Management Science* 53 (1): 16–28.

Su, P., and P. McNamara. 2012. Exploration and exploitation within and across intra-organisational domains and their reactions to firm-level failure. *Technology Analysis & Strategic Management* 24 (2): 129–49.

Talay, M. B., R. J. Calantone, and C. M. Voorhees. 2014. Coevolutionary dynamics of automotive competition: Product innovation, change, and marketplace survival. *Journal of Product Innovation Management* 31 (1): 61–78.

Wei, Z., Y. Yi, and H. Guo. 2014. Organizational learning ambidexterity, strategic flexibility, and new product development. *Journal of Product Innovation Management* 31 (4): 832–47.

Wry, T., M. Lounsbury, and P. D. Jenni. 2014. Hybrid vigor: Securing venture capital by spanning categories in nanotechnology. *Academy of Management Journal* 57 (5): 1309–33.

Yang, J. Y., J. Li, and A. Delios. 2015. Will a second mouse get the cheese? Learning from early entrants' failures in a foreign market. *Organization Science* 26 (3): 908–22.

Yu, T., M. Sengul, and R. H. Lester. 2008. Misery loves company: The spread of negative impacts resulting from an organizational crisis. *Academy of Management Review* 33 (2): 452–72.