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Contradictory yet Coherent? Inconsistency in Performance Feedback and R&D Investment Change

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In this paper, we study to what extent inconsistent feedback signals about performance affect firm adaptive behavior in terms of changes made to research-and-development (R&D) investments. We argue that inconsistency in performance feedback—based on discrepancies between two distinct performance signals—affects the degree to which such investments will be changed. Our aim is to show that accounting for inconsistent performance feedback is necessary as predictions for the direction of change in R&D investments based on the individual performance feedback signals are contradictory. Furthermore, we contribute by proposing a holistic consideration mechanism as an alternative to the selective attention mechanism previously applied to inconsistent performance feedback. Our findings show that the impact of inconsistency depends on the exact configuration of the underlying performance feedback signal discrepancies. While consistently negative performance feedback signals would amplify their impact in stimulating increased R&D investments, inconsistent performance feedback signals created more nuanced effects. Having lower performance compared to an industry-based peer group—despite doing well compared to the previous year—made firms decrease their R&D investments. For the

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opposite case of inconsistent performance feedback, we did not find an effect on change in R&D investments. These findings support to a degree our contention that explaining the effects of inconsistent performance feedback requires a holistic consideration theoretical mechanism instead of one involving selective attention. In sum, these findings suggest future research should take into account the differences between distinct instances of inconsistent performance feedback.

Keywords: *performance feedback; inconsistency; behavioral theory of the firm; R&D*

Organizational decision makers commonly strive to enhance the survival of their firms and achieve desired levels of performance. In circumstances where this does not occur, they seek ways to get their firm back on track. One of the strategies at their disposal is to invest in research and development (R&D). R&D is a vital step on the path toward the successful launch of innovations (Crépon, Duguet, & Mairesse, 1998; Greve, 2003a), even though in the short run it is a cost and thus negatively impacts accounting performance indicators, such as return on assets (Gavetti, Greve, Levinthal, & Ocasio, 2012). Innovations are impactful to firms in ensuring their continued existence and achieving above-average performance (for a recent meta-analysis, see Bowen, Rostami, & Steel, 2010). Given the benefits that can be gained from innovation, the normative implication for firm decision makers would be that they should strive to bring about innovation. As being innovative is by no means a matter of direct managerial choice, the amount of resources invested to that effect (R&D) is the primary way for decision makers to exert agency over the circumstances that foster innovation in their firms. Therefore, it becomes relevant to determine under what circumstances firms will increase or decrease their R&D expenditures.

The main focus in studies seeking to explain firm-level R&D spending has been on structural and environmental antecedents. Levin, Cohen, and Mowery (1985) showed that R&D intensity was higher in younger industries with a strong science base where the government invested substantially in technology. Cohen and Klepper (1992) compared the distribution of R&D intensities within industries and found that they are quite similar from one industry to the next. They argued that this implies within-industry variance in R&D intensity is driven by certain unobserved firm characteristics that are a function of features of the industry. Lee, Yoo, and Kwak (2011) demonstrated that among Korean firms, higher R&D activity was displayed by larger firms, firms receiving foreign direct investment, and firms experiencing conducive external industry conditions. Cefis and Orsenigo (2001) found that high levels of firm innovative activity tended to remain stable over time, while differences were found to be a matter of sector and firm size. In sum, factors driving rather stable levels of R&D among similar firms have been emphasized over the antecedents of within-firm variability in R&D intensity. Thus, the question of what stimulates an increase or decrease in R&D intensity has received less attention.

In this paper we seek to explain under what circumstances *changes* in R&D intensity at the firm level occur. Over and above the variance in R&D investment levels explained by the aforementioned structural and field level factors, there are particular firm-specific factors causing heterogeneity between firms to manifest over time. We take a behavioral approach

and conceptualize within-firm changes in R&D investment as a process of organizational adaptation. Specifically, we apply those behavioral theories linking feedback on organizational performance to organizational adaptation to explain changes in R&D investment levels. These behavioral theories offer explanatory factors that vary on the firm level—feedback on organizational performance—to explain part of the heterogeneity in R&D intensity between firms occurring over time.

How performance feedback affects organizational adaptation is an important issue in studies on organization, management, and strategy (Argote & Greve, 2007). Several contributions to the literature (Greve 2003c, 2010; Haleblian & Rajagopalan, 2005; Lant, Milliken, & Batra, 1992; Lant & Shapira, 2008; Milliken & Lant, 1991) have shown adaptation following performance feedback occurs in many organizational aspects, such as goal setting, expectation formation, evaluating alternative courses of action, and actual and impactful changes to organizational structures, procedures, and strategies. A few studies have already investigated how performance feedback affects R&D, yielding an empirical baseline we build on and advance (W. Chen, 2008; W. Chen & Miller, 2007; Greve, 2003a; Salge, 2011; Vissa, Greve, & Chen, 2010). We discuss these studies in detail in our theory section and demonstrate that in sum, they amount to a partial insight into R&D investment decision making. We aim to advance our understanding of this key organizational decision.

We extend this line of work on performance feedback by focusing on the oftentimes implicitly acknowledged role of *inconsistent performance feedback* (Baum, Rowley, Shipilov, & Chuang, 2005; Greve, 1998). Inconsistent performance feedback means that the information available to the organization to evaluate its performance and determine whether or not to engage in adaptive behavior contains internal contradictions. These internal contradictions matter because they make it hard to come to an unambiguous conclusion whether or not the organization is achieving a level of performance that compares favorably to its goals. For instance, a firm might have increased its market share yet saw the value of its sales decline in a given year. On the one hand, this firm might conclude that demand happened to be lower than usual in the current year, while its increase in market share shows its strategy is the right one. On the other hand, this firm might interpret the situation as one in which the market is becoming less interested in the current product range offered by the industry at large. In the latter situation, a firm would probably increase its R&D efforts seeking to develop products that better meet changed demands, while in the former situation, a firm would not reevaluate its R&D efforts. Based on this illustration of the countervailing pressures exerted by inconsistent performance feedback, we put forward the following research question: To what extent does inconsistent performance feedback affect change in R&D investment?

By advancing existing theory on the impact of inconsistent performance feedback, we make our most important theoretical contribution. The literature so far has proposed two diametrically opposed decision rules based on selective attention to one part of the performance feedback to capture the process by which decision makers resolve the ambiguity introduced by inconsistent performance feedback (Baum et al., 2005; Greve, 1998). Departing from this selective attention theoretical mechanism, we propose an alternative decision rule, affordance-urgency, based on a *holistic consideration* theoretical mechanism. We arrive at this after questioning the assumption behind the existing decision rules that all instances of inconsistent performance feedback will have the same effect. Inconsistent performance feedback is an

ambiguous situation. This ambiguity might be a trigger for holistic consideration of the performance feedback. As a result of such more detailed evaluation of the performance feedback, decision makers could in the end conclude that despite the inconsistency between the signals, in combination they yield a coherent interpretation. The alternative mechanism we introduce encompasses exactly such holistic consideration. As such, we recognize that a broader range of responses to inconsistent performance feedback can occur than the literature currently accounts for. Hence, we primarily contribute to the literature on performance feedback and specifically to what impact inconsistency has on the performance feedback evaluation process.

Furthermore, our study makes two additional contributions to the literature on R&D and organizational performance feedback. First, studies using structural models report that levels of R&D intensity (R&D spending relative to sales) are rather stable over time and that most of the variance can be attributed to differences across industries (Máñez-Castillejo, Rochina-Barrachina, Sanchis, & Sanchis, 2009; Peters, 2009). We contribute to this literature by exploring the sources of firm-level heterogeneity by building on behavioral theories of performance feedback. Exploring such firm-level heterogeneity brings to the fore the circumstances that make firms change their level of R&D. Second, in behavioral theories on performance feedback, firms are described in rather generic terms, postulating that the predictions apply irrespective of industry, country, or other contextual aspects. Nevertheless, as will become clear from our review of the extant literature in the next section, most empirical studies in this tradition on R&D intensity sampled firms from a single industry or limited range of industries. Therefore, the current literature provides only partial insight into how performance feedback impacts R&D investment decision making. Limited generalizability of the findings is a key reason for this. Our study includes a very broad sample of firms from a larger variety of industries and countries than thus far used in a single study or in the sum of studies linking performance feedback to R&D. We thus contribute empirically by exploring the external validity of theories on performance feedback. This puts the general applicability of the theory to the test and will provide a better picture of its generalizability.

In the next section, we discuss the theoretical arguments linking performance feedback to adaptive behavior. In addition, we present hypotheses on how (inconsistent) performance feedback results in firm-level change in R&D investment. Next, we describe the details and outcomes of our empirical investigation of these hypotheses. Last, we discuss the implications of our findings, note the limitations of our study, and provide suggestions for further research on (inconsistent) performance feedback and R&D investment and innovation.

Theory and Hypotheses

In this section, we give an overview of the existing literature on performance feedback. In particular, we focus on those contributions that studied adaptive behavior in terms of changes in R&D investment. Based on this overview, we formulate baseline hypotheses that reflect the commonly hypothesized and empirically corroborated relationships between performance feedback and adaptive behavior. Furthermore, we focus on the subsection of the literature that included inconsistency in performance feedback and discuss predictions for its effect on adaptive behavior derived from the fire-alarm and self-enhancing rules. Our primary theoretical contribution concerns questioning a shared assumption underlying the two

decision rules and the selective attention mechanism they share—that all instances of inconsistent performance feedback will have the same consequence no matter the exact contradiction in the performance feedback—resulting in the final hypothesis. In this final hypothesis, we allow for different cases of inconsistent performance feedback to have opposite consequences. We derive these predictions from the holistic consideration (of all performance feedback signals) mechanism we introduce.

Performance Feedback and Firm-Level Change in R&D Investment

Starting from the seminal work of Cyert and March (1963), *A Behavioral Theory of the Firm*, scholars have considered what role performance feedback plays in organizational behavior (Greve, 2003c; Lant & Montgomery, 1987). Performance feedback is an information-generating mechanism in which realized performance is evaluated against an aspiration level—the value of performance which a (coalition of) decision maker(s) considers satisfying. The behavioral consequences of performance feedback do not derive from the firm maximizing performance but rather from the identification of the boundary between success and failure—in effect, the lowest level of performance decision makers find acceptable—and striving to attain at the very least a level of performance indicating success. Performance above the aspiration level is seen as a sign that the firm's strategy, routines, and structure are in line with the demands of the firm's environment, implying no radical changes are necessary. Conversely, performance below the aspiration level indicates a mismatch between the firm's strategy, routines, and structure and the demands placed on it by the firm's environment and will result in (radical) changes being made. As it developed over time, this line of work has shown that the relationship between performance feedback and adaptation is a matter of degree and not just a question of being below or above the aspiration level (Greve, 2003c; Lant & Montgomery, 1987). Most findings indicate that as performance increases relative to the aspiration level, the degree of changes made will decrease. This allows for some adaptation occurring in firms that did attain their aspiration level.

While there is no universal agreement regarding this in the literature, many studies argue and show organizational decision makers utilize multiple aspiration levels (W. Chen, 2008; W. Chen & Miller, 2007; Greve, 2003c; Salge, 2011). These aspiration levels are most commonly based on (a) aggregates of past performance and previous goal levels (*historical aspiration level*) as well as (b) performance of a selection of salient competitors (*social aspiration level*) or weighted combinations of these two performance cues (Greve, 2003a, 2003c; Vissa et al., 2010). While they are both used to evaluate current firm performance, historical and social aspiration levels do involve information sources that differ in relevant respects (Baum et al., 2005). The historical aspiration level is self-referential and in most cases involves a gradual updating as information about firm performance is integrated over time. In contrast to such internally derived information, the social aspiration level involves externally derived information through contemporaneous comparison to other firms' performance levels. These other firms are selected based on relevant similarity criteria, which in empirical studies generally involves all firms in the same industry (pending data availability and sampling).

While predictions and findings in the literature often indicate performance feedback based on these two aspiration levels have similar effects (Greve, 2003c), this is not universally the case. In studies on risk taking (K. Miller & Chen, 2004) and R&D intensity (W. Chen, 2008)

by publicly traded U.S. manufacturing firms, it was shown that well-performing firms would be more likely to take risks the more favorably performance compared to prior firm performance yet be less likely to do so in case performance was compared to performance levels of similar firms. In a study on similar firms from Japan, Jung and Bansal (2009) found an inverted-*u*-shape relationship between change in the degree of internationalization and performance relative to the historical aspiration level, while for performance relative to the social aspiration level, the relationship was monotonically positive. Next to these notable discrepancies, studies on performance feedback have often shown that sometimes performance relative to the historical aspiration level has an impact on adaptation, while performance relative to the social aspiration level does not or vice versa (W. Chen & Miller, 2007; Greve, 2003b; Iyer & Miller, 2008). In addition, W. Chen (2008) stated that future research should account for both aspiration levels in order to differentiate their effects. Because we aim to advance the study of inconsistent performance feedback, minding these two different—and potentially contradictory—sources of information to evaluate current organizational performance is vital.

Performance feedback is believed to lead to adaptation in a number of distinct organizational aspects, such as adjustment of the aspiration level, changes in the willingness to take risks, and problemistic search behavior (Cyert & March, 1963; Greve 2003c, 2010). In this paper, we focus on the latter, which is called thus as it occurs in response to problems signaled by unsatisfactory performance (Cyert & March, 1963; Greve, 2003c). Problemistic search behavior can be seen as a process in which the firm reevaluates its strategy, routines, and structure and formulates one or more solutions believed to be better attuned to environmental demands. As such, these solutions present viable routes to performance improvement and hence aspiration level attainment.

Several types of search behavior have been discerned in previous studies. Firms can search for and consider alternatives in how they market their products, structure their operations, stimulate and reward their employees, and many other areas. The most studied type of search behavior is technological search behavior (W. Chen, 2008; W. Chen & Miller, 2007; Greve, 2003a; Lant & Montgomery, 1987; Levinthal & March, 1981; Salge, 2011; Vissa et al., 2010). In practice and in most empirical studies, this concerns allocating resources to R&D activities. Investments in R&D therefore are a potential key behavioral consequence of performance feedback. However, relative to the attention devoted to risky, strategic decisions in the performance feedback literature, only a few studies (Antonelli, 1989; W. Chen, 2008; W. Chen & Miller, 2007; Greve, 2003a; Salge, 2011; Vissa et al., 2010) have empirically studied this consequence of performance feedback.

While one could argue that investing in R&D is also an indication of a change in the willingness to take risks next to being problemistic search behavior, there are a number of arguments that counter this assertion. First of all, whether increased R&D investment is indicative of an increase in organizational risk is debatable (Grenadier & Weiss, 1997; Greve, 2003a; Wiseman, McNamara, & Devers, 2001). On the one hand, R&D has uncertain returns and thus investing a large amount of the organization's resources could put it at risk. Moreover, in the short term, investing in R&D generally will have a negative impact on return on assets, implying a performance decrease. On the other hand, increased investment in R&D may reduce organizational risk as it increases the number of future options for what innovations to launch given expectations about expected returns and risks associated with these options (Christensen, 1997). Taken together, these arguments define competing risks—the short-term

performance risk versus the long-term risk of lagging behind in organizational renewal and losing market share—which actually cancel each other out. For this reason, arguments about an increase in the willingness to take risks are not applicable to R&D investment decisions. Furthermore, we focus on the adjustment of the level of R&D investment in response to performance feedback rather than the specific level of such investments. Recent work by Kacperczyk, Beckman, and Moliterno (in press) illustrates that the question whether or not a particular strategic change following performance feedback is risky requires more nuanced theoretical discussion. While we argue that R&D investment changes cannot be equated with risk taking, Kacperczyk and colleagues demonstrate the same can apply to other common dependent variables in the organizational performance feedback literature.

In the current study, we conceptualize increasing R&D investment exclusively as problemistic search behavior. When performance feedback indicates the organization is not performing at desired levels, problemistic search for solutions is necessary and in effect allows an organization to reduce the risk of further performance shortfalls and eventual organizational failure (Vissa et al., 2010). A firm that increases R&D expenditures when facing a performance shortfall could actually be balancing out the abovementioned short- and long-term risks in such a way that the overall level of firm risk remains unchanged.

Applying the general performance feedback prediction outlined above, we can state that firms that find their current performance to be unsatisfactory in the light of their aspiration level(s) will increase their allocation of resources to R&D. Reflecting this, the common prediction made in the literature regarding R&D is that firms will increase such investments the greater the negative discrepancy between current performance and aspiration level(s). Fragmented evidence for this prediction in relation to R&D intensity has been found in studies on the major players in the Japanese shipbuilding industry (Greve, 2003a), publicly listed U.S. manufacturing firms (W. Chen, 2008; W. Chen & Miller, 2007), and publicly listed Indian companies in various industries (Vissa et al., 2010). Additional evidence comes from studies on R&D investment levels of Italian manufacturing firms (Antonelli, 1989) as well as the number of ongoing R&D projects relative to the number of employees in English nonspecialist public-sector hospital organizations (Salge, 2011).

Most of these studies employed both a historical (based on past organizational performance) and a social aspiration level (based on peer group performance). In sum, they provide preliminary evidence that performance feedback theory applies in a broad range of industry and institutional settings. However, the cited studies each test the main prediction on a specific sample of organizations. Our study—by virtue of its multi-industry, multicountry sample of firms—contributes to the generalizability of performance feedback theory by including all of the commercial sectors and countries studied thus far in a single empirical study. This results in the two baseline hypotheses as to how firms will change their investments in R&D given performance feedback.[1] In the remainder of this theory section, we will argue that in case performance feedback is inconsistent, these baseline hypotheses do not apply. This implies that the baseline hypotheses do apply in case of consistent performance feedback, meriting their inclusion in our model. The following are our baseline hypotheses:

Hypothesis 1a: The lower performance relative to the historical aspiration level becomes, the more firms will increase their R&D investments.

Hypothesis 1b: The lower performance relative to the social aspiration level becomes, the more firms will increase their R&D investments.

Inconsistency in Performance Feedback

In the studies on the effect of performance–aspiration discrepancies and R&D we have discussed, effects of different performance feedback signals are treated either as independent (W. Chen, 2008; W. Chen & Miller, 2007; Greve, 2003c) or as additive signals (Greve, 2003a; Vissa et al., 2010). In empirical analyses, they were sometimes treated as interchangeable (W. Chen, 2008; W. Chen & Miller, 2007), while in other studies, only a single one is discussed and/or operationalized (Antonelli, 1989; Lant & Montgomery, 1987; Salge, 2011). This indicates an implicit assumption that decision makers approach performance feedback evaluation as a fragmentary process in which each signal used to evaluate current performance is considered in isolation. We seek to question this assumption and propose an alternative, less atomistic treatment of performance feedback. This alternative treatment is meant to advance our understanding of how inconsistent performance feedback affects problemistic search behavior—and hence change in R&D investments. A number of authors have specifically called for studies of how organizations deal with contradictory performance feedback (Greve, 2003c; Salge, 2011). We aim to answer that call and start by discussing the few studies that did include inconsistent performance feedback. Interestingly, none of these studies focused on problemistic search behavior and thus investments in R&D.

The effects of inconsistency in performance feedback are discussed in the literature on multiple goals in performance feedback (Audia & Brion, 2007; Baum et al., 2005; Greve, 1998, 2008; Mezias, Chen, & Murphy, 2002). The presence of multiple goals implies that there are at least two aspiration levels to be considered. A direct consequence is that ambiguity is introduced in evaluating realized performance. Quite likely, not all performance–aspiration discrepancies will be in line with a single unequivocal evaluation of either success or failure. As a result, the subjective nature of performance evaluation becomes a relevant issue. Unfortunately, this part of performance feedback has not received much conceptual attention (Jordan & Audia, 2012). Hence, it is challenging to predict the direction and extent of organizational adaptation following such a muddled performance evaluation. The practical relevance of multiple performance goals is illustrated in a study of letters to shareholders by the hand of CEOs in annual reports by Short and Palmer (2003). They found that these CEOs use multiple performance referents (aspiration levels in performance feedback theory terminology) from a variety of sources to evaluate their company's performance (Short & Palmer, 2003). Applying this reasoning to the baseline model we discussed earlier, we observe that this model includes two aspiration levels—a historical and a social one—offering two sources of, potentially contradictory, information to evaluate performance.[2]

In Table 1 we visualize the different possible configurations of consistent and inconsistent performance feedback and indicate what predictions can be made given the two baseline hypotheses (Hypotheses 1a and 1b). In case performance feedback is consistent (Configurations 1 and 4 in Table 1), performance feedback evaluation yields similar conclusions for both historical and social aspiration levels, and thus predictions based on Hypotheses 1a and 1b are identical. For the two instances of inconsistent performance feedback (Configurations 2 and 3 in Table 1), such predictions are direct opposites of each other as the two performance feedback evaluations yield contradictory conclusions. These two inconsistent performance feedback configurations will be the topic of discussion in the remainder of this theory section.

Table 1
Performance Feedback Configurations

	Performance Declined Relative to the Social Aspiration Level	Performance Increased Relative to the Social Aspiration Level
Performance declined relative to the historical aspiration level	*(1) Consistently negative performance feedback* Hypothesis 1a and Hypothesis 1b: Increase in R&D investment	*(2) Inconsistent performance feedback* Hypothesis 1a: Increase in R&D investment Hypothesis 1b: Decrease in R&D investment
Performance increased relative to the historical aspiration level	*(3) Inconsistent performance feedback* Hypothesis 1a: Decrease in R&D investment Hypothesis 1b: Increase in R&D investment	*(4) Consistently positive performance feedback* Hypothesis 1a and Hypothesis 1b: Decrease in R&D investment

Note: R&D = research and development.

One could argue for a simple averaging out of the effects such that the larger performance–aspiration discrepancy determines whether or not investment in R&D will increase or decrease or an extreme signal heuristic in which the performance signal most distant to its respective aspiration level takes precedence. However, it seems more likely that organizational decision makers will be triggered by the inconsistency in the performance feedback. In the following, we will discuss the mechanisms from the performance feedback literature that have been or could be applied to inconsistent performance feedback. A first sort of response that might occur is inertia: Decision makers could wait for more performance feedback to arrive given that there is no clear-cut success-failure conclusion to be made. When facing ambiguous, inconsistent performance feedback, decision makers might feel confused and refrain from making changes to R&D investments (Milliken & Lant, 1991). However, from the few studies on inconsistent performance feedback, the conclusion is that decision makers do not let inconsistent performance feedback preclude them from engaging in adaptive behavior (Baum et al., 2005; Greve, 2008).

The commonly used theoretical mechanism explaining responses to inconsistent feedback involves decision rules. In accordance with the heuristics literature, decision rules are conceptualized as shortcuts in information processing decision makers use to deal with complex, cognitively challenging situations (Greve, 2003c). Inconsistent performance feedback represents such a situation. In the following, we discuss the two diametrically opposed decision rules proposed in the literature—the fire-alarm and self-enhancing decision rules—and apply them to firm-level change in R&D investments. Both assume that decision makers will be selective in what part of the performance feedback they pay attention to in order to reduce the level of complexity they are facing (Baum et al., 2005; Jordan & Audia, 2012). As mentioned before, we propose an alternative to this selective attention mechanism—holistic consideration of the entirety of the performance feedback information—postulating a more elaborate fashion in which we believe decision makers will handle the ambiguity introduced by inconsistent performance feedback. This alternative mechanism represents the key theoretical

advancement we introduce to the performance feedback literature. Based on holistic consideration, we propose an alternative decision rule: the affordance-urgency rule. With the empirical findings emerging from our study in hand, we can determine which of these mechanisms best explains firm-level change in R&D investments.

The two studies that empirically accounted for inconsistency in performance feedback (Baum et al., 2005; Greve, 1998) made reference to two decision rules, the fire-alarm rule and the self-enhancing rule.[3] These decision rules describe a cognitive shortcut whereby decision makers transform a situation of inconsistent performance feedback through selective attention to one that is more like a consistent performance feedback situation and act accordingly (i.e., follow the logic underlying the baseline model as included in Hypotheses 1a and 1b). They do so by focusing on the most relevant performance–aspiration discrepancy and proceeding as if the other one need not be factored into their decision or does not exist at all—that is, paying selective attention to a subset of the performance feedback signals (Audia & Brion, 2007; Baum et al., 2005; Greve, 1998, 2008; Jordan & Audia, 2012; Mezias et al., 2002). Thus, given similar performance feedback (either Configuration 2 or 3 in Table 1), the effects of performance feedback on subsequent R&D levels can be strikingly different depending on the decision rule employed. Therefore, inconsistent performance feedback is a good candidate to explain firm-level heterogeneity in R&D investments over time.

First, decision makers could operate according to a *fire-alarm rule* (Baum et al., 2005; Greve, 1998). This implies their attention is drawn most strongly to the performance–aspiration discrepancy that indicates a problem, in effect the one that is negative. The positive performance–aspiration discrepancy is deemed of no or far lesser relevance. As such, the fire-alarm rule is a rather straightforward extension of the baseline model to inconsistent performance feedback since decision makers still operate as problem solvers (Jordan & Audia, 2012) motivated by the desire to reduce any and all negative discrepancies between current versus desired outcomes (Audia & Brion, 2007). Any performance signal indicating a problem triggers a reevaluation of the firm's strategy, routines, and structure—even if it occurs simultaneously with a positive performance signal (Baum et al., 2005). This fits with the sequential attention-to-goals argument of Cyert and March (1963) stating that an aspiration–performance discrepancy becomes and remains relevant only insofar that it indicates a problem—that is, when it is negative (Greve, 2003c, 2008). As such, decision makers remain temporarily consistent in their standards of evaluation (Jordan & Audia, 2012) and continue striving to correct any negative performance–aspiration discrepancy (Baum et al., 2005). Based on the fire-alarm rule, one would thus predict an increase in R&D investments the greater the negative performance–aspiration discrepancy.

Second, decision makers might follow a *self-enhancing rule*. If they do, they focus on the positive performance–aspiration discrepancy and neglect the negative one. This represents a departure from the logic underlying the baseline model, in that decision makers employing this decision rule no longer function as problem solvers but rather seek to enhance their own self-image (Jordan & Audia, 2012). People in general are characterized to a smaller or larger degree by a need to see themselves in a positive light (Audia & Brion, 2007). Firm decision makers generally strive to be evaluated as competent and successful. Because they are architects of the firm's strategy, routines, and structure, evaluation of the firm's performance implies evaluation of their own personal competence and success. Furthermore, especially negative performance feedback can cause decision makers to feel threatened and insecure

about their careers. The more they feel they have a personal stake in the firm's decisions, the more self-enhancement will affect evaluation of the firm's performance (Jordan & Audia, 2012). Additionally, human beings more easily process positive evaluations than negative ones and attribute failure to external circumstances rather than their own behavior.

Reflecting these mostly psychological arguments, self-enhancement does seem likely when inconsistent performance feedback occurs. The negative performance–aspiration discrepancy can easily be the source of threat, while the more easily processed positive one allows decision makers to portray their actions in a positive light. While this line of reasoning illustrates that self-enhancement can occur in case performance feedback is inconsistent, that does not necessarily mean it will. Jordan and Audia (2012) stated that whether or not self-enhancement tendencies of individual decision makers actually manifest themselves in firm-level decisions is a function of the latitude to portray performance in a positive light being present. The more complex the decision task, which clearly applies to inconsistent performance feedback, the greater this latitude. Moreover, the ambiguous nature of inconsistent performance feedback makes it a situation in which decision makers will be prone to self-enhancement (Audia & Brion, 2007).

Jordan and Audia (2012) highlighted three strategies of dealing with performance feedback that reflect self-enhancement. The most applicable one to inconsistent performance feedback is the possibility to retroactively revise the priority of performance goals. Whereas decision makers operating as problem solvers (as the fire-alarm rule espouses) would remain temporarily consistent in how they evaluate performance feedback, those operating as self-enhancers will take ambiguity in performance signals as an opportunity to redefine standards of evaluation. A second applicable one is that in this sort of situation, they can invoke counterfactual outcomes as a standard of comparison instead of the actual ones (Jordan & Audia, 2012). In effect, this is a glass-half-full/glass-half-empty situation in which the decision makers might claim that had they not followed the firm's strategy, both performance–aspiration discrepancies would be negative instead of just the one. Inconsistent performance feedback is then actually redefined as an indication of success rather than one equally indicative of success and failure. The use of these sorts of strategies makes decision makers emphasize the positive performance–aspiration discrepancy over the negative one. Therefore, the self-enhancing rule predicts a decrease in search behavior the greater the positive performance–aspiration discrepancy.

Empirical evidence on which of the decision rules applies to inconsistency between performance relative to a historical and social aspiration level is scarce, though the study by Baum and coauthors (2005) on Canadian investment banks' partnering choices supports the fire-alarm rule. However, Greve's (1998) study on format choices by U.S. radio broadcasters did not find a significant effect of inconsistency at all. Next to these results not being mutually supporting, they apply to different dependent variables than we study—though they entail some sort of strategic change similar to the one we consider. Which of the two decision rules best explains changes in R&D investments following inconsistent performance feedback is therefore still an empirically relevant question. Thus, we propose the following two competing hypotheses:

Hypothesis 2a (fire-alarm rule): If performance feedback is inconsistent (Configurations 2 and 3 in Table 1), the lower the negative performance–aspiration discrepancy, the more firms will increase their R&D investments.

Hypothesis 2b (self-enhancing rule): If performance feedback is inconsistent (Configurations 2 and 3 in Table 1), the higher the positive performance–aspiration, the more firms will decrease their R&D investments.

While the decision rules just discussed involve decision makers' neglecting half of the performance feedback information available, one could imagine that they try and make sense of what the two apparently contradictory signals imply when considered in combination. With regard to problemistic search, an oft-repeated characterization of that process includes the assumption that search starts in the proximity of the problem area identified. Furthermore, what sort of solutions receive attention is informed by the problem diagnosis (Cyert & March, 1963; Greve, 2003c; Vissa et al., 2010). Decision makers bring to bear their previous experiences, insights into their industry, and other knowledge to the table (Gavetti et al., 2012). These factors may bias or enhance their interpretation of performance feedback and conclusion as to whether it indicates a problem and what sort of problem that may be. As contemporary organizations are often asked to satisfy multiple, in all likelihood competing goals (Greve, 2003c; Short & Palmer, 2003), they probably develop some kind of higher-order decision rule or metacognitive strategy to make sense of contradictory information. With such tools in place, decision makers acquire cognitive templates used to resolve the ambiguity created by contradictory performance feedback signals. This particular line of reasoning has not been thoroughly considered in the performance feedback literature to our knowledge.

We explore this alternative line of reasoning and propose how *holistic consideration* would affect change in R&D investments following inconsistent performance feedback. Strategic choice is driven not only by motivation but also by whether a decision maker believes there are proper opportunities to do so and the organization has the capabilities to utilize them (M. Chen, Su, & Tsai, 2007). Thus, while the performance feedback literature generally discusses what sort of performance feedback signals generate the motivation to change (Greve, 1998, 2003c), it might be useful to also consider managerial interpretations of performance feedback in terms of the presence of opportunities and capabilities to increase future organizational performance.

The classical entrepreneurial "logic" (D. Miller, Le Breton-Miller, & Lester, 2011) could serve as a potential cognitive template that does provide straightforward guidelines to draw sensible conclusions from inconsistent performance feedback. This consideration is especially applicable to one of the inconsistent performance feedback situations. When the historical performance discrepancy is positive and the social one negative (Configuration 3 in Table 1), decision makers face a situation in which the fact that their competitors on average achieve higher performance demonstrates that there are opportunities to improve their own performance. Increasing R&D investments is a suitable strategy for firms intending to appropriate such opportunities (Antonelli, 1989). Greve (1998) indicates that next to providing a source of information to evaluate firm performance, other firms may also signal market opportunities worth exploring. We build on this by asserting that the former—in case competing firms are performing better than the focal firm—can inform the firm that the latter—market opportunities worth pursuing—exists. Moreover, these firms are experiencing a positive trend in performance, and therefore they can come to the conclusion that they also have the means and thus the capability to act upon those opportunities. This may instill

confidence and the ambition to adjust goals upward (Baum et al., 2005). The actual presence of resources over and above those needed to ensure the organization can continue operating—organizational slack—has consistently been shown to increase the level of R&D investments (W. Chen, 2008; W. Chen & Miller, 2007; Greve, 2003a; Vissa et al., 2010).

Combining these elements of urgency to act and being able to afford taking action, an *affordance-urgency* decision rule implies increasing R&D investment in this particular configuration of inconsistent performance feedback. The study of Salge (2011) on English nonspecialist public-sector hospitals offers some insight into whether the logic underlying this decision rule holds. He found a positive interaction effect between performance–aspiration discrepancy (based on a social aspiration level) and organizational slack, that is, hospitals that lagged behind their competitors while simultaneously possessing high levels of slack resources would have more R&D projects relative to the number of employees than hospitals with low levels of slack. In contrast, when firms are performing at a higher level than the average competitor (Configuration 2 in Table 1), the opposite is the case. First, there is no sense of urgency to be felt but rather a potential argument for being content with the status quo as the firm evidently has seized all market opportunities worth pursuing as can be concluded from being ahead of the competition. Combined with the fact that experiencing a negative trend in performance of the organization reduces the availability of resources to take strategic action, in this case, the affordance-urgency decision rule would predict a decrease in R&D investments. On the basis of these arguments, we propose the final hypothesis:

Hypothesis 3 (affordance-urgency rule): In case performance feedback is inconsistent, the further above the historical aspiration level and the further below the social aspiration level performance is, the more firms will increase their R&D investments.

Methods

We use data from the *2010 EU Industrial R&D Investment Scoreboard* (European Commission, 2010) to test our hypotheses. This scorecard, composed by two research organizations of the European Union (the Joint Research Centre and the Research Directorates-General of the European Commission), ranked European Union (EU) firms in terms of their investment in R&D and compared them to non-EU firms also ranked in terms of their R&D expenditures. In total, data on 1,000 EU and 1,000 non-EU firms were available.[4] Data mainly concerned the 2009 fiscal year on which the ranking was based but also included measures pertaining to 2008, 2007, and 2006. For details on the compilation procedure, we refer to Annex 3 of the report (European Commission, 2010).

Our theoretical interest concerns the effect of performance feedback on firm-level change in R&D investments. Below, we will explain in detail how we operationalized these constructs respectively in terms of sales growth and R&D intensity change. As the firms were selected for the scorecard based on the monetary value of their 2009 R&D expenditures, we checked the distribution of values for the 2009 and 2008 R&D intensity measures. We found that a few rather extreme outliers were present in the data set. A scatter plot of these two variables showed that firms that had a value of 300% or higher for either of these measures deviated markedly from the general pattern of strong positive correlation. We excluded these firms as it is likely that unique firm-specific events rather than performance feedback led to such extreme year-to-year deviations in R&D intensity. In a second step, we consulted annual

reports, company websites, and/or press releases to determine what occurred for firms that showed absolute changes of 200% or higher of sales in 2007 and/or 2008. Some of these firms were excluded, with reasons for doing so being structural changes, like mergers and acquisitions, and unique events that led to a discontinuity in sales. Beyond the already named reasons for exclusion based on extreme values in R&D intensity or sales-level changes, another motivation for taking these steps is that in all likelihood, the excluded firms were not seen as relevant to compare performance with by the other firms in our sample. These steps reduced our sample to 1,922 firms.

Measures

As dependent variable—R&D intensity change—we used the difference between the R&D intensity (R&D investments / Net sales) values provided for the fiscal years 2009 and 2008. Thus, our dependent variable represents the extent to which R&D investments (relative to firm size) were increased or decreased.

We constructed two performance–aspiration discrepancy measures to serve as independent variables. Following earlier studies (Baum et al., 2005; Greve, 1998), we used a measure of the historical and the social aspiration levels. Both performance feedback measures were based on net sales growth. Historical performance discrepancy was calculated by subtracting the historical aspiration level (percentage sales growth from 2006 to 2007) from the firm's performance (percentage sales growth from 2007 to 2008).

Social performance discrepancy was calculated by subtracting the social aspiration level (average percentage sales growth from 2007 to 2008 for all other firms in the industry the firm was active in) from the firm's performance (percentage sales growth from 2007 to 2008). We used all available other firms in the industry to calculate the social aspiration level (out of the 1,922 left after the above exclusions were made), even if some of these firms used for comparison needed to be excluded from the actual analyses later on due to missing data. This procedure is most commonly used in the empirical literature to capture average performance of the peer reference group (Baum et al., 2005; Greve, 1998). By using this procedure, we select firms that also devote substantial amounts of funds to R&D and are in most cases also among the larger firms in their industry. Therefore, they should be rather visible to other firms in the industry besides facing rather similar competitive environments. For 39 firms, no data were available to calculate the social aspiration level, while the historical aspiration level could not be calculated for a further 49 firms for the same reason. This reduced our sample to 1,834 firms.

As noted in the introduction, previous work has focused on a structural explanation for differences in levels of R&D. As we aim to show that (in)consistent performance feedback matters on top of such more stable, structural antecedents, we need to account for such structural aspects. First of all, we controlled for industry. Given that we also used this industry variable to determine which firms were relevant to construct the social aspiration level, we needed to make sure the number of firms per sector was not too small. The firms in the database were classified using the Industry Classification Benchmark (ICB) system, which like the Nomenclature statistique des activités économiques dans la Communauté européenne (NACE) and the Standard Industrial Classification (SIC) systems has four levels of increased specificity (one-, two-, three-, or four-digit sector classification). Firms

were generally classified at the three-digit level, yielding 45 unique sectors. Some of these included fewer than 10 firms, so we condensed the classification prior to calculating social aspiration levels to 25 sectors as follows. In case a sector included at least 100 firms, we did not aggregate. In case the sector included less than 100 firms, we aggregated up to the two-digit level until at least 50 firms were represented in a sector or no meaningful aggregation was possible (for instance, for the media and travel-and-leisure industries). The bank, insurance, and other financial sectors were merged up to the one-digit level, as these were sparsely populated even at the two-digit level. We added a number of industry dummies to our analyses equal to the number of sectors minus 1. We used the retail industry as the excluded category and hence the comparison industry.

As our data included firms from all over the world, we also controlled for where the firms were headquartered to accommodate cross-region macroeconomical, legal, and institutional differences.[5] These data were provided at the country level, yielding 46 unique countries of which, again, quite a number were sparsely represented. We condensed these into 13 regions based on a classification provided by the United Nations (UN) Statistics Division (2011). We deviated in two instances to obtain sufficient aggregation. We categorized a firm headquartered in the Cayman Islands as North America instead of the Caribbean and merged a firm headquartered in South Africa with eight located in Brazil into a single category. While the latter category includes firms from two different continents, both are headquartered in countries that are often grouped together as emerging economies undergoing rapid economic development (BRIC [Brazil, Russia, India, and China] countries) and have similar legal and institutional features. Furthermore, as Taiwan is not a UN member, it is not included in the classification scheme we used. We chose to include Taiwan in the same category as China, Hong Kong, Japan, and South Korea (eastern Asia). We added a number of region dummies to our analyses equal to the number of regions minus 1. We used North America as the excluded category and hence the comparison region.

As a last structural feature, we controlled for organizational size by including the number of employees in 2009. We log-transformed this variable because the distribution of the number of employees of the firms represented in our sample was right skewed. As a result of 84 cases with missing data on one of the control variables, our final sample included 1,750 firms.

Model and Analyses

As is common practice in performance feedback studies, we employed splined regression to be able to detect changes in sensitivity to performance feedback around the aspiration levels (Greve, 2003c). Thus, we will include two coefficients for both performance–aspiration discrepancy variables. The first takes the value of the nonsplined variable if this is smaller than zero, and zero otherwise. The second takes the value of the nonsplined variable if this is greater than zero, and zero otherwise. Effectively, for each of the performance–aspiration discrepancy variables, we model the negative and positive range of values using separate variables. The first describes the effect on the dependent variable for an increase in performance toward the as-yet-not-attained aspiration level. The second does the same but then for an increase in performance beyond the already attained aspiration level. Prior to performing the spline procedure, we divided both performance–aspiration discrepancy measures by 100 in order to obtain interpretable regression coefficients.

Table 2
Descriptive Statistics

Variable	*M*	*SD*	1	2	3
1. Number of employees 2009 (log)	9.31	1.51			
2. Historical performance discrepancy (/100)	−0.03	0.05	.07**		
3. Social performance discrepancy (/100)	−0.02	0.05	.06*	.41***	
4. R&D intensity change	0.33	1.35	.04	−.20***	−.14***

Note: $N = 1{,}750$. R&D = research and development.
*$p < .05$.
**$p < .01$.
***$p < .001$.

As we aim to investigate the effect of inconsistent performance feedback as opposed to consistent performance feedback, we also calculated the interactions between the four performance variables (Baum et al., 2005). Three of these will take a value of zero as two of the underlying values that are multiplied to yield the performance feedback interaction variables are zero as a result of the splined regression approach.

To test our hypotheses we employ ordinary least squares (OLS) regression. To account for heteroskedasticity, standard errors were clustered by industry in these models. All statistical tests were two tailed.

Results

Table 2 displays descriptive statistics and correlations for the variables included in our analyses, excluding industry and region dummies. The pattern of correlation between our variables is in line with what would be expected based on our baseline hypotheses (Hypotheses 1a and 1b). Both performance discrepancy measures had a significantly negative correlation with the dependent variable R&D intensity change. Moreover, the two performance–aspiration variables were correlated, but not extremely so, indicating they do communicate distinct information regarding organizational success and failure to the decision maker. Last, organizational size was not strongly correlated with change in R&D intensity. It did however have a weak, positive correlation to both performance–aspiration comparisons, indicating that larger firms were slightly more likely to also be better performing firms.

Table 3 presents the results of the OLS regression analyses for R&D intensity change. To prevent unnecessary cluttering, we do not report individual coefficients for the industry and region dummies.[6] Since we controlled for industry and geographical region, the results we present apply across this broad range of firms. Model 1 includes only the control variables. Model 2 adds the splined performance–aspiration discrepancy coefficients. Model 3 adds the performance–aspiration discrepancy interaction coefficients. In each model, an increasing proportion of the variance in R&D intensity change is explained. We observe that firm size, as indicated by the number of employees in 2009 (log-transformed), did not impact R&D intensity change corroborating the picture emerging from the correlations in Table 1. Models 2 and 3 are of substantive interest to us. In Model 2, all performance discrepancy coefficients are in the expected, negative direction except for the positive social performance discrepancy

Table 3
Ordinary Least Squares Regressions of R&D Intensity Change

Variable	Model 1	Model 2	Model 3
Constant	−5.15 (5.30)	−6.17 (4.57)	−6.45 (4.64)
Number of employees 2009 (log)	0.46 (0.49)	0.50 (0.38)	0.50 (0.37)
Sector dummies	Included	Included	Included
Region dummies	Included	Included	Included
Historical performance discrepancy (<0)		−5.11 (4.68)	2.23 (1.57)
Historical performance discrepancy (>0)		−13.02 (8.12)	15.00 (10.89)
Social performance discrepancy (<0)		−5.99 (5.01)	0.67 (3.78)
Social performance discrepancy (>0)		.35 (4.15)	9.61 (5.62)
Historical (<0) * Social (<0)			41.65** (14.43)
Historical (<0) * Social (>0)			−8.47 (16.79)
Historical (>0) * Social (<0)			129.95* (57.91)
Historical (>0) * Social (>0)			−48.58 (26.17)
R^2	.02	.07	.17
N	1,750	1,750	1,750

Note: Clustered standard errors in parentheses. R&D = research and development.
*$p < .05$.
**$p < .01$.

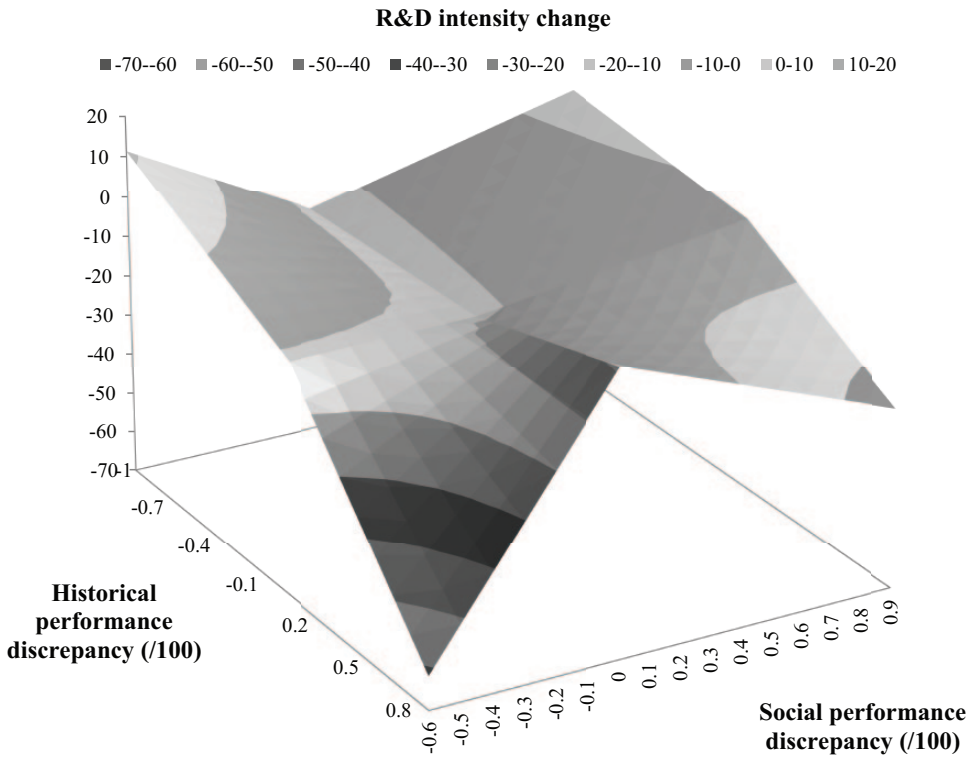
Table 4
Ordinary Least Squares Regressions of R&D Intensity Change, Continued

Variable	Model 4
Constant	−6.70 (5.20)
Number of employees 2009 (log)	0.55 (0.47)
Sector dummies	Included
Region dummies	Included
Historical performance discrepancy	−7.38* (3.55)
Social performance discrepancy	−3.60 (4.65)
R^2	.07
N	1,750

Note: Clustered standard errors in parentheses. R&D = research and development.
*$p < .05$.

coefficient. However, none of these coefficients reaches significance. As both historical performance–aspiration discrepancy coefficients pointed in the same direction, we further explore this result by estimating the model without the splined coefficients. In Table 4, the results of this additional model (Model 4) are presented. In Model 4, the coefficient for historical aspiration–performance discrepancy is negative and significant, indicating that if annual sales growth in 2009 would decline by 100% relative to 2008, R&D intensity would increase by 7.38 percentage points. This result fits Hypothesis 1a as it indicates that the less favorably performance compares against previous firm performance, the more firms will increase their R&D intensity.

Figure 1
Research-and-Development Intensity Change as a Function of Performance–Aspiration Discrepancies



To aid interpretation of Model 3, which includes interaction coefficients, the effect of performance feedback on R&D intensity change is graphically displayed in Figure 1. Firm size (log of the number of employees in 2009) was held constant at its sample mean. Recall that the retail sector and North America were the reference categories for industry and region, respectively. In Model 3, the interaction coefficient for indicating a negative historical and negative social performance discrepancy (Configuration 1 in Table 1) proved to be significant. Figure 1 (the left backward portion in particular) shows that the more negative both of these performance–aspiration discrepancies would become (Configuration 1 in Table 1), the more R&D intensity would be increased, by up to 11 percentage points. This significant finding lends support to Hypotheses 1a and 1B, which are consistent with such an effect. Furthermore, the negative coefficient for consistently positive performance feedback (Configuration 4 in Table 1) also fits with these two baseline hypotheses but is not significant. Combined with the results in Models 2 and 4, this finding allows us to conclude that we confirm the baseline model to a substantial degree. More relevantly, in particular on the basis of the results of Model 3 as shown in Figure 1, we can conclude that the baseline model applies especially to situations in which performance feedback is consistent. This indicates the merit of accounting for the multiplicative effects of the two performance–aspiration discrepancies rather than

considering them in isolation, which has been common in the performance feedback literature. As these results demonstrate, that would obfuscate important and noteworthy effects of performance feedback.

With regard to the effect of inconsistent performance feedback, the interaction coefficient for indicating a positive historical and negative social performance discrepancy (Configuration 3 in Table 1) was also significant. As is visible in Figure 1, the greater the extent to which the two performance–aspiration comparisons are inconsistent in this direction (Configuration 3 in Table 1), the more firms would decrease their level of R&D intensity, by up to 70 percentage points. In the contrasting inconsistent performance feedback situation (Configuration 2 in Table 1), we did not find a significant effect on change in R&D intensity, though based on Figure 1, the direction of the effect seems to be the opposite of the other inconsistent performance feedback situation.

This pattern of results does not fully fit any of the hypotheses we formulated on the impact of inconsistent performance feedback. Nevertheless, the one significant result does fit with the self-enhancing decision rule (Hypothesis 2b) yet contradicts the fire-alarm and affordance-urgency rules (Hypotheses 2a and 3) that both predict an increase in R&D intensity in this situation (Configuration 3 in Table 1). However, full confirmation of the self-enhancing decision rule would require a similar finding for the other situation of inconsistent performance feedback (Configuration 2 in Table 1), which, though not significant, points in the opposite direction. In the following section, we delve deeper into the theoretical implications of these findings and offer some suggestions for further study of inconsistent performance feedback.

Discussion and Conclusion

This paper asked how (in)consistent performance feedback affects to what extent firms change their level of R&D investments. In particular, we looked at (in)consistency in performance–aspiration discrepancies based on historical and social aspiration levels, which were the most commonly used performance feedback signals in the literature (Baum et al., 2005; Greve, 1998, 2003c). As inconsistent performance feedback is more ambiguous than consistent performance feedback, deriving a clear conclusion as to whether the firm's prior strategies, routines, and structures are appropriate is harder to do. Studying the impact of (in)consistent performance feedback on changes in R&D investments is important since this serves to provide the firm with opportunities for innovation, which in turn increase its chances of surviving and thriving (Bowen et al., 2010; Crépon et al., 1998; Greve, 2003a). While innovation itself is not something under the direct control of the firm's decision makers, the amount of resources spent on R&D is and thereby is an important strategy to bring about innovation to remedy performance shortfalls.

Our modeling approach was in line with a baseline model derived from received theory (Cyert & March, 1963; Greve, 2003c, 2010) and previous empirical work linking performance feedback to R&D investment (W. Chen, 2008; W. Chen & Miller, 2007; Greve, 2003a; Salge, 2011; Vissa et al., 2010). The baseline model indicates that the less favorably performance compares against a historical (Hypothesis 1a) or social (Hypothesis 1B) aspiration level, the higher the level of adaptive behavior and thus the increase in R&D investments. With this baseline model in place, we were able to explore the extension to models

accounting for inconsistency in performance feedback. As displayed in Table 1, the baseline model results in contradictory predictions regarding the direction in which firms will change their R&D investments in case performance feedback is inconsistent (Configurations 2 and 3 in Table 1).

Our results are to a large extent in accordance with the baseline model. In line with our expectations, the predictions derived from this model as stated in Hypotheses 1a and 1b applied most clearly to the two instances of consistent performance feedback (Configurations 1 and 4 in Table 1). Moreover, it seems there is a mutually reinforcing negative effect of performance feedback derived from the historical and social aspiration levels in the case of consistently negative performance feedback (Configuration 1 in Table 1). This fits similar findings in earlier studies (Greve, 2008; Labianca, Fairbank, Andrevski, & Parzen, 2009) involving multiple types of performance indicators rather than distinct sources of performance feedback signals, as we used. In introducing the need to go beyond considering performance feedback signals in isolation, we stressed that they might have more than additive or independent effects. Our results clearly show these effects are multiplicative and thus should be considered jointly. With the baseline predictions not applicable to cases of contradictory performance feedback (Configurations 2 and 3 in Table 1), expanding this baseline model with specific mechanisms and predictions to accommodate the impact of inconsistency in performance feedback proved necessary.

Our most important theoretical contribution regards the introduction of the holistic consideration theoretical mechanism as an alternative to the selective attention mechanism previously applied to explain the impact of inconsistent performance feedback on adaptive behavior. Based on the latter, scholars (Baum et al., 2005; Greve, 1998; Jordan & Audia, 2012) have proposed two diametrically opposed decision rules involving attention to a subset of the performance feedback signals to capture the process by which decision makers resolve the ambiguity introduced by inconsistent performance feedback (Baum et al., 2005; Greve, 1998; Jordan & Audia, 2012). On the one hand, the fire-alarm decision rule involves attention being directed to any negative performance feedback signal. On the other hand, a self-enhancing decision rule involves attention being directed to any positive performance feedback signal. While the significant result for one of the instances of inconsistent performance feedback (Configuration 3 in Table 1) was in line with the self-enhancing decision rule (Hypothesis 2b), the other one, though insignificant, pointed in a direction in line with the fire-alarm decision rule (Hypothesis 2a).

In our theoretical discussion of inconsistent performance feedback, we questioned the assumption that all instances of inconsistent performance feedback (Configurations 2 and 3 in Table 1) will have the same effect on adaptive behavior underlying the selective attention mechanism. The results regarding inconsistent performance feedback indicate we were correct in doing so. As an alternative to the selective attention theoretical mechanism, we proposed a *holistic consideration* theoretical mechanism. Inconsistent performance feedback is an ambiguous situation and might thus be a trigger for holistic consideration of the performance feedback. As a result of such more detailed evaluation of the performance feedback, decision makers could in the end conclude that despite the inconsistency between the signals, in combination they yield a coherent interpretation. By introducing this alternative mechanism, we recognized that a broader range of responses to inconsistent performance feedback can occur than the literature currently accounts for. Hence, we primarily contribute to the

literature on performance feedback and specifically to what impact inconsistency has on the performance feedback evaluation process.

The results do not corroborate the affordance-urgency decision rule (Hypothesis 3) we proposed involving holistic consideration of the performance feedback with regard to the opportunities and capabilities to increase R&D investments next to the common motivational effects (M. Chen et al., 2007; Greve, 1998, 2003c). Nevertheless, the fact that the impact on change in R&D intensity of the two inconsistent performance feedback instances is not uniformly positive or negative to us demonstrates that the idea of holistic consideration holds merit. Evidently, decision makers gave different interpretation to these instances of performance feedback resulting in distinct effects on change in R&D intensity. Further theorizing and empirical study is required to fully understand the nature and impact of inconsistent performance feedback. A possible direction this could be taken in future research involves exploring to what extent prior knowledge, understanding of the industry circumstances, and past experience of the firm and its decision makers result in a particular holistic interpretation of inconsistent performance feedback (Gavetti et al., 2012). Given differences in these firm and decision maker characteristics, the nonfinding for one of the instances of inconsistent performance feedback (Configuration 2 in Table 1) in the current study could very well be explained. As problemistic search generally takes place not only in areas near the identified problem but also is more likely in more familiar areas (Cyert & March, 1963; Greve, 2003c; Vissa et al., 2010), accounting for such factors of between-firm heterogeneity seems a fruitful pursuit.

Our findings indicate that our attention to inconsistency in performance feedback is a valuable addition to the literature on organizational learning from performance feedback (Greve 2003c, 2010; Haleblian & Rajagopalan, 2005; Lant et al., 1992; Lant & Shapira, 2008; Milliken & Lant, 1991). We questioned the assumption that effects of distinct performance feedback signals, a key source of information in strategic decision making, would be independent or simply additive. Our study shows reality is more complex and thereby underlines the need for understanding the qualities of multifaceted performance feedback. Moreover, we did so in relation to R&D investment, the most studied sort of search behavior (W. Chen, 2008; W. Chen & Miller, 2007; Greve 2003a; Salge, 2011; Vissa et al., 2010). As search behavior is the pathway to solutions firms can draw upon to improve performance, finding that firms will increase their R&D intensity only if both performance feedback signals are negative (see Figure 1 and Model 3 in Table 3) implies that engaging in search behavior is by no means a trivial step.

Future research could consider the impact of inconsistent performance feedback on other managerial and organizational behaviors previous research has shown to be affected by performance feedback. For instance, the willingness to take risks could be considered. This, next to search behavior, is an important precursor to important strategic decisions, such as strategic change and innovation adoption (Cyert & March, 1963; Greve, 2003c, 2010). It would be interesting to determine if the willingness to take risk following inconsistent performance feedback is greatly reduced (a self-enhancing response) or is driven by holistic consideration involving evaluation of the opportunities and capabilities to successfully take risks. In our theoretical discussion, we highlighted recent discussion on whether a strategic change can invariably be described as a risky one (Kacperczyk et al., in press). Our arguments demonstrate that R&D investment should be conceptualized as problemistic search only. Future

research should also be nuanced in terms of whether the dependent variable under study is indicative of search and/or a risk. Even so, as innovation is a generally risky pursuit (March, 1991; Massini, Lewin, & Greve, 2005), inconsistent performance feedback might dampen levels of firm innovation not only as a consequence of reducing R&D intensity but also by making it less likely decision makers accept the risk inherent in the options for innovation available to them. Following up on studies on inconsistent performance feedback and risk taking, the effect on eventual strategic decision making, for instance, pertaining to launching innovations, could be considered while accounting for its effects on search behavior (R&D) and willingness to take risks.

Our study is not without its limitations. For instance, the firms in our sample were among those that devote substantial resources to R&D since they were selected to be included in the *2010 EU Industrial R&D Investment Scoreboard* based on their high levels of R&D spending. This opens up the question whether our results apply to firms for which R&D is of less strategic importance. Hence, replication using a broader sample of firms combined with a panel data setup would serve to confirm and further expand upon the results of our study pertaining to inconsistent performance feedback. Our study was cross-sectional—even though data pertaining to performance feedback were lagged with respect to R&D intensity and change thereof—and hence we were unable to explore if effects of inconsistency might change over time. For instance, do firms that repeatedly face inconsistent performance feedback develop routines that allow them to single out those components of performance feedback in need of attention and act accordingly? Moreover, decision makers do use more than a single performance metric to evaluate their performance (Short & Palmer, 2003), and a variety of different metrics has been used in the empirical literature (Greve, 2003c, 2010). We used sales growth in our study but cannot confirm that this would be the most important metric with respect to determining R&D investment. Nevertheless, we did show that sales growth captures firm performance sufficiently to predict subsequent changes in R&D investments.

In conclusion, we show that inconsistency in performance feedback matters to search behavior as captured by changes made to R&D investments. Nevertheless, more theoretical and empirical effort is needed to provide and corroborate an exhaustive explanation for these phenomena.

Notes

1. A number of the studies just mentioned extend the linear baseline model by postulating that the strength of the relationship between performance–aspiration discrepancy and the magnitude of research-and-development (R&D) intensity differ for values below and above the aspiration level (W. Chen, 2008; W. Chen & Miller, 2007; Greve, 2003a; Vissa, Greve, & Chen, 2010). As a result of risk tolerance and inertial pressures, a kinked-curve relationship emerges where R&D intensity would be more sensitive to performance feedback above than below the aspiration level. Nevertheless, empirical studies testing this model (W. Chen, 2008; W. Chen & Miller, 2007; Greve, 2003a; Vissa et al., 2010) have failed to confirm it with regard to R&D intensity, and therefore we do not put forward any hypotheses derived from the kinked curve model.

2. In this paper, we look at inconsistency between a historical and a social aspiration level based on a single performance measure. Some of the studies (Audia & Brion, 2007; Greve, 2008) on multiple goals considered aspiration levels based on two distinct performance criteria. Over and above the discussion on whether to devote greater attention to negative or positive performance–aspiration discrepancies, in such cases the ranking of different goal dimensions in terms of their importance plays a role. In order to isolate the effect of inconsistency from that of goal hierarchy, we consider the case in which both aspiration levels pertain to the same goal criterion.

3. Audia and Brion (2007) also referred to these rules in relation to inconsistency between performance–aspiration discrepancies on two different goal dimensions. Mezias, Chen, and Murphy (2002) used these rules as well in their study on aspiration updating though did not consider them in relation to inconsistency between performance–aspiration discrepancies.

4. *Non–European Union* (EU) refers to the rest of the world, including other European countries that are not members of the EU (for instance, Switzerland, Norway, etc.).

5. In addition to these controls for region, we ran the model reported in this paper with an indicator variable distinguishing firms headquartered in an EU country from those that were not. We found that this did not impact the level of change in R&D intensity, nor did it change any of the findings reported in this paper. These models are available from the authors upon request.

6. These results are available from the authors upon request.

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