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ORIGINAL EMPIRICAL RESEARCH

When less is more: the downside of customer knowledge sharing in new product development teams

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Abstract

Despite the common belief that knowledge sharing in new product development (NPD) teams is beneficial, empirical findings are mixed. We adopt a microfoundations perspective and draw from the socio-cognitive theory to propose a model that theorizes a nonlinear effect of customer knowledge sharing behaviors on NPD performance. In particular, we identify the underlying mechanism through which shared common customer knowledge and perceived diagnostic value shape the nonlinear returns to customer knowledge sharing behaviors. In Study 1, data from the biotechnology industry provide support for the hypothesis that customer knowledge sharing behaviors in NPD teams have an inverted U-shaped relationship with NPD performance. In Study 2, data from business-to-business (B2B) industries demonstrate that customer knowledge sharing behaviors are positively related to shared common customer knowledge in NPD teams, and the latter has an inverted U-shaped effect on NPD performance. Finally, this nonlinear effect is moderated by the team's perceived diagnostic value of customer knowledge, such that the inflection point of the inverted U-shaped curve is shifted upward in teams with high levels of perceived diagnostic value of customer knowledge, strengthening the impact of shared common knowledge on NPD performance.

Keywords New product development · NPD · B2B · Customer knowledge · Knowledge sharing · Shared knowledge · Socio-cognitive theory · Team · Diagnostic

A plethora of examples highlight the benefits of knowledge sharing for innovation efforts. At Boeing, knowledge sharing in new product development (NPD) teams was essential to the success of Dreamliner 787, a revolutionary jetliner (Leonard et al. 2014). At ARM Holdings, where over 95% of the world's smartphones and tablets obtain their microprocessors, superior innovation follows the purposeful elimination of knowledge sharing barriers (Velu 2015). It is estimated that *Fortune* 500 companies lose roughly "$31.5 billion a year by failing to share knowledge" (Quast 2012, p. 46). Consider Nokia's rise and fall in the past decade: During its effort to develop the next smartphone, different departments shared little knowledge with each other. This led to slower development and the failure to keep up with companies like Apple and Google. Thus, Nokia went from having 49% of the smartphone market in 2007 to completely exiting this market in 2013 (Bloomberg 2013; Vuori and Huy 2016).

But is it really safe to assume "the more, the better" when it comes to knowledge sharing? Despite the large body of research on the benefits of knowledge sharing, researchers do not always observe its positive impact on team success (Choi et al. 2010; Zhou and Li 2012). A meta-analysis of NPD performance drivers indicates that knowledge sharing in NPD teams does not necessarily lead to new product success (Henard and Szymanski 2001). Relatedly, in another meta-analysis on information sharing in teams, Mesmer-Magnus and DeChurch (2009) offer evidence that more communicative teams may be less effective. Furthermore, controlled experiments in small group research reveal that people produce fewer and less creative ideas when they talk to others in a

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group compared to when they work alone (Diehl and Stroebe 1987; Diehl et al. 2002; Mullen et al. 1991; Nijstad and Stroebe 2006). Other studies have found highly communicative groups to be less productive (Stroebe et al. 2010), which re-affirms Mullen et al.'s (1991, p. 18) meta-analysis conclusion that "productivity loss in brainstorming groups is highly significant." Even though many studies have focused on the positive impact of in-team knowledge sharing, some empirical studies have reported non-significant effects on NPD performance (Sethi 2000a), new product quality (Keller 2001), and NPD project budget performance (Keller 2001). There are inconsistent findings regarding the impact of NPD team knowledge sharing on performance outcomes such as team efficiency, with some reporting no effect (Park et al. 2009) but others reporting a positive effect (Markham and Lee 2014).

To shed light on this, we address the following research questions: (1) How do customer knowledge sharing behaviors in business-to-business (B2B) NPD teams impact NPD performance? (2) What is the underlying socio-cognitive mechanism for this impact? We offer four main contributions. First, we conceptualize and provide evidence for a nonlinear effect of customer knowledge sharing behaviors on NPD performance. Despite emerging evidence from practice, prior research has ignored nonlinear effects and examined only linear relationships between knowledge sharing and innovation success (Table 1). If the relationship is non-monotonic, as we argue in this research, then a model assuming a linear effect is misspecified and cannot uncover the true association. Instead, it will result in an averaging of the positive and negative effects, or the positive effects dominating the negative, or vice versa, over different ranges of data.

Second, drawing from the socio-cognitive theory (Bandura 1978, 1999), we demonstrate that shared common customer knowledge in the team is an underlying nonlinear mediation mechanism through which individual team members' customer knowledge sharing behaviors impact NPD performance. In particular, we argue and show that shared common customer knowledge has an inverted U-shaped effect on NPD performance. This nonlinear effect is also moderated by the team's perceived diagnostic value of customer knowledge, such that the inflection point of the inverted U-shaped effect is shifted upward in teams with high levels of perceived diagnostic value of customer knowledge, strengthening the impact of shared common knowledge on NPD performance. There has been a lack of research clarity regarding the underlying mechanism through which knowledge sharing impacts innovation success (Table 1). In particular, prior work has not investigated or identified the associated socio-cognitive mechanism. Yet, related research shows that cognitively-rooted constructs add explanatory power to team functioning and performance models (DeChurch and Mesmer-Magnus 2010; Salas et al. 2012). Adopting a microfoundations perspective (Barney and Felin 2013; Foss and Pedersen 2016), our research fills this gap, recognizing that managing socio-cognitive dynamics can be more cost and time efficient than managing organizational dynamics such as team restructuring (Boles 1999; Olivera and Argote 1999).

Third, our research systematically investigates the impact of *customer* knowledge sharing on NPD success. Prior NPD research has primarily focused on the sharing of technical knowledge (see Tables 1 and 2), whereas customer knowledge development in NPD teams is a "key prerequisite for new product success" (Joshi and Sharma 2004, p. 47) and constitutes "a cornerstone of the marketing concept" (Homburg et al. 2009, p. 64). The current research addresses this gap.

Fourth, this paper adds to the sparse empirical literature on NPD teams in B2B industries (Table 1). Both innovation and B2B researchers identify B2B NPD as a top research priority (Griffin et al. 2013; Lilien 2016). A recent meta-analysis found that, compared to customers in the business-to-consumer (B2C) market, business customers possess more reliable and relevant knowledge, and are more motivated to share their knowledge with the NPD team (Chang and Taylor

Table 1 Summary of prior research on knowledge sharing in NPD teams

Type of market	Type of knowledge	Knowledge sharing consequence	Knowledge sharing mechanism
B2C	Customer knowledge	None	None
	Project relevant knowledge	Li and Calantone (1998)[a]; Sethi (2000a); Song et al. (2000); Hoegl et al. (2004); Park et al. (2009); Ernst et al. (2010)[a]; Markham and Lee (2014); Liu et al. (2015a)	None
B2B	Customer knowledge	------ Current paper [b] ------	
	Project relevant knowledge	Moenaert and Caeldries (1996)	None

[a] Customer knowledge or information sharing measured as one of the scale items but not as a stand-alone construct

[b] Nonlinear performance impact of knowledge sharing examined

Table 2 Representative prior research on the impact of knowledge sharing on NPD performance

Reference	Construct & measurement	Shared knowledge	Customer knowledge examined	Research design	Performance measure
Ayers et al. (1997)	"Knowledge integration": extent of information sharing and involvement across functional areas	–	✓ (customer & competitor knowledge in one construct)	One study, cross-sectional survey	Product success
Song and Parry (1997)	"Cross functional integration": extent of cross-functional interaction and communication, including level of information-sharing	–		One study, cross-sectional survey	New product success, including sales & profit in one construct
Li and Calantone (1998)	"Marketing-R&D interface": Intensity/frequency of marketing–R&D communication and cooperation	–	✓ (customer & competitor knowledge in one construct)	One study, cross-sectional survey	Market performance, including sales & profit in one construct
Sethi (2000a)	"Interdepartmental connectedness": extent to which cross-functional formal and informal communication and contact is convenient	–	–	One study, cross-sectional survey	New product performance, including sales & profit in one construct
Sethi (2000b)	"Information integration": degree to which team members share, pay attention to, and challenge one another's information and perspectives to discover new ideas	–	–	One study, cross-sectional survey	Product quality measure
Song et al. (2000)	"Cross-functional integration": degree of cross-functional communication and quality of cross-functional information	✓ (accurate, prompt, a nd timely)	–	One study, cross-sectional survey	ROI, ROS, ROA, and new product success
Troy et al. (2001)	"Openness of communication": extent of freely sharing information and communicating interpretations of market information to each other	–	✓ (general market information)	One study, cross-sectional survey	Number of new product ideas
Hoegl et al. (2004)	"(Within team) communication": extent of communication and quality of shared project information	✓ (relevance, timeliness, accuracy)	–	One study, longitudinal survey	Overall performance, quality, adherence to budget and schedule
De Luca and Atuahene-Gima (2007)	"Knowledge integration mechanisms": extent to which formal processes (e.g., information-sharing meetings) are used to capture, interpret, and integrate knowledge	–	–	One study, cross-sectional survey	Product innovation performance, including sales & profit in one construct
Park et al. (2009)	"Information sharing": extent to which team members shared or exchanged information and held meetings	✓ (usefulness)	–	One study, cross-sectional survey	NPD product innovativeness, time efficiency
Ernst et al. (2010)	"Cross-functional cooperation": the level of cross functional involvement and information sharing	–	✓ (customer & competitor knowledge in one construct)	One study, cross-sectional survey	Overall project performance, including sales & profit in one construct
Liu et al. (2015a)	"Information exchange": extent to which NPD team engages internally in frequent, rich, timely, and accurate interaction in information, knowledge, and ideas.	✓ (rich, timely, accurate)	–	One study, cross-sectional survey	Innovation performance, including sales & profit in one construct
This paper	"Customer knowledge sharing behaviors": communication process associated with NPD team members' provisioning and exchanging of projected-related customer information and knowledge with other members in the same team. "Shared common customer knowledge": project-related customer knowledge that is commonly held by team members of an NPD team, i.e., the intersection of their individual knowledge sets about the customers	✓	✓	Two Studies; cross-sectional surveys (team leader and team members) in multiple B2B industries	Study 1: Sales (subjective) Study 2: Profit (objective)

*Representative articles were identified through a literature search for investigations of the outcomes of NPD team knowledge sharing, published in the *Journal of the Academy of Marketing Science, Journal of Marketing, Journal of Marketing Research,* and *Journal of Product Innovation Management* over 21 years (1997–2017)

*We performed the same search for articles on the outcome of shared knowledge within NPD teams, but found none

2016). Therefore, customer knowledge can prove even more critical for performance outcomes of B2B than B2C teams.

The remainder of this paper is organized as follows. First, we discuss the literature and relevant research background, followed by the proposed theoretical framework. Next, we present an overview of two empirical studies, followed by the details and results of each study. The paper concludes with a discussion of the theoretical and managerial implications as well as limitations and avenues for future research.

Research background

Microfoundations research

The microfoundations perspective (Foss and Pedersen 2016) posits that "micro-level" interactions of individuals within a work unit have "macro-level" performance outcomes, and has produced empirical evidence with important contributions to the areas of firm-level performance (Eisenhardt et al. 2010), knowledge processes (Reinholt et al. 2011), absorptive capacity (Lewin et al. 2011), innovation (Grigoriou and Rothaermel 2014), and organizational capabilities (Kemper et al. 2013). More recently, it has led to a better understanding of how managerial cognitions and interactions lead to firm-level outcomes (Barney and Felin 2013; Greve 2013). The fundamental idea is to decompose macro-level constructs in terms of the actions and interactions of lower level organizational members, in order to gain an understanding of how higher level performance emerges from such interactions. Thus, microfoundations are about locating the proximate cause of a phenomenon (i.e., the explanation of an outcome) at levels of analysis lower than that of the phenomenon itself (Felin and Hesterly 2007). The main issue of interest is social aggregation, or the micro–macro link in group and organizational settings (Barney and Felin 2013). In NPD teams, individual members combine their cognitive and behavioral resources to complete team tasks and achieve team-level performance outcomes. Yet, there is a lack of microfoundations research on team decision making (Helfat and Peteraf 2015) and, despite recent calls for research, it has received little attention in the NPD literature (Grant 1996; Teece 2007). Since our research aims to understand how socio-cognitive processes in NPD teams, i.e., how individual-level knowledge sharing behaviors impact team-level outcomes, a microfoundations perspective constitutes a suitable and promising approach. Within this perspective, a particularly useful theory for the proposed work is the socio-cognitive theory, which we discuss next.

Socio-cognitive theory

The socio-cognitive process is undoubtedly an essential component of group functioning. Small group research suggests that "studying group performance *requires* an analysis of the sociocognitive processes within the group" (Van den Bossche et al. 2006, p. 492, emphasis added). However, it has been noted that "it is somewhat surprising that traditional motivation theories such as expectancy theory and socio-cognitive theory have not been used as often in knowledge sharing research. Future research should investigate knowledge sharing using these theoretical frameworks" (Wang and Noe 2010, p. 123). Responding to this call for knowledge sharing research using the socio-cognitive theory, we examine how the process of NPD team members sharing knowledge with each other is related to mutually shared cognitions in the team, and the implications on NPD team performance.

Socio-cognitive theory posits that behaviors, cognitions, and environmental influences act as interacting determinants of learning, motivation, and innovative work behaviors (Bandura 1999; Bandura 2011; Stajkovic and Luthans 2003). Thus, learning and cognitions (e.g., beliefs, expectations) are viewed as contextually embedded within a social environment (Fiore 2012). Though rarely used to study knowledge sharing in NPD, socio-cognitive theory has been used to study the relationship between team cognition and managerial behavior (e.g., DeChurch and Mesmer-Magnus 2010; Pearsall et al. 2010). Shared knowledge in a team is recognized as a cognition component that "helps team members understand and adapt to their environment and provides a common interpretative framework for their experiences" (Levine and Moreland 1999, p. 269). White (1992) considers information sharing the "nervous system" that allows organization unit members to coordinate their work efforts and create a social environment that may stimulate creative performance. Shared cognitions are especially important when the group task is complex and requires a high degree of response coordination (Levine and Moreland 1999), which is a defining characteristic of NPD project teams. Group members can acquire both task and social knowledge through their interaction (Olivera and Argote 1999).

Knowledge sharing of NPD team members includes behaviors that occur in the social environment of the team as well as within the broader market environment, where information about customers and competitors can continually shape the team's shared cognition. As behavior, cognition, and environment influence one another, knowledge sharing behaviors can sway the shared cognition of the team. The market environment can affect the team's cognition or beliefs about the importance of customer knowledge. If a team believes that utilizing a particular type of knowledge in decision making will be beneficial for its performance, then its members are more likely to use it in decision making.

Definitions

We define *customer knowledge sharing behaviors* as the communication process associated with NPD team members'

provisioning and exchanging projected-related customer information and knowledge with other members in the same team. Here, customer knowledge refers to the knowledge about customer's needs, preferences, and behaviors. Firms with a superior understanding of their customers can deploy available resources in ways that more closely match target customer requirements, and thus deliver superior customer value (Hunt and Morgan 1995; Slater and Narver 1998). We focus on customer knowledge because possessing and utilizing such knowledge is especially important in innovation activities and critical for NPD success (De Luca and Atuahene-Gima 2007). The NPD process often involves unanticipated changes and challenges, making it important to understand and collect timely feedback from customers (Eisenhardt and Tabrizi 1995; Olivera and Argote 1999).

Further, we adopt a socio-cognitive view to conceptualize shared knowledge in a team as cognitive development that results from the social, interpersonal interaction among team members. Grant (1996, p. 115) noted that, "At its most simple, common knowledge comprises those elements of knowledge common to all organizational members: the intersection of their individual knowledge sets." Based on this, we conceptualize *shared common customer knowledge* as project-related customer knowledge that is commonly held by team members of an NPD team, i.e., the intersection of their individual knowledge sets about the customers.

Customer knowledge sharing behaviors and *shared common customer knowledge* are related but distinct constructs. The former is a social, behavioral process at the individual level, whereas the latter is a socio-cognitive state, reflecting team cognition, and an outcome at the team level. Thus, it is appropriate to study knowledge sharing as an individually exhibited behavior, at the individual level, and shared common customer knowledge, at the collective or team level (Cooke et al. 2009; Gorman et al. 2010).

Hypotheses development

Individual customer knowledge sharing behaviors and NPD performance

Drawing from the microfoundations perspective, we investigate the question of how NPD team members' individual behavior can scale to a team-level outcome. We propose that customer knowledge sharing behaviors in an NPD team exert an inverted U-shaped effect on NPD performance, such that NPD performance increases when team members first engage in customer knowledge sharing, but only up to a certain level, after which the effects level off and even start to hurt NPD performance.

Abundant research touts the performance impacts of *general* knowledge sharing in NPD, including the positive effects on innovation performance (De Luca and Atuahene-Gima 2007; Liu et al. 2015a), product success (Ayers et al. 1997), the number of new product ideas generated (Troy et al. 2001), product quality (Sethi 2000b), product innovativeness (Park et al. 2009), team effectiveness (Ayers et al. 1997), and overall team and project performance (Ernst et al. 2010; Hoegl et al. 2004; Marinova 2004; Markham and Lee 2014; Moorman 1995) (Table 2). The latter studies point to several reasons for the positive effect of knowledge sharing behaviors on NPD performance. First, when team members start to share knowledge, rich opportunities emerge for novel combinations of complementary knowledge, promoting a more holistic picture of the market (Joshi and Sharma 2004; Srivastava et al. 2006). Second, knowledge sharing helps individual team members to better process and use their existing knowledge (Harvey and Fischer 1997), including to connect and integrate disparate knowledge to achieve better product innovation performance (De Luca and Atuahene-Gima 2007). Third, the act of knowledge sharing can also generate new knowledge, which, when shared in the team, can lead to creative NPD outcomes (Zhou and Li 2012). In summary, through knowledge sharing, team members can obtain a more holistic shared understanding of the customers and achieve a better market sense-making capability. Subsequently, improved decision making and quick adaptation to market changes can be expected.

On the other hand, drawing from socio-cognitive theory, we argue that too much knowledge sharing can hurt NPD performance. The act of knowledge sharing yields a flow of complex information that is shared in a team, but the inherent noise accompanying the communication process can overshadow the signal (Day and Schoemaker 2004; Velu 2015). Interactions within a group have been found to have both cognitive stimulation and interference effects on group performance (Kerr et al. 1996; Nijstad and Stroebe 2006). Thus, a meta-analysis reveals significant productivity loss in highly interactive groups such as brainstorming groups (Mullen et al. 1991), an "unintended yet inevitable consequence of communication in verbally interacting groups" (Nijstad and Stroebe 2006, p. 200). Extensive sharing behavior is thought to disrupt cognitive processes such as information retrieval and ideation. Cognitive overload, propagated by group members' divided attention between listening, processing large amount of shared information, and speaking, impedes group performance (Diehl and Stroebe 1991). Consistent with this, research on communication in teams indicates that too much information sharing can overload team members' information processing capacities, which can then inhibit team performance (Levine and Moreland 1999; Wegner 1987).

In summary, through customer knowledge sharing, the NPD team gains a better shared or collective understanding of the customers. Thus, it can better adapt the new product design to the challenges and opportunities in the marketplace.

However, for reasons stated above, too much sharing can actually negatively impact team productivity and hurt NPD performance.

H1: Individual NPD team members' customer knowledge sharing behaviors exhibit a curvilinear relationship with NPD performance, following an inverted U-shaped pattern.

The mediating role of shared common customer knowledge

We propose that shared common customer knowledge in the NPD team mediates the effect of customer knowledge sharing behaviors on NPD performance. One main benefit of knowledge sharing derives from meshing diverse knowledge from different individuals (Grant 1996). The communication process of team members sharing knowledge with each other can be seen as a means to and a facilitator of shared common knowledge in the team (Nelson and Cooprider 1996). When individual team members share their customer knowledge with each other, "through the exchange of initially unshared information" (Gigone and Hastie 1993, p. 959), the team reaches some shared common understanding of the customers. The more individual team members share knowledge with each other, the greater the extent of shared common knowledge.

From a social cognitive point of view, the NPD team, and the broader market environment, are the social environment that individual team members operate in, and cognition is contextually embedded within the social environment (Fiore 2012). Thus, even though the behavior of sharing customer knowledge occurs at the individual level, the resulting shared common customer knowledge resides at the team level. Differential team performance can be better understood by examining not only behavioral interactions among team members, but also the team's shared cognition (Cooke et al. 2009; Gorman et al. 2010). In line with this view and prior research (Alavi and Leidner 2001; Faraj et al. 2011), we consider shared common customer knowledge as an important team-level construct that results from team members' interactions.

H2: Individual team members' customer knowledge sharing behaviors have a positive effect on the level of shared common customer knowledge within the NPD team.

Social psychologists have studied shared common knowledge as a factor that influences group decisions and outcomes. In his seminal work, Grant (1996, p.115) notes that "the importance of common knowledge is that it permits individuals to share and integrate aspects of knowledge which are not common between them." Organizational behavior research has also found that some redundant or shared knowledge among different organizational members is necessary for individuals to cross functional boundaries and understand each other (Nonaka and Takeuchi 1995).

Similarly, in a team context, scholars have found that "shared knowledge … helps group members understand and adapt to their environment and provides a common interpretative framework for their experiences" (Levine and Moreland 1999, p. 269). Shared knowledge provides a common platform for team communication. It enables team members to better understand the context of new and old information, or beliefs and suggestions from others on the team. This reduces misunderstanding and the cost of explaining things to one another, therefore making the group decision process as well as the actual "doing" part of the job more efficient. Strategy research reveals that some shared common knowledge helps individuals in a team reach consistent and cohesive views of team-level goals, and it generates more relevant insights regarding the team's future actions (Turner and Makhija 2012). A shared knowledge base leads to better coordination of team efforts and improved team effectiveness (Srivastava et al. 2006), as well as an enhanced ability for team members to work toward a common goal (Nelson and Cooprider 1996).

However, there is a dark or paradoxical side of shared common knowledge in an NPD team (Grant 1996). While a low level of overlapping knowledge impedes mutual understanding due to the lack of common ground, a high level of overlapping knowledge diminishes the gain from having one another. Consistent with this, social cognitive research has found that "maximally shared information can inhibit group performance" despite its benefit of cognitive "requisite variety" (Levine and Moreland 1999, p. 287), and thus too much shared common knowledge in a team can become dysfunctional.

There are several reasons for this detrimental effect. First, team members' interpretations become less effective as the information to be interpreted begins to exceed the team's capacity to process it (Huber 1991; Nijstad and Stroebe 2006). In fact, it has been found that extensive amounts of shared knowledge in NPD teams can cause attention allocation problems (Laursen and Salter 2006), as the sheer volume of information makes it challenging for team members to sort, filter, and identify relevant knowledge.

Second, research on majority influence suggests that shared information and opinions can produce pressure toward uniformity, which reduces team members' attention to novel alternatives and in turn leads to poor decisions (Levine and Moreland 1999; Levine and Thompson 1996). As the extent of shared knowledge increases, team members are likely to perceive a group consensus. The motivation to fit in and avoid deviance from the majority group will hamper their ability to elaborate and process information effectively (Cialdini and Goldstein 2004; Erb et al. 2002). In addition, individuals

may use an accuracy heuristic that favors the majority instead of fully analyzing the information (Cialdini and Goldstein 2004), and the critical evaluation of assumptions among team members is less thorough (Kratzer et al. 2004; Nicholas 1994). As a result, they are more receptive to the position endorsed by the majority and are likely to place greater value on shared rather than on unshared information (Cialdini and Goldstein 2004).

Third, the common-knowledge effect suggests that overlapping or shared information is weighed more heavily than unshared information in decision-making (Gigone and Hastie 1993). Shared information is seen as more reliable, and hence it exerts more informational influence. The tendency of teams to discuss and attend to shared rather than unshared information increases with higher overall information load, such that teams fail to make use of all of their individual, idiosyncratic informational resources (Argote et al. 2003; Stasser and Titus 1985). Past a certain point, more shared common knowledge reduces the unique contribution of each individual team member, thus harming creativity. Indeed, Moorman and Miner (1997) find that, at times, higher levels of shared understanding and homogeneous knowledge in NPD teams can detract from creativity.

H3: Shared common customer knowledge in an NPD team exerts an inverted U-shaped effect on NPD performance.

The moderating role of the perceived diagnostic value of customer knowledge

We define an NPD team's perceived diagnostic value of customer knowledge as the extent to which the team believes that decisions based on customer knowledge will lead to specific NPD performance outcomes in a clear cause-and-effect relationship (Levitt and March 1988). Beliefs about the cause-and-effect relationship are "particularly important in supporting strategic decision making since they serve as the basis on which decision markers infer the consequence of their actions" (Gary and Wood 2011, p. 570). In particular, managerial knowledge structures that define what does and does not "work" provide a framework for team members to interpret information from the market environment, and to make inferences about their actions (Ansoff and McDonnell 1984).

Diagnostic information "provides a heuristic for filtering the vast amounts of potentially relevant information" (Harmeling et al. 2017, p. 4). In innovation contexts, rapid changes and the dynamic market environment require NPD teams to quickly recognize important new information and to understand the cause-and-effect linkages between decisions based on certain information and their outcomes (Kozlowski et al. 1999; Randall et al. 2011). Time pressure, which is inherently present during NPD, also induces decision makers to focus on salient, diagnostic information. We argue that an NPD team's perceived diagnostic value of customer knowledge can be viewed as a cognitive force that guides the team's utilization of customer knowledge in team decision making.

Socio-cognitive theory acknowledges that "environmental influences partly determine what people attend to, perceive, and think" (Bandura 1978, pp. 344–345). Strategy scholars have found that the allocation of scarce managerial attention to the most relevant issues is required for effective strategic decision-making (March and Shapira 1987). During the NPD process, team members form an attention filter through which information is considered and processed. Only information that passes through this filter can be *utilized* for team decision making (Kelly and Karau 1999). If teams do not see the linkages between customer knowledge, actions based on such knowledge, and the subsequent performance outcome, then they are less likely to use their shared common customer knowledge in decision making, thus failing to benefit from it. On the other hand, teams with a high perceived diagnostic value of customer knowledge recognize that comprehensive and up-to-date customer knowledge is critical for NPD success. Therefore, they are likely to allocate more managerial attention to customer knowledge because their pre-set cognitive filter makes the screening of such information automatic. Such information would easily surface during team decision making. Subsequently, the team is more likely to recognize and quickly respond to the latest market changes, achieving superior performance.

Overall, the social cognitive perspective maintains that all group processes are understandable through an analysis of how group members process group-relevant information (Pryor and Ostrom 1987). Behavioral decisions are influenced by one's belief of what outcome will result from a particular behavior. This has also been extended theoretically to collective behavioral decisions in groups (Bandura 2001). In the context of NPD, if a team holds the belief that customer knowledge is consequential for team performance, the problem of filtering large amounts of incoming knowledge is alleviated; hence, team members are more likely to allocate attention to and utilize their shared customer knowledge in decision making. Consequently, teams with high levels of perceived diagnostic value of customer knowledge will experience a more positive effect of shared common customer knowledge on NPD performance; the inverted U-shaped curve, as proposed in H3, will move upward.

H4: The perceived diagnostic value of customer knowledge in an NPD team moderates the curvilinear relationship between shared common customer knowledge and NPD performance such that the inflection point of the inverted U-shaped effect is shifted upward in teams with

high levels of perceived diagnostic value of customer knowledge, strengthening the impact of shared common knowledge on NPD performance.

The conceptual framework, presented in Fig. 1, is tested with two studies in different industries. In Study 1, we test and establish the nonlinear effect of customer knowledge sharing behaviors on NPD performance in a biotechnology industry setting. In Study 2, we utilize a field survey in the shipbuilding, railroad, and design engineering industries to shed light on the mechanism through which customer knowledge sharing behaviors impact NPD performance.

Study 1: Impact of customer knowledge sharing behaviors on NPD performance

Research setting and design

To test H1, we sought an industry in which NPD team members regularly communicate and collectively process knowledge to make joint innovation decisions. The biotech industry is a knowledge-intensive industry in which NPD is critical to organizational survival and success. Most biotech firms simultaneously develop multiple new products, and distribute tasks and responsibilities across many NPD teams. Such a structure helps distribute and decrease the risk inherent to innovation.

We conducted a field survey of two U.S. biotech firms with operations in the United States, Europe, and Asia. They both develop, manufacture, and market biological and chemical equipment and reagents. Each NPD team focuses on developing one new product, with significant autonomy. Team members work together, make joint decisions, and are held accountable for their team's performance. Our research approach involves a survey of team members (to assess the extent of knowledge sharing behaviors) and a survey of team leaders (to collect team performance measures), following Dillman et al. (2014). We first consulted industry experts and examined secondary data to understand the NPD process in this industry. Then, we conducted seven in-depth qualitative interviews with NPD managers from the focal firms, each lasting 60–120 min. In turn, we developed the initial survey instrument and pretested it to verify its relevance, clarity, and completeness. The survey was revised until we confirmed the content and face validity of all the measures. The survey introduction emphasized that "all questions below are regarding NPD team *x* and your interaction with team members in this team." NPD team leaders were asked to provide NPD performance measures for the particular product developed by the team. This finalized questionnaire was administered using Qualtrics software. Top management in both firms sent emails to 247 qualified respondents in 20 NPD teams, encouraging them to participate during work hours. As an incentive, we offered the firms a summary of the research findings; also, individual participants were entered into a lottery to win one of 10 gift cards to Target worth either $50 or $100. We ultimately collected data from 182 respondents from 20 NPD teams, for a 74% response rate. The average team size was 10, ranging from 4 to 22 members.

Measurement

To measure the behavior of customer knowledge sharing (*KNScust*), we adapted a reflective knowledge sharing scale from Cummings (2004), such that each respondent indicated how often he or she shared project-related customer knowledge with others in the NPD team, in response to the question, "On average, how often did you share project-related knowledge regarding the following issues with your team members?" For NPD performance, we adopted a scale from Moorman (1995), with items such as: "Relative to our firm's

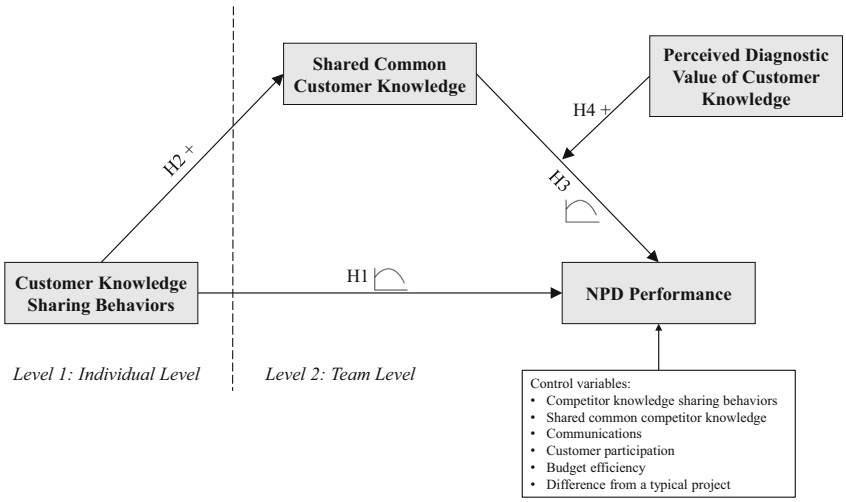

Fig. 1 Conceptual framework

other new products, this product is very successful in terms of sales." NPD team leaders answered these questions. We examined the consistency of the reported performance measures in teams with two leaders and found a high level of agreement ($\alpha = .941$).

Three variables provided controls in the model. First, a frequency of communications (*COMU*) scale measured how often team members engaged with others in the team. Second, we controlled for the perception of team performance with two items as shown in Web Appendix A. Third, we controlled for the behavior of competitor knowledge sharing (*KNScomp*) with three items as shown in Web Appendix A.

A confirmatory factor analysis (CFA) to assess the convergent and discriminant validity of the measures explicitly focused on the study constructs. That is, items corresponding to the key constructs were analyzed in a CFA using EQS. 6.2 for Windows, and constrained to load on their hypothesized factors. We provide the results in Web Appendix A. The estimated factor loadings and covariances then provided the input to assess the convergent and discriminant validity. The measurement model fit the data well (Bollen's fit index = .930, comparative fit index = .931, and root mean squared error of approximation = .070). The average variance extracted (AVE) values were higher than .50 and greater than the shared variance among constructs, and the reliability estimates were robust (.813), exceeding the .700 threshold. In terms of discriminant validity, in accordance with Fornell and Larcker (1981), the AVE exceeded the maximum shared variance. We also estimated a CFA in which we constrained the correlation between *KNScust* and *KNScomp* to 1, which offered a significantly different fit than the unconstrained model, in further support of the discriminant validity (Anderson and Gerbing 1988).

Empirical analysis and results

To account for the nested nature of the data—that is, team members are nested within teams—we estimated a random parameters model (Greene 2012). The unobserved heterogeneity across team members can be addressed with the random parameters. Thus, we ran a model with NPD performance as the dependent variable, linear and quadratic terms of customer knowledge sharing behaviors (*KNScust*) as the independent variables, and frequency of communications (*COMU*), perceived team performance, and competitor knowledge sharing behaviors (*KNScomp*) as the control variables. The log likelihood function of the hypothesized model is −29.79, and of the model with only the control variables is −123.34. The likelihood ratio test confirms that the hypothesized models fit better than the models with just the control variables ($\chi^2_{3df} = 93.55$, $p < .001$), with a pseudo R^2 of .41.

Descriptive statistics and correlations are reported in Web Appendix B. The results of the model tests are presented in Table 3. The VIFs are uniformly under 5, and thus multicollinearity is not a concern. Consistent with H1, the quadratic term of customer knowledge sharing behaviors has a negative impact on NPD performance (−.041, $p = .003$), while the effect of the linear term is positive (.149, $p = .032$). Thus, the overall effect is nonlinear in the shape of an inverted U, supporting H1. The diminishing benefits of customer knowledge sharing behaviors on NPD performance contradict prior scholarly and managerial practices, which generally support "the more, the better" perspective by assuming that knowledge sharing behavior is, in and of itself, beneficial for NPD performance. Our findings indicate that the impact of customer knowledge sharing behaviors on NPD performance is the strongest when the extent of knowledge sharing is moderate rather than high or absent.

Study 2: The role of shared common customer knowledge and perceived diagnostic value of customer knowledge

Research setting and design

Study 1 established the nonlinear effect of customer knowledge sharing behaviors on NPD performance. In Study 2, we examine an underlying mechanism for this effect and test the proposed framework across different industries.

We conducted a field survey of NPD teams across three companies in the shipbuilding, railroad, and design engineering industries in China. Each NPD team in the study focuses on developing one new product, with significant autonomy. Team members are held accountable for their team's performance, and the performance of each project is relatively independent of the other teams. As in Study 1, our research approach involved a survey of NPD team members and a survey of team leaders. We first conducted interviews with industry experts, as well as executives and NPD team leaders from the focal firms. These early interviews, which lasted approximately fifteen hours in total, helped us understand the research context and were instrumental in our attempts to craft the pretest survey.

On the basis of these interviews, we developed preliminary versions of the questionnaires. We initially developed the questionnaire in English, then used the standard forward- and backward-translation procedure to translate it into Chinese (Brislin 1990, also see Menguc et al. 2016, Wang et al. 2017). This ensured that the English and Chinese versions contained identical measures. We pretested the questionnaires and subsequently made two rounds of revisions to ensure the clarity of the instructions and the appropriateness of the used terminology. The survey introduction emphasizes that "all questions below are

Table 3 Study 1 results: Effects of customer knowledge sharing behaviors on NPD performance

Independent variables	Dependent variable: NPD performance	
	Coefficient	*SE*
Customer knowledge sharing behaviors (*KNScust*)	.149*	.080
Customer knowledge sharing behaviors^2 (*KNScust*^{2})	−.041**	.014
Controls:		
Competitor knowledge sharing behaviors (*KNScomp*)	−.032	.052
Perceived team performance	.054	.065
Communications (*COMU*)	−.019	.031
Intercept	0.579***	0.015
Log likelihood (hypothesized model)	−29.794	
Log likelihood (controls variables only)	−123.339	
Likelihood ratio test (df)	93.545 (3), $p < .001$	
Pseudo R^2	.410	

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

For all the hypothesized relationships, the p value is based on one-tailed tests. For all the control variables, the p value is based on two-tailed tests

We also performed the analysis by standardizing all the variables. All the hypothesized effects are consistent with the unstandardized coefficients displayed above in terms of significance and direction

regarding NPD team *x* and your interaction with team members in this team." NPD team members were asked to assess the extent of individual knowledge sharing behaviors and shared common knowledge in the team. Team leaders were asked to evaluate NPD performance, perceived diagnostic value of customer knowledge in the team, and project characteristics for the particular project. The finalized questionnaire was administered by the firm at internal business meetings as an anonymous survey. Altogether, data were collected from 377 respondents from 79 NPD teams, including 298 team members and 79 team leaders. The average team size was 5, ranging from 3 to 13 members.

Measurement

Both the customer knowledge sharing behaviors and shared common customer knowledge were measured with reflective items. Measurement items for customer knowledge sharing behaviors (*KNScust*) were the same as in Study 1, such that each respondent indicated how often he or she shared project-related customer knowledge with others in the NPD team, on a scale of 1 to 5, where: 1 = "Once Every Few Weeks", 2 = "Once a Week", 3 = "Several Times a Week", 4 = "Daily", and 5 = "Several Times a Day." To measure shared common customer knowledge, we asked NPD team members to rate the extent of common or overlapping project-related knowledge in the team in various aspects as related to customer knowledge (*SKNcust*). Throughout the survey, respondents were reminded that the items aim to measure knowledge sharing or shared knowledge regarding a specific NPD team project.

For the perceived diagnostic value of customer knowledge (*DIAG*), each team leader was instructed to divide 100 points among three project-related knowledge categories to indicate, based on the particular team's perception, how influential knowledge in the following three categories is for NPD performance: (1) knowledge about the customers, (2) knowledge about the competitors, and (3) technical knowledge. The points assigned to the first choice provide the data for *DIAG*.

Following management's suggestions, NPD performance is measured by new product profits (*PERF*). For confidentiality reasons, management in each firm chose a multiplier for this measure so that the highest profit level is scaled to 7%. This also allows the measurement to be comparable across firms. Team leaders were instructed to provide the scaled, objective financial performance of the products. The measurement came from a one-item scale that asked, "What is the profitability of this new product development project?" Response options are 1%, 2%, 3%, 4%, 5%, 6%, and 7% or more.

As in Study 1, we included frequency of communications (*COMU*) and competitor knowledge sharing behaviors (*KNScomp*) as control variables. The extent of shared common competitor knowledge in the team (*SKNcomp*) was similarly controlled for. Based on the qualitative interviews, we also included the extent to which the project differed from a typical innovation project in the firm (*DIFF*), customer participation (*PARTICP*), and budget efficiency (*BUDGET*) as control variables. Customer participation was measured utilizing a four-point Likert single-item measure based on Ho and Ganesan (2013) that asked for the level of agreement to the following statement: "During the development of this product, customers or potential customers have been regularly

informed of and participated in providing feedback for the project." Budget efficiency was measured utilizing a five-point Likert single-item measure from Olson et al. (1995) that asked for the level of agreement to the following statement: "During this project, the developmental budgets were adhered to."

A confirmatory factor analysis (CFA) assessing the convergent and discriminant validity of the measures was conducted, and the results are provided in Web Appendix C. The measurement model fits the data well (Bollen's fit index = .971, comparative fit index = .971, and root mean squared error of approximation = .058). The values for the average variance extracted (AVE) were all higher than .50 and greater than the shared variance among the constructs, and the reliability estimates were robust (.754), exceeding the .700 threshold. In terms of discriminant validity, in accordance with Fornell and Larcker (1981), the AVE exceeded the maximum shared variance. We also estimated a CFA in which all the items for *KNScust* and *KNScomp* are loaded under a single factor instead of two factors. This model does not fit as well (Bollen's fit index = .891, comparative fit index = .892, and root mean squared error of approximation = .083). The chi-square difference test shows that the difference in model fit is significant ($p < .001$). In addition, we estimated a CFA where we constrained the correlation between *KNScust* and *KNScomp* to 1, which offered a significantly different fit than the unconstrained model. We repeated this test for every pair of constructs, and all showed a significantly different fit than the unconstrained model, in further support of discriminant validity (Anderson and Gerbing 1988).

Empirical analysis and results

Because team members are nested within teams, we used multilevel structural equation modeling (MSEM) to test the hypothesis (Raudenbush and Bryk 2002). In our conceptual model, knowledge sharing behaviors is an individual level construct, whereas shared common knowledge and NPD performance are team level constructs. According to Preacher et al. (2010), this type of model is a 1–2-2 multilevel model. Specifically, knowledge sharing behaviors is specified as a level 1 predictor, shared common customer knowledge is specified as a level 2 mediator, and NPD performance is specified as a level 2 outcome, with level 2 control variables.

We estimated the model with the multilevel module of MPlus 8.0 software (Muthén and Muthén 2017), and followed the one-stage procedure developed by Preacher and colleagues (Preacher et al. 2010) to simultaneously accommodate the individual (team member) effects and team effects in the model. The MPlus "TYPE = TWOLEVEL" procedure was used to produce parameter estimates, standard errors, and test statistics in the presence of interdependency. Our company-level variation (three companies) was not significant to estimate a three-level multilevel model that simultaneously accounted for company-level, team-level, and individual-level variances and relationships. Therefore, following Muthén and Muthén's (2017) suggestion, we used the "CLUSTER" and "TYPE = COMPLEX" MPlus syntax. With this approach, the standard errors are adjusted using a sandwich estimator to account for the nonindependence of observations resulting from cluster sampling and to correct the potential bias in estimation that may result from potential sampling differences (Liu et al. 2015b; Rogers 1994; White 1980).

Descriptive statistics and correlations are reported in Web Appendix B. We mean-centered all variables before entering them into the model (Cohen et al. 2003; Guillaume et al. 2014; Yu and Zellmer-Bruhn 2018). Shared common customer knowledge is a team-level construct with measurement items formulated at the team-level and data collected from individual team members. Therefore, we follow Petitta et al.'s (2015) recommendation to aggregate responses from team members by taking the team average. Guided by Bliese (2000), we first assessed within-group agreement r*wg* and two intraclass correlations, ICC (1) for inter-rater reliability and ICC (2) for reliability of group means, to evaluate the appropriateness of aggregating individual scores to the team level. The ICC (1) is .82, surpassing the recommended cutoff value of .12 (James 1982); the ICC (2) is .95 and the mean r*wg* is .93, surpassing the recommended cutoff value of .70 (LeBreton and Senter 2008; Shrout and Fleiss 1979). We also aggregated responses for the control variables to the team level, and found these to be statistically justifiable. The ICC (1) is .66. and .61, the ICC (2) is .88 and .86, and the mean r*wg* value is .92 and .92, for shared common competitor knowledge and communications, respectively.

Table 4 provides the MSEM results for simultaneously testing all the hypotheses. The hypothesized model explains 44.43% of the variance, compared to the null model that explains 23.81% of the variance. Customer knowledge sharing behaviors have a negative, significant quadratic (−.991, $p < .001$) effect on NPD performance, supporting H1. Figure 2 shows this effect visually. Customer knowledge sharing behaviors exhibit an inverted U-shaped effect on NPD performance. The inflection point is 2.777, where 2 = "Once a Week", 3 = "Several Times a Week", and 4 = "Daily." This indicates that the optimal frequency of customer knowledge sharing within teams is several times a week, i.e., more than once a week but less than daily. The corresponding profit is 4.355%. In addition, it can be seen from Table 4 that customer knowledge sharing behaviors have a positive, significant linear effect on shared common customer knowledge (.368, $p = .004$), supporting H2.

H3 hypothesized a nonlinear effect of shared common customer knowledge on NPD performance. The results in Table 4 revealed a negative, significant quadratic effect of shared

Table 4 MSEM results for testing hypotheses in Study 2

Independent variables	Dependent variables			
	Shared Common Customer Knowledge		NPD Performance	
	Coefficient	*SE*	*Coefficient*	*SE*
Customer knowledge sharing behaviors (*KNScust*)	.368**	.129	−.350	.186
Customer knowledge sharing behaviors^2 (*KNScust*^{2})			−.991***	.269
Shared common customer knowledge (*SKNcust*)			−.369	.646
Shared common customer knowledge^2 (*SKNcust*^{2})			−1.184*	.590
Perceived diagnostic value of customer knowledge (*DIAG*)			.106***	.034
SKNcust × *DIAG*			−.034***	.008
SKNcust^2 × *DIAG*			−.033***	.006
Controls				
Competitor knowledge sharing behaviors (*KNScomp*)	.100	.169	−.060	.269
Shared common competitor knowledge (*SKNcomp*)	−.152	.173	.152	.117
Communication (*COMU*)	.026	.103	−.029	.054
Project difference (*DIFF*)	.053	.040	−.232***	.016
Customer participation (*PARTCP*)	.157	.090	.980***	.204
Budget *(BUDGET)*	.047	.057	.250	.282
Intercept			4.406***	.229
Pseudo R^2 (controls only)			.238	
Pseudo R^2 (hypothesized model)			.444	

*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Because team members are nested within teams, we use multilevel structural equation modelling (MSEM) to test the hypotheses. Specifically, customer knowledge sharing behaviors is specified as a level 1 predictor, shared common customer knowledge is specified as a level 2 mediator, and NPD performance is specified as a level 2 outcome, with level 2 control variables

common customer knowledge on NPD performance (−1.184, $p = .036$), lending support to H3. To illustrate this nonlinear effect, we plotted the effects of shared common customer knowledge on NPD performance in Fig. 3. The result is an inverted U-shaped relationship.

To test the mediation effect of shared common customer knowledge, we estimated the indirect effects of customer knowledge sharing behaviors on NPD performance (Hayes and Preacher 2010). Because we used the "TYPE = TWOLEVEL" procedure in MPlus, MPlus generated confidence intervals for the indirect effect based on the asymptotic normal theory (Muthen & Muthen, 2017; Petitta et al. 2015). The nonlinear mediation effect coefficient, upper and lower bounds of the confidence interval, and the significance tests are shown in Table 5. Mediation can be inferred if the confidence interval for the indirect effect excludes zero. As evident in Table 5, at a low (20%) level of perceived diagnostic value of customer knowledge, the nonlinear indirect effect is not significant (−.065, CI = [−.167, .036]), whereas at a medium (50%) and high (70%) level of perceived diagnostic value of customer knowledge, the nonlinear indirect effect is significant (−.201, CI = [−.353, −.048]; −.268, CI = [−.534, −.003], respectively). Therefore, there is a mediating effect of shared common customer knowledge at a high but not at a low level of perceived diagnostic value of customer knowledge.

Finally, H4 predicted that perceived diagnostic value of customer knowledge moderated the curvilinear relationship between shared common customer knowledge and NPD performance. Consistent with this prediction, we find a *negative*, significant interaction between the quadratic term of shared common customer knowledge and the perceived diagnostic value of customer knowledge (−.033, $p < .001$), in addition to the *negative*, significant interaction between the linear term of shared common customer knowledge and the perceived diagnostic value of customer knowledge (−.034, $p < .001$). To show the pattern of this interactive effect, we plotted the effects of shared common customer knowledge on NPD performance at low (20%), medium (50%), and high (70%) levels of perceived diagnostic value of customer knowledge in Fig. 3. The result is a set of inverted U-shaped curves, which shift vertically as a function of perceived diagnostic value of customer knowledge. Visually, it is apparent that when perceived diagnostic value of knowledge is high, the inflection point of the inverted U-shaped curve is shifted upward, strengthening the impact of shared common knowledge on NPD performance.

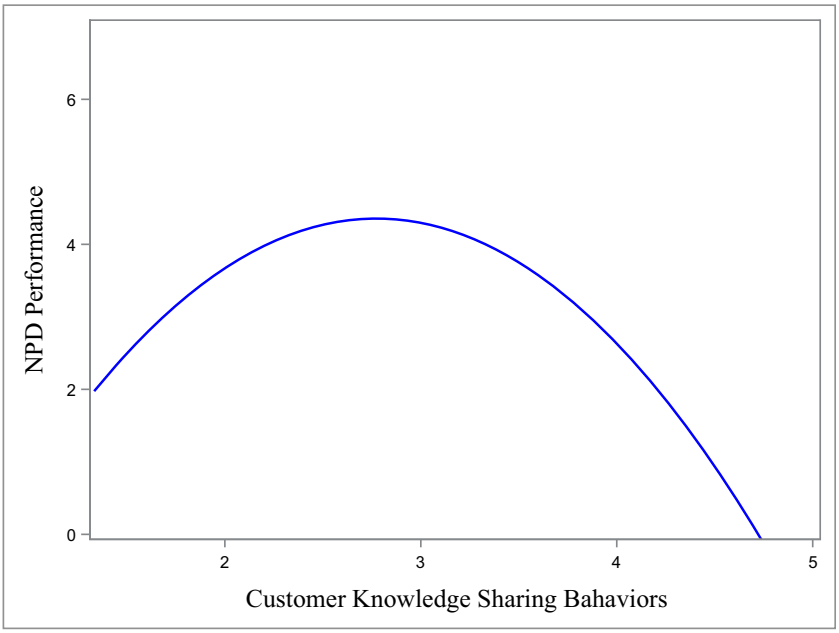

Fig. 2 The effects of customer knowledge sharing behaviors on NPD performance in Study 2

We further evaluated the inflection point of the curve and the corresponding profit as perceived diagnostic value of customer knowledge increases from low to high. The optimal shared common customer knowledge is 3.66, 3.22, and 3.11, at low, medium, and high levels of perceived diagnostic value of customer knowledge, where 3 = "Some" and 4 = "Quite a Bit". The corresponding profit is 2.15%, 4.32%, and 7.00%, respectively.

In a subset (72%) of the sampled firms, we assessed shared common knowledge with two sets of scales containing identical questions but different scale labels. In the first set of scales, which is used in the survey for all firms, the labels are 1 = "None", 2 = "A Little", 3 = "Some", 4 = "Quite a Bit", and 5 = "Extensive." In the second set of scales, the labels are 1 = "0–20%", 2 = "20–40%", 3 = "40–60%", 4 = "60–80%", and 5 = "80–100%". Answers to the two Likert scales were highly correlated (r = .86). Since the inflection point is between 3 and 4 at any level of perceived diagnostic value of customer knowledge, the optimal level of shared common customer knowledge in an NPD team is between 40 and 60% and 60–80%, or around 60% on average.

As a robustness check, we estimated the model with an alternative dependent variable. Team leaders evaluated NPD performance with a five-point Likert scale, indicating their level of agreement to the following statement: "Relative to our original objective, this product is very successful in terms

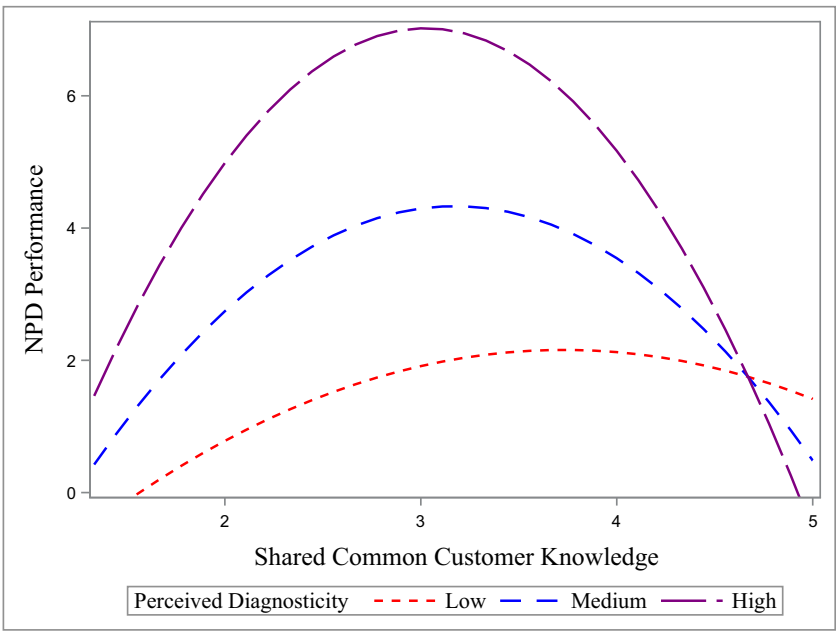

Fig. 3 The effects of shared common customer knowledge on NPD performance in Study 2. (Perceived diagnostic value of customer knowledge: Low = 20%, Medium =50%, High = 70%)

Table 5 Mediation analysis: Curvilinear indirect effects of customer knowledge sharing behaviors on NPD performance in Study 2

Perceived diagnostic value of customer knowledge	Coefficient	LLCI	ULCI	95% CI significance
Low	−.065	−.167	.036	ns
Medium	−.201	**−.353**	**−.048**	**sig**
High	−.268	**−.534**	**−.003**	**sig**

*Perceived diagnostic value of customer knowledge: Low = 20%, Medium = 50%, High = 70%

*Mediation is supported when the CI excludes zero. Values in bold show where the CI excludes zero

of customer satisfaction." Results for the MSEM model are shown in Table 6 and follow the same consistent pattern.

Further, to address the potential endogeneity of customer knowledge sharing, we estimated an alternative MSEM model using an instrumental variable (IV) approach (Germann et al. 2015). We identify competitor knowledge sharing behaviors as a suitable instrumental variable because it correlates with customer knowledge sharing behaviors (r = .360, $p < .001$) but not with NPD performance (r = −.154, $p = .176$), meeting the instrument relevance criterion and the exclusion restriction (Angrist and Pischke 2009). This enables us to partition the variation of NPD performance into that which can be explained by customer knowledge sharing behaviors, and that "which is contaminated and could result in an endogeneity bias" (Rossi 2014, p. 655). We estimated the MSEM model with this IV, and the results are shown in Table 6. All hypothesized effects show the same pattern though the significance level varies.

Discussion

Despite the intuitive and widely acknowledged importance of knowledge sharing, researchers have been unable to consistently observe a positive effect of knowledge sharing on team performance (Choi et al. 2010; Haas and Hansen 2007; Zhou and Li 2012). A meta-analysis on information sharing even indicates that more communicative teams can be less effective (Mesmer-Magnus and DeChurch 2009). This raises the question: Does knowledge sharing really have a positive effect on an NPD team's innovation performance and, if not, then what influence does it have, and how? Our research addresses these questions and offers new insights for both research and practice. Contrary to "the more, the better" assumption, we demonstrate that customer knowledge sharing has a nonlinear effect on NPD performance. Too few or too many knowledge sharing behaviors in a team may hurt, rather than benefit, NPD performance. Adopting a microfoundations perspective and building upon the socio-cognitive theory, we investigate the role of team cognition, i.e., shared common customer knowledge and perceived diagnostic value of customer knowledge, in this process to better understand the nonlinear returns to customer knowledge sharing behaviors.

Theoretical implications

Across field studies in multiple B2B industries, our findings demonstrate that customer knowledge sharing behaviors exert a positive impact on NPD performance, but only to a certain level, beyond which this effect becomes negative. Thus, teams with a moderate amount of customer knowledge sharing behaviors, i.e., several times a week, witness the best performance outcome. Importantly, in contrast to prior research that has adopted "the more, the better" perspective, our findings suggest that it is excessive sharing, rather than insufficient sharing, that should be more concerning to managers. In a sample of 79 teams in Study 2, about one third of the NPD teams had less than an optimal level of shared common knowledge, but two thirds had more than an optimal level of shared common knowledge. Thus, too much shared common knowledge seems to be more commonplace than too little. To the best of our knowledge, previous studies, including those in Mesmer-Magnus and DeChurch's (2009) comprehensive meta-analysis on information sharing and team performance, have not examined nonlinear effects. Further, there have been mixed findings in prior research about the effects of knowledge sharing on NPD performance, where positive, non-significant, and occasionally negative effects have been reported. Our research contributes to the theoretical literature by revealing a plausible explanation. Prior research has only examined the linear relationship between knowledge sharing and NPD performance, resulting in (a) an averaging of the positive and negative effects, or (b) the positive effects dominating the negative, and vice versa, over different ranges of data.

As a second contribution, motivated by a microfoundations perspective, our research adopts a socio-cognitive lens to identify an underlying theoretical mechanism, which demonstrates that the influence of customer knowledge sharing behaviors on NPD performance is mediated by the shared common customer knowledge in the team, and that a moderate, rather than a low or high level of shared common customer knowledge is best for NPD performance. In Study 2, the optimal amount of shared common customer knowledge in a team is around 60% on average. This extends social psychology research that warns that too much shared information is not beneficial for group performance in general (Levine and Moreland 1999).

Table 6 Robustness check: MSEM results for alternative models in Study 2

Independent variables	Dependent variables			
	Shared Common Customer Knowledge		NPD Performance	
	Alternative Model 1[a]	*Alternative Model 2*[b]	*Alternative Model 1*[a]	*Alternative Model 2*[b]
Customer knowledge sharing behaviors (*KNScust*)	.371** (.132)	.742*** (.186)	.116 (.187)	−.535 (1.380)
Customer knowledge sharing behaviors^2 (*KNScust*^{2})			−1.325* (.558)	−.550 (2.026)
Shared common customer knowledge (*SKNcust*)			−.460* (.644)	−.307 (1.073)
Shared common customer knowledge^2 (*SKNcust*^{2})			−.370 (.318)	−1.593** (.551)
Perceived diagnostic value of customer knowledge (*DIAG*)			.072*** (.018)	.104*** (.039)
SKNcust × *DIAG*			−.029 *** (.007)	−.021 (.031)
SKNcust^2 × *DIAG*			−.030*** (.003)	−.007 (.141)
Controls				
Competitor knowledge sharing behaviors (*KNScomp*)	.105 (.166)		.036 (.231)	
Shared common competitor knowledge (*SKNcomp*)	−.153 (.171)	−.139 (.187)	.059 (.090)	.086 (.206)
Communication (*COMU*)	.030 (.103)	.014 (.085)	−.095 (.140)	−.115*** (.031)
Project difference (*DIFF*)	.058 (.042)	.020 (.056)	−.295*** (.053)	−.122 (.090)
Customer participation (*PARTCP*)	.155 (.091)	.182* (.084)	.636** (.226)	.938*** (.200)
Budget *(BUDGET)*	.046 (.055)	.063 (.084)	.307 (.257)	.233 (.271)
Intercept			3.465*** (.227)	4.466*** (.154)
Psudo R^2 (controls only)			.251	.239
Psudo R^2 (hypothesized model)			.490	.362

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Standard errors are shown in parentheses

[a] Alternative model 1 uses an alternative NPD Performance measure which is customer satisfaction

[b] Alternative model 2 uses competitor knowledge sharing behaviors as an instrumental variable for customer knowledge sharing behaviors. The NPD Performance measure is the same as in the hypothesized model in Table 4

Furthermore, we isolate the moderating influence of the perceived diagnostic value of customer knowledge in the team on the uncovered nonlinear relationship between shared common knowledge and NPD performance. In particular, our results reveal that the inflection point of the inverted U-shaped curve is shifted upward in teams with high levels of perceived diagnostic value of customer knowledge, strengthening the impact of shared common knowledge on NPD performance. This finding extends the literature on NPD management, which has not investigated the role of such managerial beliefs on NPD performance outcomes.

Managerial implications

Be wary of the downside of customer knowledge sharing Companies spend billions of dollars in order to facilitate knowledge sharing behaviors in NPD teams. Katie Burke, the Chief People Officer at HubSpot, explains that her

company strives to "continue our practice of sharing as much information as possible with team members at every level" (Burke 2015). However, our findings reveal that more is not necessarily better. With 2.5 quintillion bytes of data generated every day in this big data era (Marr 2018), companies need to be mindful about not getting lost in a sea of data. This is especially relevant to new product development where improperly leveraging knowledge in NPD teams can become a liability. The current research shows that sharing customer knowledge several times a week is better than sharing once a week or less, which is consistent with the common wisdom that knowledge sharing is necessary for team success. However, it also reveals a downside of knowledge sharing—teams that engage in sharing daily or even a few times a day perform worse than those that engage in sharing several times a week. Managers should be aware that customer knowledge sharing is a double-edged sword. The best way for a team to work together is not by team members sharing and cross-learning everything, but by sharing moderately so that they can utilize each one's strength and work efficiently as a team.

Preserve individual customer knowledge stock Since shared customer knowledge is a direct consequence of knowledge sharing behaviors and is also the conduit of the inverted U-shaped effect that knowledge sharing exerts on NPD performance, it is equally if not more important for companies to monitor the extent of shared common customer knowledge in NPD teams. In the popular TV series "The A-team", when pondering why the A-Team always outperforms, Colonel Decker famously noted, "Ah, they're the best. They think as one, feel as one and act as one." Our findings suggest that this common recipe for team success needs to be reconsidered. There is no doubt that teams should possess some common knowledge, but they also need to preserve individual knowledge stock.

Manage team perception of customer knowledge Importantly, our research indicates that a team that perceives customer knowledge as consequential or diagnostic for innovation success will benefit more from the sharing of it. As shown in Fig. 3, at any given amount of shared common customer knowledge in a team, if a team perceives customer knowledge as high in diagnostic value, then it will receive higher returns on NPD performance. This can be an actionable insight for managers who are unsure about the optimal point of knowledge sharing. Knowledge-intensive processes remain "plagued by information quality problems, such as incorrect information and irrelevant information" (Gorla et al. 2010, p. 209). As such, managers should identify ways to promote purposeful, selective sharing of customer knowledge that is relevant, accurate, and valuable.

Finally, as a word of caution, our research should not be interpreted as simply a call to discourage knowledge sharing in NPD teams. In fact, our results confirm that knowledge sharing activities are essential in order for team members to have access to each other's knowledge and expertise, and to create shared knowledge at the team level. It is only when there is excessive sharing that problems arise. Based on our findings, we have suggested an optimal amount of within-team knowledge sharing—several times a week but less than daily. We encourage companies to set up guidelines for NPD team knowledge sharing best practices accordingly.

Limitations and avenues for future research

Our research has some limitations that yield promising avenues for future research. First, we did not address when and why there can be too much customer knowledge sharing in a team. Future research should investigate the antecedents of customer knowledge sharing to offer insights on how to avoid the trap of having "too much." Second, there can be other potential mechanisms linking customer knowledge sharing to NPD performance. For example, other potential mediators may include the relevance and quality of the shared knowledge, the extent to which members share unique knowledge, and the breadth versus depth of the shared knowledge, just to name a few. In addition, future research can investigate the role of trust among members, and how the norm of reciprocity may affect knowledge sharing outcomes. Third, NPD is a stage-gate process (Eling et al. 2013). It is possible that our observed effect is stronger in one stage than in another. Future research should examine this and other possible moderating mechanisms. The development of knowledge sharing itself might also be multi-staged. Quantity of knowledge sharing may be the major concern at the early stages of NPD, whereas quality of knowledge sharing may be the major concern at the late stages. Lastly, future research can use longitudinal studies to capture the dynamic effects of knowledge sharing behaviors on NPD performance.

In conclusion, knowledge sharing is a critical process, without which NPD teams lose their purpose, but too much sharing as well as too much shared common knowledge can hinder NPD performance. In a two-year research effort, code-named Project Aristotle, Google studied 180 of its work teams to answer the following question: What makes a team effective? As explained upon the conclusion of the project by Rozovsky (2015), Google's people analytics manager, "who is on a team matters less than how the team members interact." Going back to Aristotle's quote, "the whole is greater than the sum of its parts," our research confirms that having just the right amount of customer knowledge sharing behaviors in an NPD team is an important balance for firms to find and maintain.

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