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Those Who Know, Do. Those Who Understand, Teach. Disseminative Capability and Knowledge Transfer in the Automotive Industry*

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Innovations in the automotive industry are increasingly building on contributions from different technological fields. Correspondingly, firms in this industry more than ever tend to form research and development (R&D) alliances that aim at innovating new products through integrating separate fields and transferring knowledge. While, in symmetrical R&D alliances, each partner intends to ultimately maintain their distinctive and specialized knowledge base, overlapping knowledge facilitates cooperation and ultimately alliance success. Thus, the capability for knowledge transfer between partners is crucial in such R&D alliances. The literature provides ample evidence that such knowledge transfer is more likely to succeed if the recipient firm has absorptive capability. However, whereas the characteristics of the knowledge transfer process and the recipient firm are well understood, limited attention has so far been given to the issue of the knowledge source firm's ability to transfer knowledge to R&D alliance partners. This study focuses on the impact of source firm capability on successful knowledge transfer in R&D alliances. The study develops a theoretical framework of disseminative capability consisting of five dimensions and tests it on a sample of 59 projects in R&D alliances in the automotive industry. To ensure content validity and avoid common source bias, data were collected from both alliance partners. To test the hypotheses, multiple regression analyses were performed. The results reveal that the source firm's disseminative capability including the attainment of expert knowledge, assessing the recipient firm's knowledge base, and encoding knowledge are positively related to knowledge transfer success, while, surprisingly, detaching knowledge and support of knowledge application in the recipient firm are negatively related. Intentionally or unintentionally, disseminating knowledge across firm boundaries is widely perceived as detrimental to a firm's competitive advantage. Accordingly, the literature tends to downplay disseminative capability as an important means of exploiting external knowledge in collaborative settings. By demonstrating potential benefits for the source firm to transfer knowledge to the allying R&D partner firm, this paper reinvigorates the collaborative dimension in knowledge transfer. Further, the paper is the first of this kind to theoretically explain and empirically show that dimensions of disseminative capability of collaborators in R&D alliances are important for knowledge transfer, whereas disseminative capability is the complementary inverse of an organization's absorptive capacity.

Introduction

The challenges facing the automotive industry today range from strict regulations on energy consumption and the pressure to reduce manufacturing costs to an urgent need for clean mobility while adhering to driving safety standards. At the same time, the industry seeks to explore and adopt new technological possibilities (i.e., wireless communication and the Internet). Novel developments in a variety of technical disciplines and areas of engineering are required, such as materials and lightweight construction, alternative energy storage, and drivetrain technology, or sensors and electronics for, i.e., assisted driving. However, it is the integration of systems that fuels a more holistic view of the vehicle and enables the performance changes that are needed by magnitude. Automobile manufacturers and their automotive suppliers often lack the full breadth of specialized knowledge needed to develop innovative vehicle modules or components. Consequently, firms operating in the automotive industry access, transfer, and integrate additional knowledge by increasingly engaging in research and development (R&D) alliances. Examples are Johnson Controls and Maxwell Technologies, which are mutually developing lithium-ion battery electrodes

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for use in vehicles, or BMW and Google, which are jointly developing innovative automobile communication systems. Many alliances are characterized by one firm seeking to absorb the knowledge of their partners without reciprocating (Hamel, 1991). However, in symmetrical R&D alliances, while each partner intends to ultimately maintain their distinctive and specialized knowledge base (Faems, Van Looy, and Debackere, 2005; Grunwald and Kieser, 2007), overlapping knowledge facilitates cooperation and ultimately alliance success (Brusoni and Prencipe, 2001; Brusoni, Prencipe, and Pavitt, 2001; Cohen and Levinthal, 1990; Emden, Calantone, and Droge, 2006; Grant, 1996; Reagans and McEvily, 2003; Rindfleisch and Moorman, 2001). Thus, the capability for knowledge transfer between partners is crucial in such R&D alliances (Argote and Ingram, 2000). This is particularly relevant in the automotive industry (Landmann and Kappen, 2011) because—apart from the aircraft and aerospace industry—the technological variety to be not only combined, but integrated in a single product and the pace of knowledge and technology development to be mastered in many of the specialized areas is unmatched by other products or industries.

R&D alliances are likely to comprise knowledge transfer in both directions, with each partner taking turns to be the knowledge source and the recipient firm. For example, in order to reach the full potential of the BMW–Google alliance, Google acquires knowledge about the usage of cars, which can potentially be applied to transportation chains or the tracking of stolen vehicles, while BMW learns about search software and mapping for future improvements in mobility (i.e., Innovanaut, 2012). A substantial body of knowledge exists on how recipients' absorptive capacity impact knowledge transfer success (e.g., Choi and Lee 1997; Cummings and Teng, 2003; Lane, Koka, and Pathak, 2006), for example, uncovering that centrality of the location of an R&D department impacts successful absorption of technical knowledge (Zhang, Baden-Fuller, and Mangematin, 2007), or that trust, cultural, and industry contingencies moderate the absorption and integration of knowledge in R&D alliances (Fang, 2011). Yet scholarly work on knowledge transfer in R&D alliances tends to adopt an unbalanced view in favor of the recipient firm, perhaps because of the assumed benefit of absorbing from rather than bestowing knowledge on partners. Although scholars have recognized the source's capability to disseminate knowledge as also important for a symmetrical transfer of knowledge in R&D (Cohen and Levinthal, 1990; Darr, Argote, and Epple, 1995; Szulanski, 2000; Yang, Mudambi, and Meyer, 2008), there is little extant research on this side of the transfer (Tang, 2011; Tang, Mu, and MacLachlan, 2010). The concept of disseminative capability is underdeveloped, and an understanding of its effect on knowledge transfer success is limited at best. This study helps close this research gap by theorizing and empirically examining the concept of disseminative capability, particularly in R&D alliances.

The paper is organized as follows: the next section provides the theoretical background. The approach is novel: the study integrates research on knowledge transfer in alliances with theory and research on education to build a theoretical framework of disseminative capability. Based on this theorizing, the third section identifies five dimensions that form the overall construct of disseminative capability. The fourth and fifth sections present the research design, analysis, and results of the empirical study. The paper concludes with a discussion and with a set of implications for future research and management, particularly regarding R&D alliances in the automotive industry.

Disseminative Capabilities: Foundations and Antecedents

In the following section, the paper briefly discusses two streams of literature relevant for building the theoretical framework of disseminative capability, namely work on knowledge transfer and work on teaching.

BIOGRAPHICAL SKETCHES

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Knowledge Transfer

The literature on knowledge transfer in strategic alliances has recognized key factors affecting transfer success, such as knowledge attributes (Argote and Ingram, 2000; Chen, 2004; Lam, 1997; Ranft and Lord, 2002; Reed and DeFillippi, 1990; Simonin, 1999; Zander and Kogut, 1995), knowledge-sharing routines (Dyer and Singh, 1998), trust between allies (Szulanski, 2000; Szulanski, Cappetta, and Jensen, 2004; Wasko and Faraj, 2000), and governance structures of the alliance relationships (Szulanski, 1996), as well as motivation (Bock and Kim, 2002; Constant, Sproull, and Kiesler, 1994; Inkpen, 2000; Szulanski, 1996, 2000) and commitment to transfer knowledge (Amesse and Cohendet, 2001). Moreover, authors have identified the recipient firm's capability as important for knowledge transfer success, and a number of studies have focused on absorptive capacity (Chen, 2004; Cohen and Levinthal, 1990; Dyer and Singh, 1998; Lane et al., 2006; Lane and Lubatkin, 1998; Lucas and Ogilvie, 2006; Mowery, Oxley, and Silverman, 1996, 1998; Nooteboom, 2004). Although transfer of knowledge in alliances requires both the recipient and the source firm to have specific capabilities (Martin and Salomon, 2003), little work has been done on the source firm's capability.

Alliance researchers have alluded to individual dimensions of source firm capability. Carlile and Rebentisch (2003) suggest considering the recipient firm's knowledge, as some are more experienced than others, and to also share sufficient background knowledge. Moreover, they describe that on-site training can provide important contextual information to understand the interdependencies associated with the specialized knowledge to be transferred and offers the possibility of immediate feedback. Further, along with Grunwald and Kieser (2007), they recognize speaking the basics of the partners' language as a requirement for successful reciprocal learning. Others refer to the importance of decontextualizing knowledge so that the recipient can convert it (Cummings and Teng, 2003). While indicating dimensions of source firm capability as relevant, these authors have not utilized these ideas in developing and testing a concept of source firm capability. In an alliance setting, only a few studies have theorized and examined the effects of individual dimensions of source firm capability. Doz and Hamel (1998) emphasize that there are merits for each alliance partner to learn about the skills of the other; studying the Renault–Mazda and Ford–Nissan alliances, Heller (2006) finds that supporting the knowledge application of the recipient is effective, and Park and Kang (2009) find the teaching firms' capability to convert tacit knowledge to codified knowledge relevant to technology alliances. Overall, none of the existing studies have developed a compound concept of sender capability to transfer knowledge in alliances (see Table 1).

In order to fill this gap, the study considers the literature on intraorganizational knowledge transfer. It offers conceptual and empirical insights into knowledge source capability facilitating the transfer of knowledge within firms, which may prove to be as relevant in alliances. Scholars found that the sources' experience facilitates the understanding of relevant knowledge, which, in turn, helps to transfer knowledge more efficiently (Joshi, Sarker, and Sarker, 2007). When a source knows why a given action results in a certain outcome, routines and templates are reproduced more accurately (Szulanski et al., 2004). In this vein, a recipient is likely to challenge and resist the advice and examples of a source not perceived as knowledgeable (Szulanski, 2000). Martin and Salomon (2003) propose that a source should act as a proficient sender by transmitting underlying information and by transmitting it properly. Sobek, Liker, and Ward (1998) illustrate how Toyota's engineers are instructed to document their learning in order to transfer the created knowledge efficiently throughout the organization to interfacing divisions, whereas Szulanski (2000) points out that the source's capability to articulate knowledge is often deficient. Hence, knowledge senders should have well-developed abilities to efficiently and effectively codify and articulate knowledge (Minbaeva, 2007; Mu, Tang, and MacLachlan, 2010; Tang, 2011; Tang et al., 2010). Other authors emphasize workplace learning to train the recipient group's personnel to close technical gaps (Brown and Duguid, 1991; Szulanski, 2000). Finally, Brown and Duguid (1991) examine the issue of the degree of knowledge decontextualization that is optimal for knowledge transfer.

Overall, the knowledge transfer literature's theoretical reasoning and empirical evidence that helps predict the impact of knowledge source capability on knowledge transfer success in alliances is limited. Hence, the study next turns to the literature on education and teaching, which has made dissemination of knowledge its focus of research.

Effective Teaching

In early work, Sid Winter (1987) suggested that the transfer of knowledge in economic settings demands teaching. In spite of this conjecture, there is limited work on the nature of teaching and dissemination of knowledge in

Table 1. The Knowledge Source Firm's Capability in the Knowledge Transfer Literature

(1)	(2)	(3)	(4)	Relevant Study
Attainment of expert knowledge	a	s	c	Doz and Hamel (1998): Managers should do as much as possible to understand their skills as the most valuable competencies are . . . least understood. (p. 179)
	w	s	e	Joshi Sarker, and Sarker (2007): Development teams, 114 respondents; An individual source's credibility is positively related to the extent of that source's knowledge transfer. Experience facilitates the understanding of relevant knowledge. This, in turn, helps knowledge sources transfer knowledge more effectively. (p. 326)
	w	s	e	Szulanski (1996): 271 observations of 122 best-practice transfers; Important barriers to internal knowledge transfer. An expert source will easily initiate a transfer of knowledge from itself to a recipient and is thus more likely to influence the recipient. The data did not support this hypothesis. (p. 31)
	w	s	e	Szulanski et al. (2004): 110 sources, 101 recipient units, 60 third parties; The perception of a source's trustworthiness is positively related to the accuracy with which the template is reproduced. The source firm is perceived as trustworthy when it knows why a given action results in a given outcome. (p. 601f)
	w	m	e	Szulanski (2000): questionnaires; While searching for stages of transfer and factors expected to correlate with difficulty at different stages of the transfer, Szulanski draws on Walton (1975) by stating that the recipient is likely to challenge and resist the advice and examples of a source not perceived as knowledgeable. (p. 14)
Assessment of recipient's knowledge base	a	s	c	Doz and Hamel (1998): The source firm needs to learn enough about the partner skills to commingle them successfully. (p. 178)
	a	m	e	Carlile and Rebentisch (2003): two existing studies; While concentrating on knowledge transformation, they highlight the need to consider the recipient because some individuals are more experienced than others. (p. 1182)
	w	s	c	Martin and Salomon (2003): The authors examine source transfer capacity. They propose that a source firm should evaluate how ready the recipient firm is to access knowledge. This could help the source firm to define how the relevant knowledge should be transferred. (p. 363)
Detachment of knowledge	a	m	e	Carlile and Rebentisch (2003): two existing studies; While developing the knowledge transformation cycle, the authors highlight the need to share sufficient background knowledge. (p. 1182)
	a	m	e	Cummings and Teng (2003): 69 R&D executives at U.S. high-technology companies; The authors examine the effect of knowledge characteristics on knowledge transfer success. Although their study does not include variables for the specific partner sides, the authors highlight the importance of decontextualizing knowledge so that the recipient can convert it. (p. 42)
	a	m	e	Hamel (1991): nine international alliances; Hamel examines the understanding of the determinants of interpartner learning. He finds that discrete knowledge is more easily extracted than systemic knowledge. (p. 95)
	w	s	c	Argote and Ingram (2000): The authors use a framework of knowledge reservoirs (repositories where knowledge is embedded in organizations). They demonstrate why it is difficult to transfer knowledge embedded in firms' different structural elements. (p. 157)
	w	m	c	Brown and Duguid (1991): The authors highlight the connections among work, learning, and innovation in the context of actual practices. They examine the controversial issue of the degree of knowledge decontextualization that is optimal for knowledge transfer but do not make specific recommendations on how to determine this degree. (p. 48)
	w	m	c	Reed and DeFillippi (1990): The authors argue that ambiguity derived from tacitness, complexity, and specificity protects firms from competition as it hampers knowledge transfer. (p. 93f)
	w	m	e	Sobek et al. (1998): Interviews within one OEM (automotive); The authors examine Toyota's vehicle development process. Toyota's engineers are instructed to document their learning in order to transfer them to other solutions. (p. 46)

Table 1. ***Continued***

(1)	(2)	(3)	(4)	Relevant Study
Ability to encode knowledge	a	m	e	Cummings and Teng (2003): 69 R&D executives at U.S. high-technology companies; The authors examine the effect of knowledge characteristics on knowledge transfer success. Although their study does not include variables for recipient/source firms' specific tasks, the authors highlight the importance of allowing the recipient access to the knowledge package. (p. 42)
	a	m	e	Carlile and Rebentisch (2003): two existing studies; While examining knowledge transformation, the authors highlight the need to establish a shared language. (p. 1182)
	a	m	e	Grunwald and Kieser (2007): four case studies; The authors develop the concept of transactive organizational learning. They draw on Lubatkin, Florin, and Lane (2001) by arguing that speaking the basics of the partner's language is a requirement for successful reciprocal learning. (p. 370)
	w	s	c	Martin and Salomon (2003): The authors examine source transfer capacity and propose that a source firm should act as a proficient sender by transmitting underlying information properly. (p. 363)
	w	s	e	Minbaeva (2007) and Minbaeva and Michailova (2004): Survey of 58 Danish MNCs and 92 subsidiaries worldwide in 11 countries. The knowledge sender's higher capability to share knowledge (disseminative capacity) causes a higher degree of knowledge transfer to the subsidiary. In order to share knowledge, knowledge senders should have well-developed capabilities to articulate knowledge (p. 578, 669).
	w	m	c	Szulanski (2000): two-step questionnaire survey; While searching for factors that are expected to correlate with difficulty at different stages of the transfer, the source's capability to articulate a practice is often deficient. (p. 14)
	w	s	c	Tang et al. (2010), Tang (2011), and Mu et al. (2010): formal model and simulation of dynamic behavioral patterns of intraorganization networks. Efficient knowledge transfer necessitates disseminative capacity of knowledge senders, e.g., the ability of people to efficiently, effectively, and convincingly articulate, spread knowledge in a way that other people can understand accurately and, finally, put the learning into practice.
Support of knowledge application	a	s	e	Heller (2006): two extensive longitudinal case studies; The author finds that direct support from the source firm and successful organizational learning have a positive effect. (p. 75)
	a	m	e	Carlile and Rebentisch (2003): two existing studies; According to the authors, on-site training provides important contextual information to understand the interdependencies associated with that specialized knowledge. In this context, they highlight the value of immediate feedback. (p. 1186)
	w	m	c	Brown and Duguid (1991): The authors emphasize workplace learning for practitioners. (p. 48)
	w	m	c	Leonard-Barton and Sensiper (1998): The authors state that much knowledge is generated and transferred through two- and three-dimensional prototypes that a group of people can shape interactively. (p. 124)
	w	m	e	Szulanski (2000): two-step questionnaire survey; In order to close technical gaps, it may be necessary to train the recipient firm's personnel. (p. 14)

(1) disseminative capability dimension; (2) w: within firm; a: alliance setting; (3) s: studied; m: mentioned in the study (4) c: conceptual; e: empirical study. MNC, multinational company; OEM, original equipment manufacturer; R&D, research and development.

R&D alliances, and the relation to the research question may therefore not be immediately obvious: a source firm transfers knowledge to its partner in order to expedite the progress of joint business, such as a collaborative product development project, while a teacher imparts knowledge so that students can complete the curriculum. Furthermore, while knowledge transfer is an organizational-level construct, teaching is an individual-level activity in the educational literature. With these differences in mind, there are still convincing similarities in the two streams of literature: their shared goal is successful knowledge transfer. Moreover, as demonstrated with the concept of absorptive capacity (Cohen and Levinthal, 1990), there may be important insights to be gained from applying

individual-level constructs (from individual activity and cognition) to the observation, description, and understanding of organizational level phenomena. As this paper will show, the same applies to teaching as the overarching element of disseminative capability (see also Table 2).

In the formative education literature, Shulman (1986) coined the term "pedagogical content knowledge," which is essential for effective teaching and which can be applied regardless of specific disciplines (Fernández-Balboa and Stiehl, 1995). Pedagogical content knowledge is a combination of subject matter knowledge (content, what to teach) and pedagogical knowledge (how to teach) (Shulman, 1986). Teachers with subject matter knowledge are capable of identifying and examining significant content for the student's task at hand (Fernández-Balboa and Stiehl, 1995). Moreover, only knowledgeable teachers can assess a student's current state of knowledge (Hashweh, 2005; Park and Oliver, 2008; Smith and Neale, 1989).

The educational literature identifies the need to detach knowledge (Fernández-Balboa and Stiehl, 1995). When wishing to transfer knowledge, teachers need to select the relevant content from their knowledge base (Lehner and Ziep, 1997), which requires them to know how this knowledge is organized (Mietzel, 2007). Teachers must also understand how a proposition connects to other propositions (Shulman, 1986). This is especially important as teachers become irrelevant if they apply content that fails to answer students' questions (Fiet, 2000).

Effective teachers possess a pedagogical capability. They have to know their students to adapt their instruction to their students' needs (Loewenberg Ball, Thames, and Phelps, 2008; Mietzel, 2007; Pil and Leana, 2009; Porter and Brophy, 1988). This student assessment helps teachers adapt teaching material to students' capabilities (i.e., Cochran, DeRuiter, and King, 1993). They are capable of recognizing students' misconceptions, (pre)conceptions, and difficulties, and can present well-aligned teaching efforts (Park and Oliver, 2008; Shulman, 1987) and assistance, as they have a repertoire of analogies as well as content-specific examples and metaphors (Hashweh, 2005; Shulman, 1987). Additionally, teaching requires encoding skills (i.e., Cochran et al., 1993; Spitzberg and Cupach, 1989). Effective teachers transform relevant content to make it comprehensible to a particular group of learners (Fernández-Balboa and Stiehl, 1995; Loewenberg Ball et al., 2008). Finally, students' exercising and practicing have a positive effect on learning success (Porter and Brophy, 1988; Tamir, 1988) and effective teachers can assist this.

Toward a Theoretical Framework of Disseminative Capability

The knowledge transfer and education literature provides critical initial insights into the sender capability for successful knowledge transfer in R&D alliances. From anecdotal evidence, it is known, for example, that engineers from partner firms and suppliers in the automotive industry spend considerable time as guest engineers teaching personnel at the recipient firm implementing new technology (Takeishi, 2001). It is safe to assume that the effectiveness of their teaching and training matters for the effective sharing of technical knowledge locally. At the same time, having engaged in alliances and partnerships in the past, the firm may have developed an overall organization-level capability to teach or more broadly disseminate knowledge. This extends beyond the pedagogical skills of individual employees to patterns of collective behavior (routines), including, for example, training and feedback mechanisms for staff. For example, a vocational institute not only relies on excellent teachers, but also on their mutual engagement in collective learning and development. However, both the knowledge transfer in alliances and the educational literature do not draw extensively on each other, although there may be overlaps to the benefit of predicting effective knowledge transfer based on the source firm's capability. For example, educational researchers consider teachers' assessment of their students' characteristics as indispensable for teaching (i.e., Hashweh, 2005; Park and Oliver, 2008; Smith and Neale, 1989), while knowledge transfer researchers hardly mention this. Yet, it seems reasonable to assume that the source firm's engineers who accurately assess the skills levels and needs of the staff of the recipient firm may conduct more effective transfers. However, dimensions of the source's capability have hardly been theoretically explained or empirically tested for their relevance to knowledge transfer success in the context of alliances. The literature therefore lacks a conceptual and empirical examination of a comprehensive set of source firm capability dimensions regarding knowledge transfer.

The study integrates contributions from so far unrelated literature streams toward a theoretical framework (see Table 3). Thus, five distinct patterns of collective behavior are identified at the source firm involved in the knowledge transfer with the alliance partner: (1) attaining expert knowledge and being expert in a subject matter, (2) assessing the recipient firm's knowledge base and its needs, (3) selecting and detaching relevant knowledge content with respect to the joint endeavor's goal, (4) transforming this content by encoding knowledge to

Table 2. The Knowledge Source's Capability in the Education Literature

(1)	(2)	
Attainment of expert knowledge	c	Hashweh (2005): A teacher draws on many sources of knowledge. A very important source is the knowledge of subject matter (p. 278). An expert teacher can develop a repertoire of analogies for use in teaching. (p. 286)
	e	Fernández-Balboa and Stiehl (1995): Expert teachers have the ability to examine content for its significance. (p. 294)
	e	Loewenberg Ball et al. (2008): In order to help students learn a content, teachers need to know the content well themselves. (p. 404)
	e	Marks (1990): In order to gain pedagogical content knowledge, the teacher needs to—among others—interpret the subject knowledge. (p. 7)
	c	Mietzel (2007): Effective teachers possess a great deal of quantitative knowledge. (p. 18ff)
	e	Park and Oliver (2008): Good teachers need to consider students' misconceptions, and a teacher with a richer understanding of the content topics and concepts can better recognize these misconceptions. (p. 281)
	c	Shulman (1987): A good teacher needs to understand subject matter structures and the principles of conceptual organization (p. 8). Depending on the characteristics of the subject matter, a teacher is likely to use content-specific examples and metaphors (p. 16). The teacher needs to transform the content with respect to students' characteristics (e.g., conceptions, preconceptions, language, and difficulties). (p. 15)
	e	Smith and Neale (1989): Knowledge of the content is a critical component of effective teaching. (p. 17)
	e	Tamir (1988): Teachers should be knowledgeable regarding their subject matter. (p. 99)
Assessment of recipient's knowledge base	c	Cochran et al. (1993): A teacher needs to adapt the material to students' abilities and needs to tailor the material to the specific student to whom the information will be taught. (p. 264)
	c	Hashweh (2005): A teacher draws on many sources of knowledge. A very important source is the assessment of the students. (p. 278)
	e	Hill, Ball, and Schilling (2008): A teacher should be familiar with aspects of the students' thinking and their common errors. (p. 395)
	e	Loewenberg Ball et al. (2008): Teachers need to anticipate what students are likely to think and what they will find confusing. (p. 401)
	e	Marks (1990): In order to be effective, a teacher needs to be aware of students' learning processes. (p. 7)
	c	Mietzel (2007): PCK enables teachers to adjust the teaching to students' state of knowledge and needs. This is vital for effective teaching. (p. 18ff)
	e	Park and Oliver (2008): The examination of students' understanding, reasoning types, misconceptions, learning styles, and motivation plays a critical role in shaping pedagogical content knowledge and is therefore important for effective teaching. (p. 280f)
	e	Porter and Brophy (1988): An effective teacher knows the students in order to adapt instructions to their needs. (p. 82)
	e	Smith and Neale (1989): Knowledge of students' likely preconceptions is a critical component of effective teaching. (p. 17)
Detachment of knowledge	e	Fernández-Balboa and Stiehl (1995): Expert teachers have the ability to examine content for its significance. (p. 294)
	c	Fiet (2000): We become irrelevant as teachers if we fail to apply theory as a tool to answer student questions. (p. 101)
	c	Lehner and Ziep (1997): The careful selection [abstraction] of a knowledge source's relevant contents is sufficient for learning success. (p. 30)
	c	Mietzel (2007): Effective teachers possess a great deal of quantitative knowledge and know how this knowledge is organized. (p. 18ff)
	c	Shulman (1986): Teachers must understand how a proposition is related to other propositions. (p. 9)
Ability to encode knowledge	c	Cochran et al. (1993): The teacher needs to transform the subject matter for teaching. (p. 264)
	e	Fernández-Balboa and Stiehl (1995): Expert teachers transform relevant content to make it comprehensible to particular learner groups. (p. 294)
	e	Loewenberg Ball et al. (2008): Teachers need to talk explicitly about how [technical] language is used. (p. 36)
	e	Shulman (1987): Codification of knowledge is necessary for teaching. (p. 11)
	c	Spitzberg and Cupach (1989): The ability to translate goals and selected responses into specific actions constitutes encoding skills. (p. 13)
Support of knowledge application	e	Porter and Brophy (1988): Effective teachers provide their students with structured opportunities to exercise and practice independent strategies. (p. 81)
	e	Tamir (1988): Skills (know-how) can only be acquired by experience. This has to be considered when teaching. (p. 100)

(1) disseminative capability dimension (2) c: conceptual; e: empirical study.
PCK, pedagogical content knowledge.

Table 3. Contributions on the Knowledge Source's Capability from the Knowledge Transfer and the Education Literature

Disseminative Capability Dimensions	Mentioned	Studied	
		Conceptual	Empirical
Attain expert knowledge	Szulanski (2000)	Doz and Hamel (1998)	Joshi et al. (2007)
		Hashweh (2005)	Szulanski (1996)
		Mietzel (2007)	Szulanski et al. (2004)
		Shulman (1987)	Fernández-Balboa and Stiehl (1995)
			Loewenberg Ball et al. (2008)
			Marks (1990)
			Park and Oliver (2008)
			Smith and Neale (1989)
			Tamir (1988)
Assess recipient's knowledge	Carlile and Rebentisch (2003)	Doz and Hamel (1998)	Hill et al. (2008)
		Martin and Salomon (2003)	Loewenberg Ball et al. (2008)
		Cochran et al. (1993)	Marks (1990)
		Hashweh (2005)	Park and Oliver (2008)
		Mietzel (2007)	Porter and Brophy (1988)
			Smith and Neale (1989)
Detach knowledge	Carlile and Rebentisch (2003)	Fiet (2000)	Fernández-Balboa and Stiehl (1995)
	Cummings and Teng (2003)	Lehner and Ziep (1997)	
	Hamel (1991)	Mietzel (2007)	
	Argote and Ingram (2000)	Shulman (1986)	
	Brown and Duguid (1991)		
	Reed and DeFillippi (1990)		
	Sobek et al. (1998)		
Encode knowledge	Cummings and Teng (2003)	Martin and Salomon (2003)	Fernández-Balboa and Stiehl (1995)
	Carlile and Rebentisch (2003)	Cochran et al. (1993)	Loewenberg Ball et al. (2008)
	Grunwald and Kieser (2007)	Spitzberg and Cupach (1989)	Shulman (1987)
	Szulanski (2000)		
Support application	Brown and Duguid (1991)	Carlile and Rebentisch (2003)	Heller (2006)
	Leonard-Barton and Sensiper (1998)		Porter and Brophy (1988)
	Szulanski (2000)		Tamir (1988)
Knowledge transfer in alliances			
Knowledge transfer within firms			
Knowledge transfer in education			

make it comprehensible, and (5) supporting the recipient in knowledge application.

These five patterns provide the basis for defining a theoretical framework (Figure 1). They indicate collective behavior that is present to various degrees in R&D and are believed to be relevant for knowledge transfer in R&D alliances. In particular, this study regards these knowledge source firm patterns as "dimensions" of a disseminative capability, which is the flip side of an absorptive capacity. On the one hand, firms invest in building their capacity to absorb, for example, alliance partners' and other source firms' R&D-relevant knowledge (i.e., Chen and Paulraj, 2004; Mowery et al., 1996). On the other hand, a disseminative capability is the source firm's concerted, collective activities of diffusing knowledge to the partnering firm with the aim of

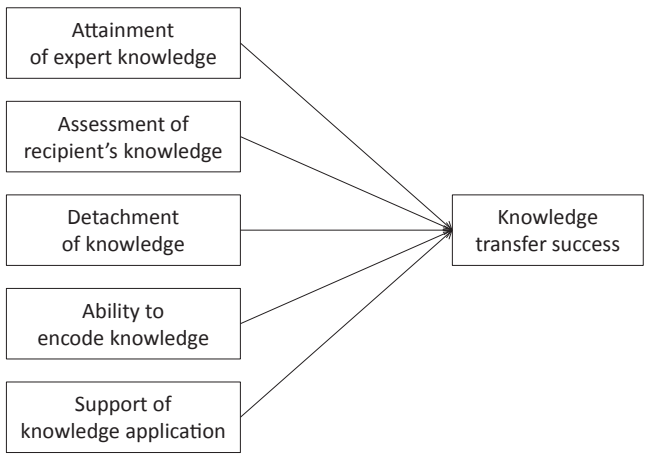

Figure 1. Framework of Disseminative Capability and Its Impact on Knowledge Transfer Success

transferring the knowledge needed for a successful R&D alliance. More specifically, this study defines disseminative capability as the ability of knowledge holders to convey knowledge in a way that a recipient can comprehend it and put it into practice (Tang et al., 2010). Further, disseminative capability is regarded as an organization-level construct that demonstrates its benefits through its individual members' capabilities, relationships, and actions in R&D alliances.

In the following section, the paper introduces the dimensions of disseminative capability and relates them to knowledge transfer success. The examination has theoretical boundaries. First, R&D alliances are likely to comprise transfer processes in both directions (Amesse and Cohendet, 2001). However, the research at hand simplifies this by a targeted examination of the knowledge transfer process between source and recipient firms. In the interest of a thorough investigation of the source's capability, a dynamic change in the source and recipient's roles is therefore excluded, as are the interactions within the bidirectional knowledge transfer processes. Second, the intended knowledge transfer and its integration in R&D alliances are the focus point, which excludes unintended transfers of knowledge and the use of alliances as vehicles to absorb partners' knowledge base (Hamel, 1991). Third, the empirical analysis is limited to the joint development of new products or components through R&D alliances, which excludes subcontracting third parties' R&D both in the framework and data set.

Hypotheses

Here the study assumes that knowledge, and especially tacit expert knowledge, is built by experience. It is this expert or specialist knowledge that makes firms a feasible partner for an R&D alliance. To paraphrase words of wisdom from Polanyi (1966), although firms "may know more than they can tell, they cannot tell more than they know." Only a firm experienced in thoroughly attaining knowledge and with the capability to do so may effectively contribute to transferring this knowledge (Doz and Hamel, 1998; Joshi et al., 2007; Loewenberg Ball et al., 2008; Marks, 1990; Park and Kang, 2009; Park and Oliver, 2008; Smith and Neale, 1989; Szulanski, 1996, 2000; Szulanski et al., 2004; Tamir, 1988). Experts require the capability to examine content in terms of its significance for the task at hand (Fernández-Balboa and Stiehl, 1995). Moreover, when the knowledge source firm is technically versed and knowledgeable in the relevant domain, it can provide in-depth knowledge on technical details on shift scales and may take a "generalist's" view of the particular knowledge (Mietzel, 2007; Nonaka and von Krogh, 2009). The firm has information on how its knowledge is organized, and employees may be better able to provide adequate analogies, content-specific examples, and metaphors for use in the knowledge transfer (Hashweh, 2005). Further, a knowledgeable source firm may analyze the causes of unexpected occurrences and support knowledge transfer further by readjusting the contents of what is to be disseminated. Supporting this argument, Joshi et al. (2007) find that source firm reliability and the extent of the knowledge transferred by that source firm are positively related. Hence:

H1: The extent of the source firm's attainment of expert knowledge is positively related to knowledge transfer success in alliances.

The common content knowledge (e.g., the overlapping knowledge bases) needed to facilitate a joint new product development endeavor is limited as each partner seeks to secure its specialization in an alliance (Grant and Baden-Fuller, 2004; Grunwald and Kieser, 2007). Only selected knowledge is needed to build or complement this limited overlap, and the knowledge source's capability to assess the recipient's knowledge base and to determine what knowledge is valuable for joint development is therefore crucial (Carlile and Rebentisch, 2003; Hashweh, 2005; Martin and Salomon, 2003; Mietzel, 2007; Shulman, 1987). A source firm appraising the recipient's current knowledge also identifies the recipient firm's strengths and weaknesses, assesses the "capacity to absorb" potential knowledge from the source (Doz and Hamel, 1998; Martin and Salomon, 2003), and can therefore align its transfer activities accordingly (Porter and Brophy, 1988). For example, through Continental and Deutsche Telekom's decision to jointly develop infotainment solutions for cars by complementing each other's engineering competencies, Deutsche Telekom helps Continental avoid an overload of advanced cellular and telematics knowledge required in the Federal Communications Commission and Federal Aviation Agency filings and zones' meetings, thereby improving the chances of knowledge transfer success. Insights into the recipient firm's readiness and its capacity to absorb are also useful for selecting efficient transfer instruments such as demonstrations and analogies (Martin and Salomon, 2003; Shulman, 1986). Hence:

H2: The extent of the source firm's assessment of the recipient's existing knowledge base is positively related to knowledge transfer success in alliances.

In order to transfer knowledge to the partner, the source firm needs to detach transfer-relevant knowledge from its current environment. It does so by abstracting this knowledge from its local context such as technical tools, routines, and experiences (Argote and Ingram, 2000), and, simultaneously, providing it with enough background information (Brown and Duguid, 1991; Carlile and Rebentisch, 2003; Cummings and Teng, 2003; Fiet, 2000; Lehner and Ziep, 1997; Reed and DeFillippi, 1990). Abstraction, on the one hand, involves generalization while omitting the details of the knowledge creation process such as mistakes and unproductive trails (Sobek et al., 1998; Szulanski, 2000). On the other hand, the source firm also confronts the need for required background knowledge and contextual information. Indirectly related to the current project task, such knowledge is of value to the recipient firm because ". . . the relevant knowledge [is] often . . . based on [the] path-dependent history of activities within the organization. In many situations, such history is of significant value as individuals retrieve and reuse knowledge and experiences to meet their needs" (Carlile and Rebentisch, 2003, p. 1189). Hence:

H3: The extent of the source firm's detachment of knowledge from its local context is positively related to knowledge transfer success in alliances.

Knowledge differs from information as, based on the beliefs and previous experiences of its source or recipient, it can be understood and interpreted differently (Nonaka and Takeuchi, 1995). In addition, organizations often use firm-specific terms or abbreviations or even use the same term for different procedures or objects. This may cause misunderstandings, mistakes, and malfunctions that hamper successful knowledge transfers. If it is not possible to receive and understand knowledge, it is also useless for problem-solving purposes (Carlile and Rebentisch, 2003). Accordingly, the transfer of knowledge requires encoding, with the source firm aligning knowledge so that the alliance partner can comprehend it (Badir, Büchel, and Tucci, 2009; Cochran et al., 1993; Cummings and Teng, 2003; Fernández-Balboa and Stiehl, 1995; Martin and Salomon, 2003; Monge, Bachman, Dillard, and Eisenberg, 1982; Shulman, 1986; Spitzberg and Cupach, 1989; Szulanski, 2000). Encoding entails being aware of the used nomenclatures, tools, and syntaxes and transforming these where necessary, as this is indispensable for later decoding at a distance (Arrow, 1969; Brown and Duguid, 1991). For example, when Sanyo Electric and Volkswagen teamed up to develop lithium-ion batteries, Volkswagen needed to either explain, or refrain from using, the language and abbreviations commonly applied within the Volkswagen group in order to make itself understood by Sanyo. Moreover, Grunwald and Kieser (2007) argue that deploying a shared language is obligatory for the creation of a joint solution. Accordingly:

H4: The extent of the source firm's ability to encode knowledge is positively related to knowledge transfer success in alliances.

Finally, knowledge, especially tacit and expert knowledge, is related to human action (Nonaka and Takeuchi, 1995) and is considered successfully transferred as soon as the recipient can work independently with this knowledge. Such knowledge "ownership" means that the recipient firm is capable of single handedly solving problems using the knowledge or that it can pursue its tasks while contributing to the development of a joint product (Cummings and Teng, 2003). It is not sufficient to send and receive relevant knowledge; it must also be applied. Causal ambiguity, misunderstandings, and the recipient's lack of, or low, retentive capacity hamper knowledge transfer success (Lucas and Ogilvie, 2006; Szulanski, 2000). The deployment of transferred knowledge is thus impeded, especially regarding complex knowledge where many paths exists among actions, decisions, solutions, and problems (Galbraith, 1990). The source firm can mitigate these barriers by, for example, conducting on-site training that teaches the recipient to actively apply the newly gained knowledge (Szulanski, 2000). Members of the source firm can act as coaches, supporting knowledge deployment, providing corrections and real-time feedback, or they can immediately provide supplemental knowledge if this is required (Carlile and Rebentisch, 2003). When the source firm assists with and supports the knowledge application, thus enabling the recipient firm to act on the knowledge (Brown and Duguid, 1991; Carlile and Rebentisch, 2003; Leonard-Barton and Sensiper, 1998), it enhances knowledge transfer success (Heller, 2006; Porter and Brophy, 1988). Hence:

H5: The extent of the source firm's support of the recipient in applying the transferred knowledge is positively related to knowledge transfer success in alliances.

Research Design

Research Setting

The framework was tested by examining 59 new product development projects jointly undertaken by two firms. The allying firms' objective was the collaborative devel-

opment of an innovative and complex technical product, software, or process. The firms belong to the automotive industry and are located in Switzerland, Germany, and Austria. The study only included projects completed within the last three years. Hence, the respondents could still recall information-relevant details, which allowed the study to measure the project success. All constructs considered in this investigation refer to the new product development project as the unit of analysis. Furthermore, a joint project was defined as the expression and realization of an alliance between two organizations. Hence, all measures are specified on the project level.

Data Collection

The project selection was based on an existing database of development projects complemented with secondary data from press releases on development cooperation. R&D managers' names and contact information were added, and the relevant projects' details were obtained by phone. Thereafter, one partner was appointed as the *source firm* and the other as the *recipient firm* to include *both* partners in order to obtain unbiased data. Multiple respondents were contacted from each project for the data collection procedure: the project manager, the project leader, and at least four randomly selected recipient firm team members as well as the source firm's project leader. The respondents' participation was strictly voluntary and their anonymity ensured. All the respondents received a link to their personalized and standardized online questionnaire via e-mail. The type of questionnaire to which they were linked depended on the role that they had played in the project. The number of team members answering the questionnaire differed, as this depended on the response rate and project size, although both the partner firms were always represented. In total, the study comprises 252 valid responses, which constitute 59 sets of data. The response rate of the firms requesting a link to their particular questionnaire was 88%, resulting in a final sample of 60 firms. These firms had undertaken a development project with one other firm from this sample. Some firms, however, answered the questionnaires in respect of various projects that they had undertaken with different partners. The questionnaires were administered in German. Whenever possible, this research used construct definitions and measures from the literature to ensure content validity (Churchill, 1979; Nunally and Bernstein, 1994) (see Appendix). To encourage realistic answers, the respondents were asked to describe a specific set of knowledge that had to be transferred. Thereafter, they answered the questions related to this knowledge set's transfer.

Dependent Variable

Knowledge transfer is considered successful if the recipient can work independently with the transferred knowledge (Walter, Lechner, and Kellermann, 2007). This research adopts Cummings and Teng's (2003) approach and defines *knowledge transfer success* as "the degree to which a recipient obtains ownership of, commitment to, and satisfaction with the transferred knowledge" (p. 42). Three items were derived from these authors' work. Accordingly, questions were introduced regarding the transferred knowledge's practical and independent applications and the respondents' degree of satisfaction with this knowledge. One item was added from the study by Mietzel (2007), who maintains that a deep understanding is a basic teaching requirement, by asking the respondents to indicate the source firm's capability with regard to conveying the knowledge set to others.

Antecedents

The *attainment of expert knowledge* was measured using items derived from discussions by Shulman (1987), Szulanski et al. (2004), and Szulanski (2000). These scholars maintain that teachers with a deep understanding are experienced, can easily provide examples, know the effects that actions will have, and are known to be experts. The *assessment of relevant knowledge* was measured by building on Carlile and Rebentisch's (2003) related construct. Measures for the *detachment of knowledge* were drawn from the work by Cummings and Teng (2003), Carlile and Rebentisch (2003), Sobek et al. (1998), Fiet (2000), and Mietzel (2007). All authors underscore that there is a need to provide tacit and adjacent knowledge to enable the recipient to implement the transferred knowledge. A reverse question was also added to check the relevance of the background information provided. The measures for the *ability to encode knowledge* were based on Arrow (1969), who contends that knowledge representation influences the degree of understanding and that experts often lack such a proper representation. Consequently, the comprehensibility of the abbreviations and technical terms that the source firm uses was examined and the degree of misunderstanding checked. These items were reverse coded. The *support of the recipient firm in applying the knowledge* is an item partly based on Carlile and Rebentisch (2003). According to these authors, experts need to coach the recipient firm and should provide an opportunity for immediate feedback. The item "supporting us in a way that ensured a

quick and consistent learning progress" was added to verify efficient support.

Control Variables

A control was undertaken for *modularization*, which allows allying partners to develop separate modules independently and reduces the need for knowledge transfer (i.e., Baldwin and Clark, 2000). Because the *degree of innovation* might affect the complexity of the knowledge that has to be transferred and might also affect the transfer success (Gemünden, Salomo, and Krieger, 2005), this too was controlled. Moreover, the recipient firm's capability to *absorb knowledge* also has a significant impact on the knowledge transfer process and success (i.e., Lane and Lubatkin, 1998). To control for this, two constructs were deployed, namely *the recipient firm's absorptive capacity* and *the recipient firm's experience with knowledge transfer*.

The data sets were also controlled for the *scale of tacit knowledge* because the transfer of tacit knowledge between organizational members is exceptionally difficult and costly (Santoro and Bierly, 2006; Simonin, 1999). In addition, open questions requiring a description of the two partners' cultures were included to control for the alliance partners' *cultural diversity* (i.e., Cummings and Teng, 2003). The answers were coded and transferred to a 3-point Likert-type scale, ranging from (1) no match at all to (3) a total match. The construct validity assessments, as well as the correlations of the study variables, are shown in Table 4.

Multiple Informants

To ensure content validity and avoid common source bias, data from different respondents were used to measure the different constructs (variables or constructs were adhered to and used consistently). Hence, the recipient firm's project team members were assigned the questionnaire with the independent constructs concerning the knowledge source firm's *disseminative capability*. In addition, different team members were questioned to avoid single source bias (Sproull, 1995). Furthermore, specific controls were evaluated by different individuals from both the partners. Table 5 provides an overview of the model constructs and the respondents.

Before aggregating the respondents' respective scores, a one-way analysis was undertaken of the variance in each affected item. Project affiliation was used as the independent variable to establish whether there was greater variability in the ratings between the projects than

Table 4. Construct Validity Assessments and Correlations

	n	Mean	SD	Items	Chronbach's Alpha	1	2	3	4	5	6	7	8	9	10	11
1 Attainment of expert knowledge	59	3.77	.75	5	.93											
2 Assessment of recipient's knowledge base	59	3.81	.61	3	.84	.248										
3 Detachment of knowledge	58	3.50	.79	5	.89	.281*	.371**									
4 Ability to encode knowledge	59	3.59	.67	3	.79	.401**	.272*	.166								
5 Support of knowledge application	59	3.80	.84	3	.86	.217	.314*	.279*	.132							
6 Knowledge transfer success	59	3.81	.71	3	.90	.261*	.448***	.041	.415**	−.105						
7 Degree of modularization	52	4.08	.76	3	.83	.114	.017	−.125	.099	.016	.192					
8 Degree of innovation	46	3.40	.71	3	.81	.168	−.219	−.116	.129	−.315*	.115	.226				
9 Recipient firm's absorptive capacity	56	3.70	1.00	3	.87	.001	.188	−.107	.201	−.174	.521***	.221	−.045			
10 Recipient firm's transfer experience	53	4.10	.75	3	.76	−.083	−.029	−.193	.059	.071	−.006	.093	.096	.061		
11 Scale of tacit knowledge	55	28.93	23.67	1	—	.076	−.327*	−.152	.081	.060	−.320*	−.057	.061	−.155	.192	
12 Cultural diversity	56	1.96	.83	2	—	.056	−.058	.011	−.068	−.004	−.34**	.050	−.186	−.352***	−.077	.145

* $p < .05$ (two tailed); ** $p < .01$ (two tailed); *** $p < .001$ (two tailed).
SD, standard deviation.

Table 5. Constructs and Respondents

Variables		Source Firm	Recipient Firm
Antecedent	Disseminative capability		1–4 team members
Dependent	Knowledge transfer success	Project leader	Project leader and 1–4 team members
Controls	Degree of modularization	Project leader	Project leader and project manager
	Degree of innovation	Project leader	Project leader and project manager
	Recipient firm's absorptive capacity	Project leader	
	Recipient firm's transfer experience		Project leader
	Scale of tacit knowledge		Project leader and 1–4 team members
	Cultural diversity		Project leader

within them (Winer, Brown, and Michels, 1971). Aggregation was supported, as the F ratio was significant for each item ($p < .001$). Furthermore, different recipient firm team members who had worked on the same project were questioned in this context. Given the multiple respondents' ratings, multiple item estimators were used for within-group interrater agreement (r_{wg}) (James, Demaree, and Wolf, 1984). The average intra-group reliability of this scale was .88, which further legitimizes the individual team member scores' aggregation (George and Bettenhausen, 1990). Subsequently, this datum was aggregated by calculating the arithmetic mean.

Data Analysis and Results

All analyses were conducted at the project level ($n = 59$). Exploratory and confirmatory factor analyses yielded factor loadings all above .6, Cronbach's alphas .79, and convergent and discriminant validity was established. Further, multiple regression analyses were performed to test the hypotheses (Cohen, Cohen, West, and Aiken, 2003). The collinearity statistics calculated for the regression analyses show no distortion of the results because of possible correlations between the independent variables (the variance inflation factor of the variables was below 1.7).

Table 6 illustrates the regression models based on the dependent variable *knowledge transfer success*. In model 1, the control variables were included to avoid spurious or masked effects. In model 2, the antecedents were entered. The results of model 2 support a significant relationship between all five antecedents and knowledge transfer success. In particular, they support the predicted positive relationship among *attainment of expert knowledge* (H1),

Table 6. Regression Analysis

		Dependent Variable	
		Knowledge Transfer Success	
Hypotheses	Independent Variables	Model 1	Model2
	Degree of modularization	.10	.06
	Degree of innovation	.07	.04
	Recipient firm's absorptive capacity	.38**	.22*
	Recipient firm's transfer experience	.03	–.02
	Scale of tacit knowledge	–.32**	–.22*
	Cultural diversity	–.18	–.17†
H1	Attainment of expert knowledge		.22*
H2	Assessment of recipient's knowledge		.38**
H3	Detachment of knowledge		–.20†
H4	Ability to encode knowledge		.28**
H5	Support of knowledge application		–.19†
	R^2	.40	.66
	Adjusted R^2	.33	.58
	F	5.70**	8.43**
	df	58	58

** Significant at the .01 level (two tailed). * Significant at the .05 level (two tailed). † Significant at the .1 level (two tailed).

assessment of recipients knowledge (H2), and *ability to encode* (H4) and knowledge transfer success. Moreover, the data reveal unexpected significant negative relations of *detachment of knowledge* (H3) and *support of knowledge application* (H5) and knowledge transfer success in R&D alliances. In addition, the controls *scale of tacit knowledge* and the recipient firm's *absorptive capacity* are significant.

Discussion and Implications

Theoretical Contributions and Implications

The research contributes to a more complete understanding of a firm's disseminative capability and its effect on knowledge transfer success in R&D alliances, where disseminative capability is the complementary inverse of an organization's absorptive capacity. In the automotive industry, R&D alliances have been observed such as that of Ford and GM that united to create a six-speed automatic transmission. This endeavor was driven by the companies' sharing of the innovation costs, the risk, and their individual capacities, which enhanced their new product development efficiency and effectiveness (Faems et al., 2005; Pérez-Nordtvedt, Kedia, Datta, and Rasheed, 2008; Rindfleisch and Moorman, 2001). Changes in the industry, however, alter organizations' motivation to collaborate. Innovative products are increasingly emerging from interactions between different disciplines, often represented by dissimilar partners with high levels of diversity in knowledge and expertise (Hargadon and Sutton, 1997; Joshi et al., 2007; Loewenberg Ball et al., 2008; Marks, 1990; Park and Oliver, 2008; Smith and Neale, 1989; Szulanski et al., 2004; Tamir, 1988; Taylor and Greve, 2006). For example, Toyota and the Copenhagen Institute of Interaction Design's engineers and designers teamed up to develop the "Window to the World" vehicle concept. By using augmented reality, what used to be a pane of glass begins to provide passengers with information about landmarks and other objects as they pass by. The window can also be used as a canvas for drawings, which then interact with the passing environment. It was the mutual exploitation of the two firms' knowledge bases that yielded innovation. However, such alliances are also fraught with difficulty. To succeed, allies need an overlap of their otherwise distant knowledge, which they often have to create (Rindfleisch and Moorman, 2001). The more crucial the need for overlap creation is, the more important the transfer of knowledge between the allies and knowledge transfer capabilities.

While research has paid much attention to the recipient's absorptive capacity, e.g., the capability to create such an overlap by transferring knowledge from the partner, it has made cursory reference to disseminative capability, e.g., the source firm's capability to transfer knowledge to a recipient. Although a few authors have conceptually (Doz and Hamel, 1998) or empirically (Heller, 2006) developed single dimensions of this capability, none has tested these empirically to identify their significance and impact knowledge transfer in R&D alliances. Accordingly, this paper contributes to answering a pertinent research question: what source firm capability is necessary for successful knowledge transfer in R&D alliances? Building on contributions of the knowledge transfer and education literature, the study develops an overarching framework, and derives and tests five dimensions of source firm capability, analyzing data from 59 transfer-intensive R&D alliances.

The study finds that the *extent of attaining expert knowledge* and knowledge transfer success in alliances are positively related, which supports Doz and Hamel's (1998) conceptual work. The result suggests that this disseminative capability dimension is important not only for knowledge transfer success within firms (Joshi et al., 2007; Szulanski et al., 2004) or between teachers and their students (i.e., Mietzel, 2007; Park and Kang, 2009), as suggested by the existent literature—it is also important in R&D alliances. The finding that the extent of the source firm's *assessment of the recipient firm's knowledge base* and successful knowledge transfer are positively related indicates that the education literature's position on this relationship may also applicable (i.e., Hashweh, 2005) in an organizational context. The current study thus strengthens the conceptual arguments in that this relationship pertains to alliances (Doz and Hamel, 1998) as well as to knowledge transfer within firms (Martin and Salomon, 2003). Moreover, educational researchers have conceptually and empirically identified the positive impact that a knowledge source's *ability to encode knowledge* has on knowledge transfer success (i.e., Fernández-Balboa and Stiehl, 1995; Loewenberg Ball et al., 2008), while the knowledge transfer literature mainly mentions the importance of this dimension. The education literature's results were replicated in an alliance setting. This provides an indication for the relevance of encoding in organizational settings.

The study's finding of a significant negative effect of the source firm's *detachment of knowledge* on knowledge transfer success contradicts extant research (e.g., Argote

and Ingram, 2000; Lam, 1997, knowledge transfer literature; e.g., Fernández-Balboa and Stiehl, 1995, Lehner and Ziep, 1997, education research). Potential explanations for this surprising result may be that researchers conducted their studies mainly on knowledge transfer in operational (i.e., manufacturing) settings. There, knowledge replication and, hence, the transfer of contextual knowledge are important (Carlile and Rebentisch, 2003; Szulanski, 2000). However, in an innovative environment, replication is not desired. Instead, the transferred knowledge provides the basis for the development of new knowledge. Here, abstracted knowledge is beneficial (Nonaka and von Krogh, 2009). In the same vein, the surprisingly detected negative effect of the extent of *support of the recipient in applying the knowledge* may be explained. While authors emphasize the use of templates and on-site training for knowledge transfer success in an operational environment (i.e., Brown and Duguid, 1991; Jensen and Szulanski, 2007; Lyles, von Krogh and Aadne, 2003; Szulanski, 2000; Szulanski and Jensen, 2004), in new product development both partners need a general understanding of each other's expertise rather than training the other. Instead, the knowledge applied at the recipient firm is reshaped by the new context, and congruence with the source firm's original knowledge might hamper innovation.

When formulating the hypotheses, the study followed the theoretical argumentation of the literature that studied knowledge transfer in operational settings (i.e., manufacturing). However, in innovation settings, such as R&D alliances, transferring context and supporting the recipient are detrimental. By revealing this differential effect, the study makes a significant contribution to the literature. Whether the two respective dimensions yield a positive (e.g., in an operational setting) or negative (e.g., in an innovative setting) effect depends on the knowledge transfer situation. So far, the existent literature has not made this differentiation.

Further, the study has developed the concept of disseminative capability and tested its effect on knowledge transfer success in R&D alliances in the automotive industry. However, the study's findings are believed to be generalizable to horizontal R&D alliances that collaborate for innovation where knowledge is dispersed across different firms. While the research results are relevant for such alliances, they might be less so for firms that possess the knowledge stock needed for innovation and possibly purchase the development of single adjacent parts, resulting in establishing buyer–supplier relationships or vertical alliances (Rindfleisch and Moorman, 2001).

Intentionally or unintentionally disseminating knowledge across firm boundaries is widely perceived as detrimental to a firm's competitive advantage (Argote and Darr, 2000). Accordingly, the literature tends to downplay disseminative capability as an important means of exploiting external knowledge in collaborative settings (Bierly, Damanpour, and Santoro, 2009). By demonstrating potential benefits for the source firm to transfer knowledge to the partner firm in the context of R&D alliances, this paper reinvigorates the collaborative dimension in knowledge transfer (Martin and Salomon, 2003; Szulanski, 1996). Simultaneously, the study corroborates the literature on new product development, showing that firms can improve their innovative capacity by leveraging others' knowledge through R&D alliances and the transfer of knowledge (Kogut and Zander, 1992; Van Wijk, Jansen, and Lyles, 2008).

Managerial Implications

How can R&D managers improve their firms' knowledge transfer success in R&D alliances? This study indicates that not only absorptive capacity, but also disseminative capability should be part of a firm's decision calculus when it allocates resources for collaborative innovation activities. As a result, managers should not only consider mutual learning for the success of knowledge transfer and, eventually, joint innovation, but also mutual teaching. In particular, three implications emerge. First, clearly firms should consistently develop their knowledge in order to remain experts in a specific field. Then they have something to bring to the party in terms of benefits from knowledge transfer. Second, managers should assess their firm's knowledge bases and those of the partner very carefully before engaging in knowledge transfer and answer questions like "Where and how is their own knowledge stored?," "Where are the partners' relevant knowledge gaps?," etc. Third, managers may be well advised to encode the transfer-relevant knowledge and to encourage the development of a joint language to avoid misunderstandings. Further, in R&D alliances, management of the source firm should avoid providing contextual information and background knowledge. Instead, it would be beneficial to abstract the knowledge to be transferred from its original context. There is also no need to provide directive support of the alliance partner in the local knowledge application. While these activities are beneficial for transferring routines in a manufacturing setting, they are likely to be detrimental in R&D alliances.

Limitations and Future Research

This study's limitations result in a number of promising opportunities for future research. First, this study considers the disseminative capability of only one alliance partner. In an R&D alliance, however, knowledge transfer is bidirectional, and partners take turns in being source and recipient. Future studies should consider both knowledge transfer directions, thus helping to better understand how the different roles that one firm can take (e.g., source and recipient) are related to each other (e.g., Do firms with a higher absorptive capacity also have a higher disseminative capability? or How does a firm's display of disseminative capability influence their partner's disseminative capability?) Second, while this study focuses on the evaluation of the constructs' main effects, future research could also consider potential moderators such as feedback. A source firm capable of considering and reflecting on its partner's feedback may eliminate ineffective parts of the knowledge transfer process (Sypher and Sypher, 1981) by, for example, adapting its terms and explanations, therefore enhancing its assessing and encoding efforts' effects. Third, this study investigated only bilateral partnerships. Future studies could examine the disseminative capability required for knowledge transfer R&D alliance networks (Badir, Büchel, and Tucci, 2005). Fourth, the study found an interesting interaction effect between the control *absorptive capacity* and the disseminative capability dimension of *assessment of recipients' knowledge*. Future studies can depart from here and investigate the interaction effect between the recipients' *absorptive capacity* and the knowledge source's *disseminative capability*. While this study contributes to understanding the concept of disseminative capability by considering different dimensions of the concept and simply controlling for absorptive capacity with a single factor, future research needs to consider a balanced measurement of both constructs. Fifth, for a better understanding of the effect of the dimensions *detachment of knowledge* and *support of knowledge application*, future research needs to theorize and test in more detail knowledge transfer in the settings of manufacturing and innovation. In this regard, the study entails a limitation, as the measure of detachment of knowledge contains a double entendre (ambiguity), covering abstraction and contextualization. For future studies, compound measures need to be improved. Finally, while this study has collected alliance data from both partners of an alliance, a limitation of the study is the sample size, which is rather small. Future empirical investigations should be conducted with a larger sample size.

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Appendix. Items and Constructs

Antecedents

Attainment of expert knowledge

(1) Our partner had applied this set of knowledge in several past projects. (Szulanski, 2000)
(2) Our partner provided examples or additional explanations in order to convey this set of knowledge. (Shulman, 1987)
(3) Regarding the described set of knowledge, our partner knew which actions result in which outcomes. (Szulanski, 1996)
(4) Our partner is known to be an expert in the according knowledge field. (Szulanski, 2000)
(5) Our partner had a deep understanding of the according set of knowledge. (Szulanski, 2000)

Assessment of recipient's knowledge

(1) The knowledge our partner conveyed fully matched the set of knowledge we needed. (Carlile and Rebentisch, 2003)
(2) To select the knowledge to be transferred, our partner successfully identified the gaps in our knowledge base. (Carlile and Rebentisch, 2003)
(3) The knowledge conveyed by our partner was always appropriate in the current situation. (Carlile and Rebentisch, 2003)

Detachment of knowledge

When conveying the above-mentioned set of knowledge, our partner . . .
(1) . . . also considered the relevant tacit knowledge, i.e., hardly describable skills and experiences. (Cummings and Teng, 2003)
(2) . . . delivered all the necessary background information. (Carlile and Rebentisch, 2003)
(3) . . . knew precisely how it was related to adjoined fields of knowledge. (Mietzel, 2007)
(4) . . . successfully abstracted it from its day-to-day context. (Sobek et al., 1998)
(5) . . . provided contextual information, i.e., other methods or software that had to be used together with this set of knowledge. (Carlile and Rebentisch, 2003)

Ability to encode knowledge

When conveying the above-mentioned set of knowledge . . .
(1) . . . there were many misunderstandings (reverse coded). (Arrow, 1969)
(2) . . . our partner used many abbreviations that we did not understand (reverse coded). (Arrow, 1969)
(3) . . . our partner used many technical terms that we did not understand (reverse coded). (Arrow, 1969)

Support of knowledge application

Our partner supported us by applying the above-mentioned set of knowledge by . . .
(1) . . . coaching us (i.e., by means of instructions, demonstrations of utilizations, etc.). (Carlile and Rebentisch, 2003)
(2) . . . providing immediate feedback. (Carlile and Rebentisch, 2003)
(3) . . . supporting us in a way that ensured our quick and consistent learning progress. (own)

Dependent construct*

Knowledge transfer success

(1) We are highly satisfied with this set of knowledge. (Cummings and Teng, 2003)
(2) We are proud to tell others that we are now working with this set of knowledge. (Cummings and Teng, 2003)
(3) We apply this set of knowledge independently. (Cummings and Teng, 2003)
(4) We are able to convey this set of knowledge to others. (Mietzel, 2007)
(5) The knowledge was successfully transferred. (own)

Controls

Degree of modularization*

(1) With regard to development tasks, there was a strong functional dependence between our partner and us. (Ethiraj and Levinthal, 2004)
(2) The contribution of the partner was very important for the joint development. (Baldwin and Clark, 2000)
(3) Developing this component generated specialized expertise in both partners. (Baldwin and Clark, 2000)

Degree of innovation*

The new product/software/process . . .
(1) . . . followed a new technological principle. (Gemünden et al., 2005)
(2) . . . created a totally new customer benefit. (Gemünden et al., 2005)
(3) . . . improved our market position. (Gemünden et al., 2005)
(4) . . . improved our partner's market position. (Gemünden et al., 2005)

Recipient firm's absorptive capacity*

(1) Our partner had a clear vision of the objective of the knowledge transfer. (Szulanski, 1996)
(2) The expertise of our partner concerning upcoming tasks was always state-of-the-art. (Szulanski, 1996)
(3) Our partner took specific actions to prepare their staff to comprehend this knowledge. (Szulanski, 1996)

Recipient firm's experience with knowledge transfer*

(1) In the past, we carried out new product development projects in collaboration with other firms, during which we successfully implemented the partner's knowledge in our firm. (Fosfuri and Tribo, 2008)
(2) In the past, we specifically bought know-how. (Fosfuri and Tribo, 2008)
(3) In the past, we also searched for specific know-how carriers (i.e., domain experts) from outside. (Fosfuri and Tribo, 2008)

Cultural diversity**

(1) Please give a brief characterization of your business relationship with your partner. (Cummings and Teng, 2003)
(2) Please characterize your culture (firm and national culture) briefly. (Cummings and Teng, 2003)

Scale of tacit knowledge*

What percentage of the transferred knowledge was clearly tacit knowledge, i.e., hardly describable skills, intuition, or experiences? (Maskell and Malmberg, 1999; Simonin, 1999)

* Scale format: 1 = "totally disagree", 5 = "totally agree."
** Open question; answers codified into a scale format: 1 = "no match at all," 3 = "total match."