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From Boundary Spanning to Intergroup Knowledge Integration: The Role of Boundary Spanners' Metaknowledge and Proactivity

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ABSTRACT Intergroup knowledge integration, that is the acquisition, processing, and utilization of knowledge across group boundaries, is a critical source of competitive advantage in modern organizations. Prior research has highlighted the important role of boundary spanning knowledge exchange for intergroup knowledge integration, neglecting, however, the question of what makes individual boundary spanners more effective in fostering intergroup knowledge integration. Integrating boundary spanning literature with theories of group information processing, we hypothesize that the effect of individual boundary spanning ties on intergroup knowledge integration depends on the boundary spanners' levels of metaknowledge, i.e., knowledge of who knows what in their respective groups, and proactivity. We find general support for our predictions in a study of 457 engineering consultants nested in 22 interdependent business units within an organization. Additional criterion analyses confirm the material importance of intergroup knowledge integration for group performance. Our findings have implications for literatures on intergroup effectiveness, team cognition, and proactivity.

Keywords: boundary spanning, intergroup knowledge integration, metaknowledge, proactivity, transactive memory

INTRODUCTION

Knowledge is the primary resource of many modern organizations (Grant, 1996a; Kogut and Zander, 1996; Powell and Snellman, 2004). However, it is a resource that is distributed across the individuals who form an organization. Thus, an organization's ability to *integrate*

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knowledge, i.e., to combine differentiated but complementary knowledge, constitutes a critical source of competitive advantage (Carlile, 2004; Grant, 1996b). A particular challenge to knowledge integration is the knowledge-based differentiation inherent in organizational structures, which typically cluster people possessing related specialized knowledge into groups such as divisions, departments, or organizational units. At the same time, as groups are faced with increasingly complex and interdependent tasks and act in dynamic and uncertain environments, they become increasingly dependent on knowledge held in other groups (Choi, 2002; Haas, 2010; Joshi et al., 2009; Tushman, 1977). In other words, *intergroup knowledge integration* is of critical importance for organizations operating in such conditions (Singh, 2008). We understand intergroup knowledge integration as a dyadic relation between two groups in which one group – the *recipient* group – acquires, processes, and utilizes knowledge stemming from another group – the *source* group – in their own work. Importantly, knowledge utilization is the defining principle of this construct: Intergroup knowledge integration goes beyond mere transfer of information from the source to the recipient group, involving also its dissemination, translation, and application to the recipient group's own problems (Bechky, 2003; Carlile, 2004; Tippmann et al., 2017; Tushman and Scanlan, 1981). The network of intergroup knowledge integration relationships among organizational groups in turn constitutes the backbone of an organization's knowledge architecture which critically contributes to organizational performance in knowledge intensive organizations (Balkundi and Harrison, 2006; Tsai, 2001; Tsai and Ghoshal, 1998).

One of the key foundations for knowledge integration at the intergroup level is boundary spanning communication at the individual level, as it is interactions between individuals that give rise to relationships between the groups they belong to (Brass et al., 2004; Breiger, 1974; Phelps et al., 2012; Schotter et al., 2017). While individual boundary spanning lays the basis for intergroup knowledge integration, effective intergroup knowledge exchange further requires the resolution of a key paradox repeatedly demonstrated in the group information processing literature: Although unique and non-redundant knowledge is particularly valuable, it is typically underutilized in groups (Mesmer-Magnus and DeChurch, 2009; Stasser and Titus, 1985). Applied to the process of intergroup knowledge integration this basic principle implies two major challenges. The first challenge is obtaining unique expertise from a group through boundary spanning ties. While seeking knowledge from an individual in another group can give access to that individual's knowledge, this does not necessarily imply access to the collective knowledge of the group that consists of unique expertise distributed over many individuals (Zhao and Anand, 2013). To effectively contribute to intergroup knowledge integration, the boundary spanner in the source group needs not only to share their own knowledge in response to a recipient group's request, but also stimulate a collective process of knowledge mobilization in the source group. The second challenge is for the recipient group to make full use of group-external knowledge obtained through boundary spanning interactions. To effectively contribute to intergroup knowledge integration the boundary spanner in the recipient group needs not only to use the obtained knowledge for their own work, but also to stimulate a collective process of knowledge integration by disseminating relevant knowledge to other members in the recipient group.

While the group information processing literature thus challenges a simplistic view of the relationship between individual boundary spanning and intergroup knowledge

integration, it also points to facilitating factors. First, it has been shown repeatedly that collective mobilization and integration of non-redundant knowledge are greatly facilitated by individual *metaknowledge*, that is, knowledge of who knows what (Argote and Ren, 2012; Lewis, 2003; Ren and Argote, 2011; Richter et al., 2012; Wegner, 1987). Specifically, members with a particularly high level of metaknowledge about their groups have been shown to have a disproportionate impact on knowledge mobilization and integration within groups (Mell et al., 2014). Second, stimulating knowledge mobilization and integration requires additional effort on the part of the boundary spanner and, consequently, it requires not only the ability to contribute to intergroup knowledge integration but also the motivation to do so (Chen and Kanfer, 2006; Reinholt et al., 2011). An individual characteristic that is particularly relevant as a motivational foundation for contributing to intergroup knowledge integration in the context of a knowledge intensive organization is *proactivity*, that is, the disposition to take action to exert a constructive influence on one's environment (Bateman and Crant, 1993).

Leveraging and extending these insights, we propose that boundary spanners with high levels of metaknowledge play a key role for intergroup knowledge integration – and that this role is the more pronounced the more proactive their disposition is. We test our predictions in a network study of 457 knowledge workers nested in 22 interdependent business units of an engineering consultancy and find support for the main tenets of our theory. Furthermore, in additional criterion analyses we show that a group's centrality in the intergroup knowledge network has positive implications for its performance above and beyond the aggregate effect of individual boundary spanning. This underlines the importance of intergroup knowledge integration as an organizational phenomenon.

A key contribution of this paper lies in highlighting the interacting roles of boundary spanners' ability and motivation – that is, their metaknowledge about other group members and their proactivity – in shaping the relationship between individual boundary spanning ties and intergroup knowledge integration. Integrating the boundary spanning and the group information processing literatures in this way enhances our understanding of systematic differences in the effectiveness of individual boundary spanning and, by explicating how knowledge ties at the group level emerge from individual activity, contributes to the development of multilevel theory of knowledge networks in organizations (Moliterno and Mahony, 2011; Phelps et al., 2012). In doing so, this paper furthermore feeds back into the literatures it builds on. It contributes to transactive memory theory by providing further insight into the role of within-group variation in metaknowledge for collective outcomes (Mell et al., 2014). And it contributes to the literature on proactivity by showing how individuals' proactive personality impacts outcomes at the group and intergroup level (Harris and Kirkman, 2016).

CONCEPTUAL BACKGROUND AND HYPOTHESES

Intergroup Knowledge Integration as a Foundation of Group Performance

Broadly, knowledge integration refers to the combination of individuals' informational resources in ways that create value (Grant, 1996a, 1996b; Kogut and Zander, 1996).

Intergroup knowledge integration, then, refers to the combination of informational resources held in different groups. More precisely, we understand it as one group's acquisition, processing, and utilization of knowledge resources stemming from another group. Importantly, acquisition, processing, and utilization are not independent dimensions. Rather, knowledge utilization is the key defining principle of knowledge integration, albeit it presumes that knowledge from another group has been acquired and processed. Thus, knowledge integration goes beyond mere transfer of knowledge as it also involves its dissemination and discussion within the recipient group, its translation and recombination with knowledge held in the recipient group, and its application to the recipient group's work (Bechky, 2003; Carlile, 2004; Tippmann et al., 2017; Tushman and Scanlan, 1981).

Integrating knowledge from other groups facilitates future group performance as it results in the internalization of external knowledge. For example, a group may adapt a routine from another group to solve a specific problem in a current project (Argote and Ingram, 2000; Bresman, 2010, 2013), but the solution often will also remain in the collective knowledge repository of the recipient group as it is discussed, shared, and stored in the collective memory (Marsh and Stock, 2006; Teece et al., 1997; Wegner, 1987). Groups that are more central in the intergroup knowledge integration network – that is, groups that have internalized more external knowledge – can thus draw on a larger internal knowledge stock in future projects without incurring new search costs. Thus, as previous research has shown, there is a positive association between an organizational group's – e.g., a business unit's – centrality in the intergroup knowledge integration network and its performance (Balkundi and Harrison, 2006; Tsai, 2001; Tsai and Ghoshal, 1998).

Boundary Spanning as Antecedent to Intergroup Knowledge Integration

Research on knowledge integration highlights the role of communication and collaboration between individuals (Gardner et al., 2012; Grant, 1996a). Intergroup knowledge integration in particular relies on social and collaborative ties between groups (Bresman, 2013; Frost and Zhou, 2005; Mell et al., 2020; Singh, 2008), and, more specifically, on informational boundary spanning ties, that is, knowledge exchange relationships between individual members of different groups (Tortoriello et al., 2012). Prior research points to an important role of boundary spanning ties for combining knowledge resources from distinct parts of an organization (Cross and Sproull, 2004; Dokko et al., 2014; Tortoriello et al., 2012; Tortoriello and Krackhardt, 2010; Zhao and Anand, 2013) and underscores the role of interpersonal ties in the emergence of intergroup ties (Brass et al., 2004; Breiger, 1974). Prior work on the connection between individual boundary spanning and intergroup knowledge integration tends to fall into two perspectives: structural and agentic.

The structural perspective focuses on how the number and structure of boundary spanning ties between groups contribute to knowledge transfer and integration and, through this, facilitate desirable outcomes such as individual innovativeness or group performance. This literature has proposed multiple alternative paths to positive outcomes, including establishing many ties (Marrone et al., 2007; Tortoriello and Krackhardt, 2010; Tushman, 1977), balancing internal and external activities by establishing a moderate

rather than high numbers of ties (Choi, 2002; Gibson and Dibble, 2013; Oh et al., 2006), establishing collective bridges between units (Tortoriello and Krackhardt, 2010; Wong et al., 2021), aligning boundary spanning roles with internal network positions (Olabisi and Lewis, 2018; Tortoriello et al., 2014), or adjusting the intensity and the structure of the boundary spanning arrangement according to the complexity of knowledge to be transferred (Kim and Anand, 2018; Zhao and Anand, 2013). Notably, however, the strategies that emerge from this more structural perspective tend to ignore personal characteristics of boundary spanners.

In contrast, the agentic perspective on boundary spanning underscores the role of boundary spanners' personal characteristics for their effectiveness in the boundary spanning role. For example, prior work has shown positive effects of individuals' openness to experience, intrinsic motivation, and superordinate identification on individuals' and groups' utilization of external information and intergroup effectiveness (Baer, 2010; Dokko et al., 2014; Kane, 2010; Kane et al., 2005; Mell et al., 2020; Minbaeva and Santangelo, 2018; Richter et al., 2006).

We integrate the structural and the agentic perspectives in arguing that the existence of boundary spanning knowledge exchange ties between two units is a necessary but not sufficient condition for intergroup knowledge integration. Rather, intergroup knowledge integration also requires activities from the boundary spanners that go beyond just seeking information or responding to a colleague's request for information. Specifically, in order to effectively contribute to intergroup knowledge integration, boundary spanners need to stimulate collective processes in their respective groups. On the source group side, seeking out any one individual in a source group may give access to what they know, but not necessarily provide sufficient access to the group's collective knowledge (Kim and Anand, 2018; Olabisi and Lewis, 2018; Zhao and Anand, 2013). To do the latter, the boundary spanner in the source group needs to proactively stimulate a collective process of *knowledge mobilization*, in which the source group assesses the value of the group's collective knowledge for the recipient group and helps the transfer and translation of relevant expertise (Bresman, 2013). On the recipient group side, non-redundant information obtained through external contacts may be particularly valuable, but it is also particularly likely to go underutilized by the group as a whole (Brodbeck et al., 2007; Mesmer-Magnus and DeChurch, 2009; Stasser and Titus, 1985). To contribute to intergroup knowledge integration, the boundary spanner in the recipient group needs to proactively initiate a collective process of *knowledge integration*, in which the recipient group recognizes the broader value of a source group's knowledge and applies it to its own problems (Kane, 2010).

This in turn means that the extent to which a boundary spanner is able to proactively stimulate the requisite collective knowledge mobilization and knowledge integration processes in their group will shape the extent to which their boundary spanning activity will be contributing to intergroup knowledge integration. Building on group information processing literature, we propose individuals' metaknowledge, i.e., knowledge of who knows what, as a critical ability factor facilitating knowledge mobilization and knowledge integration (DeChurch and Mesmer-Magnus, 2010; Hinsz et al., 1997; Ren and Argote, 2011; Wegner, 1987). While boundary spanners with high levels of metaknowledge will thus be better able to contribute to intergroup

knowledge integration, ability alone is not sufficient without the motivation to engage in the additional activities required for this (Reinholt et al., 2011). Based on research on proactive behaviour in organizations we argue that, in the context of a knowledge intensive organization, individual proactivity provides a critical and proximal motivational foundation to contribute to the type of knowledge mobilization and knowledge integration processes necessary for constructing a more effective organizational knowledge architecture (Bateman and Crant, 1993; Belschak and Den Hartog, 2016; Gong et al., 2012). In the following, we discuss how the metaknowledge and proactivity of the boundary spanners in the source group (*knowledge sources*) and the metaknowledge and proactivity of the boundary spanners in the recipient group (*knowledge seekers*) affect the extent to which the boundary spanning ties they establish between their respective groups contribute to intergroup knowledge integration.

Ability to Facilitate Intergroup Knowledge Integration: The Role of Boundary Spanners' Metaknowledge

Transactive memory system theory posits that groups develop collective systems for encoding, storing, and retrieving knowledge (Argote and Ren, 2012; Hollingshead, 2001; Wegner, 1987). The structural backbone of transactive memory systems is formed by members' specialized knowledge and their metaknowledge, i.e., their knowledge about who knows what in the group (Lewis, 2003; Wegner, 1995). Individual members' *levels of metaknowledge* about their group reflect the extent to which they have an accurate understanding of what knowledge their fellow group members possess (Borgatti and Cross, 2003). Metaknowledge forms a critical basis for knowledge integration within groups: Groups whose members, on average, possess higher levels of metaknowledge are typically more effective at sharing, utilizing, and recombining their members' expertise (Stasser et al., 2000; Stewart and Stasser, 1995; van Ginkel and van Knippenberg, 2009) which results in greater performance, learning, and creativity (Austin, 2003; Lewis, 2004; Liang et al., 1995). However, individuals can also *vary* in their levels of metaknowledge due to differences in workflow and interaction patterns (Brandon and Hollingshead, 2004; Mortensen, 2014), role requirements (Peterson and Kim, 2012), and individual preferences (Galunic et al., 2014). Individuals with particularly high levels of metaknowledge can play a critical role for knowledge integration within their group as they can stimulate knowledge coordination processes (Mell et al., 2014). Building on this, we suggest that such individuals may also play an important role in enabling knowledge integration *between* groups when they act as boundary spanners.

Boundary spanning ties reaching to source group members with high metaknowledge about their group can give a recipient group superior access to the source group's knowledge. Within an existing group, some knowledge is typically shared among all members while other, usually more specialized, knowledge is distributed across the group members. A recipient group's attempt to access relatively unique knowledge is likely to be more successful when knowledge seekers turn to sources with a good understanding of who knows what in the source group because these can more effectively stimulate knowledge mobilization in the source group. Sources with a higher level of metaknowledge about their own group are better able to assess whose expertise best addresses a seeker's needs and they can engage in more targeted information

retrieval from fellow group members (Mell et al., 2014). Through this they can involve additional source group members who can complement, elaborate, confirm, or qualify their own response, thus establishing a temporary collective bridge (Zhao and Anand, 2013). As a result of the source sharing not only their own knowledge but also mobilizing others' expertise on a seeker's behalf, the seeker is more likely to get a high quality response to their query (Cross and Sproull, 2004). Conversely, a lack of metaknowledge has been shown to lead to relevant expertise remaining hidden (Stasser et al., 2000; Stewart and Stasser, 1995). Moreover, seekers do not need to maintain ties to many different experts in the source unit as long as they maintain ties to sources with high metaknowledge who can refer them to relevant experts when needed. This frees time for processing, disseminating, and integrating the acquired knowledge in their own and their group's work (Hansen et al., 2001). Thus,

> *Hypothesis 1a*: There is a positive association between the metaknowledge of the boundary spanning knowledge source and the level of intergroup knowledge integration between the recipient group and the source group.

Similarly, there are several reasons to expect that knowledge obtained by seekers with higher metaknowledge will more likely be integrated in the recipient group's work. Individuals with a high level of metaknowledge have been shown to engage in behaviours that stimulate knowledge integration processes in their group (Mell et al., 2014). For example, they have been shown to attribute more importance to discussion and integration of information and, consequently, to engage in more information sharing (van Ginkel and van Knippenberg, 2009). Correspondingly, individuals with high metaknowledge often are also central in their own group's advice network (Borgatti and Cross, 2003; Cross and Cummings, 2004), which puts them in a better position to disseminate the external information they receive (Olabisi and Lewis, 2018; Tushman and Scanlan, 1981). Yet, metaknowledge constitutes a potential for knowledge integration beyond simple centrality in the communication network. Individuals with high metaknowledge are better able to see how external knowledge relates to the expertise of other group members and to recognize opportunities for knowledge recombination (Leonardi, 2014). This allows boundary spanners with high metaknowledge to better target information sharing, directing incoming information to the specific group members for whom it is most relevant and who are most likely to utilize it (Aral and van Alstyne, 2011; Wegner, 1995). In sum,

> *Hypothesis 1b*: There is a positive association between the metaknowledge of the boundary spanning knowledge seeker and the level of intergroup knowledge integration between the recipient group and the source group.

Motivation to Facilitate Intergroup Knowledge Integration: The Role of Boundary Spanners' Proactivity

Stimulating collective knowledge mobilization and knowledge integration processes requires effort that goes beyond the focal boundary spanning interaction. Such effort, in

turn, requires motivation (Chen and Kanfer, 2006; Reinholt et al., 2011; Roberts and Beamish, 2017). Thus, while metaknowledge provides individuals with the ability to be more effective in facilitating intergroup knowledge integration, the extent to which individuals will act upon this ability will be moderated by their motivation to invest effort in influencing collective knowledge processes. An important dispositional characteristic shaping the motivation for such effort is proactive personality.

Proactive personality is defined as a disposition to take action to exert a constructive influence on one's environment (Bateman and Crant, 1993). Proactive individuals 'identify opportunities and act on them, show initiative, take action, and persevere until meaningful change occurs' (Crant, 2000, p. 439). Proactive behaviour within organizations can be directed at three distinct foci (Belschak and Den Hartog, 2010, 2016). Pro-organizational proactive behaviour aims to constructively influence the organization as a whole. Pro-social proactive behaviour aims to constructively influence specific others such as specific colleagues or one's work team. Pro-self proactive behaviour aims to constructively influence personal and career goals. While proactive behaviours can take different shapes including interpersonal helping, constructive voice, or increased engagement in one's own work (Crant et al., 2016), in the context of a knowledge intensive organization, proactivity is likely to become manifest in behaviours that connect people with knowledge they need and, in this way, contribute to a knowledge architecture that is more conducive to individual, group, and organizational performance. This is because knowledge is a highly valuable and, therefore, highly salient resource in such organizations (Grant, 1996a). Thus, connecting people with knowledge they need is a salient way to have a constructive influence on one's environment in a knowledge intensive organization. Consequently, we propose that the more boundary spanners – source and seeker alike – are proactive, the more they will put their metaknowledge to use in facilitating intergroup knowledge integration in their respective roles.

On the source unit's side, we argued earlier that knowledge sources with a higher level of metaknowledge are better able to mobilize their group's expertise on the seeker's behalf. To do this, however, the source would have to engage in intense interaction both with the seeker – aiming to gain a clearer understanding of the expertise the seeker requires – and with the members of their own group – employing their own social capital to marshal help for the seeker. More proactive individuals can be expected to engage more in this additional effort for at least three reasons linked to the different foci of proactive behaviour. First, helping a knowledge seeker from another unit to obtain relevant expertise allows the source to have a constructive influence on organizational goals by helping the other unit increase its performance. Second, connecting a knowledge seeker from another unit to the most suitable experts in one's own unit allows the source to have a constructive influence not only on the performance of the specific colleague from the other unit, but also on colleagues in their own unit by giving them opportunities to increase their visibility as experts throughout the organization, to build their social capital by helping colleagues from other units, and to increase their own human capital by possibly joining interdisciplinary projects. Third, exerting effort in order to provide the seeker with a high quality response to their query allows the source to have a constructive influence on their

own future performance and career progression by building their own social capital (Grant and Ashford, 2008; Seibert et al., 2001) and by motivating future reciprocal effort from the seeker which is particularly critical in boundary spanning knowledge exchange (Caimo and Lomi, 2015).

In sum, proactivity motivates boundary spanning knowledge sources to engage in behaviours that put their metaknowledge to a fuller use, thus positively moderating the effect of sources' metaknowledge on intergroup knowledge integration.

Hypothesis 2a: The higher the boundary spanning sources' proactivity, the more positive the relationship between sources' metaknowledge and intergroup knowledge integration is.

On the recipient unit side, earlier we argued that knowledge seekers' metaknowledge about their own group makes them better able to stimulate knowledge integration processes within their own group. This entails exerting effort beyond the own knowledge utilization, for example, on disseminating externally obtained knowledge within their own group. More proactive individuals will likely engage more in this additional effort for at least three reasons. First, sharing knowledge obtained from other units with members of one's own unit allows the seeker to have a constructive influence on unit performance, and, hence, on organizational goals (Tushman, 1977). Second, sharing knowledge obtained from other units with members of one's own unit allows the seeker to have a constructive influence on specific colleagues' performance by providing them with key resources for their work (Tortoriello et al., 2014). Finally, sharing knowledge obtained from other units with members of one's own unit allows the seeker to have a constructive influence on their own future performance through motivating future reciprocal knowledge sharing and, more generally, building up social capital within the own unit (Gong et al., 2011, 2012; Grant and Ashford, 2008; Seibert et al., 2001).

In sum, proactivity motivates boundary spanning knowledge seekers to engage in behaviours that put their metaknowledge to a fuller use, thus positively moderating the effect of boundary spanner metaknowledge on intergroup knowledge integration.

Hypothesis 2b: The higher the boundary spanning seekers' proactivity, the more positive the relationship between seekers' metaknowledge and intergroup knowledge integration is.

DATA AND METHODS

We conducted a survey study in an engineering consultancy in the Netherlands. To test our hypotheses, we collected data on the network of inter-unit relationships of intergroup knowledge integration, individual-level boundary spanning ties among members of the units, and individuals' metaknowledge and proactivity. In addition, we also examined the relationship between units' positions in the intergroup knowledge integration

network and their performance as a check of the criterion validity of intergroup knowledge integration as our focal dependent variable.

Setting

The setting for our study was a multi-unit engineering company in the Netherlands consulting on engineering projects across various disciplines such as hydraulic, geotechnical, construction, and environmental engineering. Engineering work is highly knowledge-intensive, often calling for the integration of knowledge from diverse fields of expertise. Engineering projects are often idiosyncratic, requiring unique compilations of knowledge for most new projects. As complementary knowledge is often dispersed across specialized groups and units, knowledge exchange and integration across intra-organizational boundaries are critical for the effectiveness and success of such companies (Hansen, 2002; Tsai, 2001).

At the time of the study, the company consisted of around 1000 employees across 26 business units organized around different areas of expertise. These units are relatively autonomous, responsible for their own project acquisition, staffing, and execution. Projects vary widely in size, duration, and complexity, with the majority of projects being completed within less than a year. Employees are typically members of multiple project teams simultaneously. While project teams are thus of a temporary and concurrent nature, the business units form stable expert pools from which project teams are assembled. Business units are also responsible for retention of knowledge created during project work. In sum, the business units are considered the primary groups comprising the organization, constituting the core differentiated groups among whom knowledge exchange and integration takes place within project work. We therefore defined the business units as our units of analysis at the group level.

Due to the multidisciplinary nature of most projects, each unit depends on close collaboration with other units. Such collaboration occurs both formally through staffing project teams with experts from various units and informally through exchanging knowledge across unit boundaries. These informal boundary-spanning knowledge exchange relationships are of particular importance for the organization, often forming the base for as well as complementing formal collaboration.

Data Collection and Sample

First, we interviewed 12 members of the organization across all hierarchical levels (unit leaders, work group leaders, and consultants) in order to better understand the organization, identify the relevant group and network boundaries, identify suitable key informants for intergroup knowledge integration, and adapt our survey instruments to the setting. The interviews confirmed that the business units were the most appropriate units of analysis at the group level, emphasizing the business units as the primary groups that house the different disciplines and centres of expertise and with which employees primarily identify. We limited our sample to the 22 business units located in the Netherlands and constituting the core business, excluding four units located in other parts of the world. On the group-dyadic level, this resulted in a sample of $N_d = 22*(22-1) = 462$ directed dyads. On the individual level, we defined the boundary of the network to be studied as all employees of the selected units

in primary functions, i.e., those engaged in project work, project management, and work group management, excluding administrative and support functions. In total, our sample comprised 645 employees nested in 22 interdependent business units, each unit comprising 20 to 50 individuals.

Then, we collected data on the knowledge exchange network among individual employees, metaknowledge within the business units, individual proactivity, and the inter-unit knowledge integration network using an online survey. In total, 457 respondents (71 per cent) completed the survey: all 22 unit leaders, 80 out of 92 work group leaders, and 355 out of 531 consultants. Unit-level response rates ranged between 50 per cent and 95 per cent (M = 71 per cent, SD = 12.64 per cent). Respondents were 36.42 years old on average (SD = 9.43) and had been in the company for 10.27 years (SD = 7.88). Most respondents were male (85.12 per cent) and held a higher education degree (94 per cent). Based on archival data, respondents did not differ from non-respondents on gender or tenure.

Furthermore, we obtained archival data on units' positions in the organizational structure, on inter-unit flows of monetary compensation for work contributed to each other's projects in the year before the survey, and on project characteristics and performance in the year following the survey.

Measures for Main Analyses

Interunit knowledge integration. Consistent with prior research on interunit ties (Hansen, 1999, 2002; Hansen and Løvås, 2004; Sosa et al., 2015), we relied on key informants to report on the extent to which their unit as a whole utilized knowledge from each other unit. In our context, unit leaders were identified as uniquely suitable as key informants as they oversee all projects conducted within their unit and have a good understanding of how knowledge is utilized within all projects. Unit leaders got a roster listing all business units and responded to this question on a six-point Likert scale ('very inaccurate' to 'very accurate'),: 'Please indicate to what extent the following statement describes the working relationship of *your unit as a whole* with each of the other units: *In our unit, we often use knowledge provided by this unit. This means that we exchange knowledge with this unit, discuss the knowledge gained from this unit in our groups, and integrate it in our work, for example as a solution for a problem or as a new approach to some aspect of our work*'. This resulted in a 22 × 22 matrix of directed relations among the units.

A limitation of this measure is that it is a single-item perceptual measure – a common limitation of network research. We took several steps in order to mitigate construct validity concerns. First, in developing the question, we followed established sociometric procedures, including providing a detailed definition of our construct to respondents and pretesting the survey instrument through a pilot focus group (Borgatti and Cross, 2003; Marsden, 1990). Second, through our interviews and the focus group, we established that the key informants that we selected (the unit leaders) were suitable to accurately report on inter-unit knowledge integration relationships. Third, we examined convergent validity of the intergroup knowledge integration measure with known antecedents to intergroup knowledge integration, namely formal collaboration between groups (Frost and Zhou, 2005) and informal boundary spanning information exchange (Mell et al., 2020). These measures are described in detail in the control variables section and we found them to correlate significantly with

intergroup knowledge integration ($r = 0.38$, $p < 0.001$, and $r = 0.46$, $p < 0.001$, respectively). Finally, we examined our measure's criterion validity using objective data on the financial performance of projects conducted by the units in the year following the survey and we present the results of these supplementary analyses further below.

Individual informational boundary spanning. First, we captured the complete knowledge exchange network within our population through a name generator asking participants to name up to twelve colleagues they 'have turned to for specialist knowledge or information in the past three months'. To facilitate recall, we included an interactive scheme of the complete organization side by side with the name generator text fields so participants could review the list of employees in any unit as they wished. At a response rate of 71 per cent, we obtained a 457 × 457 matrix of directed relations among individuals. We considered a knowledge seeking tie from individual i to individual j to be boundary spanning whenever i and j were members of different business units. Of the 3097 reported knowledge seeking ties, 1960 were boundary spanning ties. Based on the captured boundary spanning ties, we identified the boundary spanners connecting each pair of units (see section 'boundary spanners' metaknowledge and proactivity' below).

Individual metaknowledge. We captured individuals' metaknowledge about the members of their business unit via an established sociometric approach (Borgatti and Cross, 2003; Cross and Cummings, 2004). First, we captured dyadic metaknowledge by presenting a roster of all unit members with this question: 'Expertise awareness in an organization means that you understand what specialist knowledge another person has, potentially over and above what is revealed by his or her position in the organizational scheme. For example, you might know what kinds of projects a person typically works on and what kind of knowledge he or she uses to contribute to these projects. This does not necessarily mean that you have the same knowledge or that you interact regularly, but just that you understand what the other person is knowledgeable or expert about. Please, mark those people about whom the following statement is true for you: *I have a good understanding of this person's knowledge that goes beyond what is reflected in his or her position in the organizational scheme*'. Then, as a measure of individual metaknowledge, we calculated the proportion of fellow unit members about whose expertise an individual reported having a good understanding. Across all respondents, individual metaknowledge levels were distributed around a mean of 0.46 ($SD = 0.27$).

A limitation of this sociometric measurement approach is its reliance on individuals' self-reports of metaknowledge. We took two steps to further validate the sociometric metaknowledge measure employed in our study. First, we examined convergent relationships of the sociometric measure with known antecedents and consequences of metaknowledge both in our own data and reported in prior work using the same metaknowledge measure. Second, we conducted a supplementary study with a different sample in order to examine the convergent validity of the sociometric self-report metaknowledge measure (Borgatti and Cross, 2003) with an alternative and more objective metaknowledge accuracy measure (Austin, 2003). We present the detailed

results of these additional validation efforts in Supplement 1. In summary, the results show that despite its limitations, the sociometric self-report measure of metaknowledge displays convergent validity with multiple theoretically related antecedent and consequence variables at different levels of analysis as well as with a more objective measure of metaknowledge accuracy.

Individual proactivity. We captured individual proactivity using five items of the proactive personality scale (Bateman and Crant, 1993; Seibert et al., 2001; see Supplement 2 for items). The short scale displayed adequate internal consistency ($\alpha = 0.70$). Proactivity was distributed around an average of 4.27 ($SD = 0.65$). In order to make zero meaningful and facilitate later interpretation, we mean-centred the variable on the individual level.

Boundary spanners' metaknowledge and proactivity. To model boundary spanners' impact on intergroup knowledge integration, we aggregated boundary spanners' metaknowledge and proactivity to the inter-unit level (Chan, 1998; Klein and Kozlowski, 2000). First, for each directed unit dyad (u,v) where u is the recipient unit and v is the source unit, we identified the dyad-specific boundary spanning knowledge seekers (members of unit u who sought knowledge from members of unit v) and the dyad-specific boundary spanning knowledge sources (members of unit v who were sought out for knowledge by members of unit u). To avoid common source bias stemming from unit leaders reporting both on their own boundary spanning ties and on intergroup knowledge integration, we excluded unit leaders' outgoing ties from the determination of boundary spanners (Podsakoff et al., 2003). Thus, unit leaders could appear as boundary spanning sources, but not seekers. Then, for each directed unit dyad (u,v), we computed *seekers' average metaknowledge* as the average metaknowledge level of the dyad-specific boundary spanning knowledge seekers and we computed *sources' average metaknowledge* as the average metaknowledge level of the dyad-specific boundary spanning knowledge sources. We used the additive composition model (average score) to aggregate individual metaknowledge to the intergroup level because intergroup knowledge integration is arguably best viewed as an additive task where each boundary spanner potentially contributes to the outcome in a manner proportional to their ability and motivation rather than a conjunctive or disjunctive task where the lowest or the highest input determine the outcome (LePine et al., 1997; Steiner, 1972; van Kleef et al., 2009). In cases where no ties reached from unit u to unit v, we set the average metaknowledge of the seekers and of the sources to zero, corresponding to the minimal possible value of metaknowledge (Burt, 2010). We aggregated boundary spanners' proactivity in the same way, computing *seekers' average proactivity* and *sources' average proactivity* for each pair of units u and v. In cases where no ties reached from unit u to unit v, we set the average proactivity of the seekers and of the sources to zero – that is, corresponding to the sample mean. We present an example to further illustrate the calculations explained above in Supplement 3.

Control variables: Additional boundary spanners' attributes. We controlled for two additional attributes of boundary spanners. First, as metaknowledge can be linked to individuals'

positions in information exchange networks (Borgatti and Cross, 2003; Cross and Cummings, 2004), which in turn can have an effect on individuals' ability to mobilize and to disseminate knowledge (Krackhardt, 1990; Tushman and Scanlan, 1981), we controlled for boundary spanning seekers' and sources' average *degree centrality* in their units' internal knowledge exchange networks, expressed as the sum of all incoming and outgoing knowledge seeking ties of an individual within their own unit (Freeman, 1978). We aggregated boundary spanners' degree centrality to the inter-unit level in the same manner as boundary spanners' metaknowledge and proactivity. Second, we controlled for boundary spanners' formal positions as group or unit leaders, given that leaders may have more metaknowledge and, at the same time, also be better able to mobilize or disseminate knowledge thanks to formal influence. We aggregated boundary spanners' formal positions to the inter-unit level by calculating, for each unit dyad, the *proportion of group leaders* among the boundary spanning seekers and sources and the *proportion of unit leaders* among the boundary spanning sources. As we excluded unit leaders' outgoing ties from our analyses earlier, there were no unit leaders among boundary spanning seekers.

Control variables: Unit attributes. We controlled for several unit-level attributes that capture features of the unit's information processing structure and that can, at the same time, influence a unit's general capability and propensity for knowledge integration. Specifically, we controlled for the *average levels of metaknowledge* in the recipient and in the source units because average metaknowledge can impact knowledge integration (Austin, 2003; Gardner et al., 2012; Stasser et al., 2000; van Ginkel and van Knippenberg, 2009). On similar grounds, we also controlled for the *unit-level transactive memory systems* in the recipient and in the source units using Faraj and Sproull's (2000) subscales of expertise location (sample item: 'The unit has a good 'map' of each others' talents and skills') and bringing expertise to bear (sample item: 'People in our unit share their special knowledge and expertise with one another'). The scale showed good internal consistency ($\alpha = 0.84$). We aggregated responses within each unit by averaging them.

Furthermore, we controlled for recipient and source unit members' frequency to utilize the company's *knowledge management system*. This was measured using the single item 'How often did you use the [knowledge management system] to find an expert in the past three months?', rated on a five-point scale ranging from 'never' to 'several times per week' and averaged across all unit members. To capture the broader information processing structure in the units, we also controlled for the recipient and the source units' *density* of the unit-internal knowledge exchange network. Finally, we controlled for the *size* of the recipient and of the source unit to control for differences in resources, visibility within the organization, and ease of unit-internal knowledge coordination (Palazzolo et al., 2006).

Control variables: Inter-unit relationships. We controlled for the total number of boundary spanning ties between each pair of units by summing up the boundary spanning ties among business units in a 22 × 22 matrix, each cell (u,v) containing the number of knowledge seeking ties reaching from the recipient unit u to the source unit v. Furthermore,

prior research on relative absorptive capacity (Lane and Lubatkin, 1998) and on inter-unit relationships (Tsai, 2000, 2002) has noted that knowledge exchange and learning between groups are facilitated by similarity in terms of knowledge bases, customer bases, and typical projects. We controlled for such similarity using an indicator variable denoting units' membership in the same 'business sector' in the organizational scheme. Prior research also points to the role of formal collaboration for knowledge integration (Frost and Zhou, 2005). In the studied organization, while each project is owned by one business unit, project members can also be hired from other units and are then internally paid for their work hours or 'deliveries'. We controlled for prior formal collaboration between units by including two dyadic covariates: the amount of deliveries a recipient unit (a) obtained from and (b) provided to a source unit in the year prior to the survey. Deliveries were expressed in money flows and we took the natural logarithms of the transferred sums plus one.

Measures for Criterion Analysis

To examine the criterion validity of our intergroup knowledge integration measure, we analysed the relationship between units' centrality in the intergroup knowledge integration network and their performance. As many knowledge intensive organizations, the organization in our study organizes their work in projects. Thus, unit performance is founded on and expressed in project performance (Chatterjee, 2017; Prencipe and Tell, 2001). Therefore, for the criterion analysis, we obtained data from the company's time accounting and financial accounting systems on all projects completed in the year following the survey. To ensure that we had full information on project composition, we only included projects that started and finished within the observation window. Furthermore, to isolate the extent to which intergroup knowledge integration truly results in the internalization of external knowledge, we only included 'solo' projects – that is, projects composed of members of a single unit. This resulted in a sample of 255 projects.

We operationalized project performance as a project's profit margin, a measure commonly used to capture organizational performance in research and in practice (Combs et al., 2005; Maltz et al., 2003). For each project, we summed the intergroup knowledge integration scores of its host unit across all other units. Finally, we included control variables on unit level and on project level. We present an overview of these variables and their operationalization in Supplement 4.

Analytical Approach

Intergroup knowledge integration represents a dyadic relation in the inter-unit network of an organization. Network data violate the assumption of independent observations in OLS regression as observations are autocorrelated within rows (recipient units) and columns (source units) and thus call for analytical procedures that do not assume independence. The quadratic assignment procedure (QAP) and its extension to multiple regression (MRQAP) overcome the autocorrelation problem through constructing non-parametric significance tests (Dekker et al., 2007; Krackhardt, 1987, 1988) and are suitable for research questions whose focus is on the effect of explanatory variables on dyadic

outcomes (Snijders, 2011). QAP correlations and MRQAP regression coefficients can be interpreted in a manner identical to Pearson correlations and OLS regression coefficients. Significance tests are obtained in a permutation procedure, in which distributions of coefficients are generated from random permutations of the rows and columns of the observed matrices. We based our tests on 10000 random permutations using the double semi-partialing procedure (Dekker et al., 2007), implemented in the *sna* package for R (Butts, 2014).

RESULTS

Criterion Analysis

Table I provides the descriptive statistics and intercorrelations among the variables included in the criterion analysis. Table II presents the results of the criterion analysis, using a Hierarchical Linear Model accounting for the nesting of projects in business units. As expected, a unit's total intergroup knowledge integration was positively related with subsequent performance of projects ($b = 0.52$, $SE = 0.20$, $p = 0.01$). To get an intuitive sense of the effect size, we compare projects conducted by units on the lower end of the intergroup knowledge integration distribution (25 per cent quantile: 38) with projects conducted by units on the higher end of the intergroup knowledge integration distribution (75 per cent quantile: 67): All else being equal, the expected difference in profit margin is $(67 - 38) * 0.52 = 15.08$ per cent. Importantly, intergroup knowledge integration predicted subsequent project performance above and beyond a simple aggregation of individual-level boundary spanning. Having thus established the criterion validity of our dependent variable, we now turn to our main analyses examining the influence of individual boundary spanners' metaknowledge on interunit knowledge integration.

Main Analysis

Table III contains uncentered descriptive statistics and correlations of the variables included in the main analysis. Table IV presents the results of the MRQAP analyses testing our hypotheses. For ease of interpretation, all variables with the exception of the dummy denoting shared sector membership have been mean-centred prior to entering the regressions presented in Table IV. Model 1 is the baseline model, containing only the control variables. Model 2 introduces the number of boundary spanning ties reaching from the recipient unit to the source unit. Consistent with prior research, boundary spanning ties reaching from the recipient unit to the source unit were positively associated with intergroup knowledge integration. In Model 3, we include the variables denoting the average metaknowledge of the individual seekers and of the individual sources who maintain boundary-spanning ties between two units. Consistent with Hypothesis 1a, we find a significant positive association between the average metaknowledge of boundary spanning seekers and intergroup knowledge integration between the recipient and the source unit ($b = 0.79$, $p = 0.03$).

Table I. Descriptive statistics and correlations of project-level variables (criterion analysis)

	M	***SD***	*1.*	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*	*9.*	*10.*	*11.*	*12.*	*13.*
1. Profit margin	6.66	34.86													
2. Project in home country	0.99	0.09	−0.02												
3. Project duration	4.65	0.65	0.00	0.02											
4. Team size	1.20	0.65	−0.02	0.07	0.1										
5. Project workload	3.05	1.28	0.03	0.00	0.15	0.47									
6. HU's prior performance	108.7	16.99	−0.05	0.02	0.15	−0.11	−0.20								
7. HU's coll. experience (out)	0.71	0.6	−0.17	−0.10	0.01	−0.02	−0.01	0.16							
8. HU's coll. experience (in)	0.53	0.39	−0.08	−0.01	0.11	−0.21	−0.15	0.46	0.45						
9. HU's human capital	0.60	0.21	0.07	0.08	−0.05	−0.02	0.13	−0.03	−0.25	−0.26					
10. HU's size	30.42	6.69	−0.05	−0.14	−0.15	0.23	0.01	−0.30	0.26	−0.25	−0.23				
11. HU's average MK	0.48	0.09	−0.01	0.09	−0.08	−0.06	0.15	0.07	−0.04	−0.21	0.62	−0.49			
12. HU's boundary spanning	93.4	31.92	0.08	−0.03	−0.12	0.18	0.16	−0.07	0.17	−0.18	0.06	0.32	0.16		

(Continues)

Table I. (Continued)

	M	***SD***	*1.*	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*	*9.*	*10.*	*11.*	*12.*	*13.*
13. Other units' total KI from HU	56.64	6.62	0.05	−0.07	−0.08	−0.05	0.15	−0.25	0.23	−0.01	0.45	0.07	0.31	0.29	
14. HU's total KI from other units	52.17	15.20	0.08	−0.09	0.00	0.09	0.06	−0.36	0.07	−0.12	−0.44	0.35	−0.44	−0.19	0.06

Abbreviations: HU, host unit, MK, metaknowledge, KI, knowledge integration.

Table II. Results of criterion analyses

	DV: Profit margin					
	Model 1			*Model 2*		
	b	***SE***	***p***	***b***	***SE***	***p***
Intercept	51.39	53.29	0.34	23.56	53.70	0.66
Project in home country	−11.06	24.47	0.65	−10.79	24.16	0.66
Project duration	−0.23	3.50	0.95	−0.22	3.46	0.95
Team size	−2.10	3.96	0.60	−2.43	3.91	0.54
Project workload	0.71	2.02	0.73	0.22	2.00	0.91
HU's prior performance	−0.02	0.16	0.91	0.03	0.16	0.85
HU's coll. experience (out)	−8.26	5.36	0.12	−8.09	5.29	0.13
HU's coll. experience (in)	−5.10	8.72	0.56	0.04	8.83	1.00
HU's human capital	10.02	15.90	0.53	31.11	17.71	0.08
HU's size	−0.87	0.56	0.12	−1.04	0.55	0.06
HU's average MK	−77.50	44.37	0.08	−63.58	44.13	0.15
HU's boundary spanning	0.17	0.08	0.04	0.26	0.09	0.00
Other units' total KI from HU	0.35	0.45	0.43	−0.16	0.48	0.74
HU's total KI from other units				0.52	0.20	0.01
Observations	250			250		
LogLikelihood	−1234.1			−1230.8		

Abbreviations: HU, host unit, MK, metaknowledge, KI, knowledge integration.

Contrary to Hypothesis 1b, however, we find no association between the average metaknowledge of boundary spanning sources and intergroup knowledge integration. In Model 4, we include the main effects of seekers' and sources' average proactivity and in Model 5, we include the interaction effects testing Hypotheses 2a and 2b. As predicted, proactivity of the seekers as well as of the sources positively moderates the respective effects of seekers' and sources' metaknowledge on intergroup knowledge integration. Figure 1 illustrates the interactions. In order to further unpack the interactions, we conducted floodlight analyses to identify at which levels of proactivity across its full range (−1.53 up to 1.46 after mean-centring) the effect of boundary spanners' metaknowledge is significant (Spiller et al., 2013). On the recipient side, we found that the effect of seekers' metaknowledge was significantly positive at centred proactivity levels of −0.08 (i.e., slightly below the mean) and higher and it was not significant at proactivity levels lower than that. On the source side, we found that at low proactivity levels up to −0.15, the effect of sources' metaknowledge is significantly negative. At high proactivity levels equal and above 0.80, on the other hand,

Table III. Descriptive statistics and correlations

	M	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*
1. Intergroup knowledge integration	2.60	1.70																									
2. Same sector	0.18	0.39	0.36																								
3. Received deliveries	2.97	2.09	0.38	0.31																							
4. Sent deliveries	2.97	2.09	0.35	0.31	0.35																						
5. Size of recipient unit	29.32	7.49	0.09	−0.02	0.15	0.19																					
6. Size of source unit	29.32	7.49	0.06	−0.02	0.19	0.15	−0.05																				
7. Av. MK of recipient unit	0.47	0.10	−0.04	0.02	−0.28	−0.06	−0.49	0.02																			
8. Av. MK of source unit	0.47	0.10	0.03	0.02	−0.06	−0.28	0.02	−0.49	−0.05																		
9. Knowledge exchange density of recipient unit	0.09	0.03	−0.14	0.06	−0.23	−0.09	−0.58	0.03	0.52	−0.02																	
10. Knowledge exchange density of source unit	0.09	0.03	0.05	0.06	−0.09	−0.23	0.03	−0.58	−0.02	0.52	−0.05																
11. Av. KMS use of recipient unit	3.11	0.36	−0.04	−0.05	−0.11	0.16	−0.09	0.00	0.38	−0.02	0.11	−0.01															
12. Av. KMS use of source unit	3.11	0.36	0.04	−0.05	0.16	−0.11	0.00	−0.09	−0.02	0.38	−0.01	0.11	−0.05														
13. TMS of recipient unit	4.34	0.30	−0.08	0.03	0.03	−0.15	−0.33	0.02	0.39	−0.02	0.31	−0.01	−0.33	0.02													
14. TMS of source unit	4.34	0.30	0.07	0.03	−0.15	0.03	0.02	−0.33	−0.02	0.39	−0.01	0.31	0.02	−0.33	−0.05												
15. Av. proactivity of recipient unit	4.28	0.12	0.14	−0.01	−0.14	0.04	−0.06	0.00	0.26	−0.01	0.17	−0.01	0.36	−0.02	−0.30	0.01											

(Continues)

Table III. (Continued)

	M	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*
16. Av. proactivity of source unit	4.28	0.12	−0.04	−0.01	0.04	−0.14	0.00	−0.06	−−0.01	0.26	−0.01	0.17	−0.02	0.36	0.01	−0.30	−0.05										
17. Av. seekers' centrality	0.12	0.10	0.16	0.17	0.11	0.21	−0.16	0.06	0.18	0.03	0.32	0.01	0.13	0.05	−0.01	−0.01	−0.01	−0.05									
18. Av. sources' centrality	0.12	0.11	0.30	0.19	0.27	0.19	0.15	−0.12	−0.02	0.17	−0.12	0.35	0.09	0.09	−0.08	0.11	−0.04	−0.04	0.43								
19. Group leader proportion among seekers	0.14	0.26	0.02	0.01	0.04	−0.05	0.00	−0.03	−0.04	0.07	−0.04	0.05	−0.04	0.08	−0.04	−0.02	−0.03	0.00	0.23	0.28							
20. Group leader proportion among sources	0.16	0.27	0.06	0.00	−0.05	0.08	0.03	−0.06	0.02	−0.07	−0.05	−0.06	0.02	−0.04	−0.12	−0.06	0.03	−0.01	0.25	0.25	0.21						
21. Unit leader proportion among sources	0.03	0.10	0.12	0.08	0.03	0.12	−0.05	−0.04	0.09	0.05	0.03	0.05	0.16	−0.03	−0.06	0.09	0.11	−0.10	0.05	0.06	0.10	−0.05					
22. Number of boundary spanning ties	4.05	5.61	0.46	0.34	0.48	0.45	0.10	0.25	0.01	−0.05	−0.06	−0.04	0.07	0.01	0.05	0.00	−0.09	−0.03	0.31	0.36	0.00	−0.02	0.04				
23. Av. seekers' MK	0.36	0.28	0.25	0.11	0.17	0.24	−0.04	0.05	0.25	0.00	0.03	−0.01	0.24	0.08	−0.03	−0.01	0.01	−0.01	0.66	0.51	0.34	0.29	0.07	0.32			
24. Av. sources' MK	0.36	0.30	0.27	0.19	0.23	0.23	0.07	−0.03	0.00	0.24	−0.08	0.19	0.15	0.15	−0.10	0.09	0.02	−0.01	0.50	0.64	0.30	0.33	0.24	0.34	0.52		
25. Av. seekers' proactivity	0.04	0.36	0.00	−0.05	−0.04	−0.08	−0.08	−0.03	0.07	0.05	0.06	0.07	0.11	0.03	−0.18	0.00	0.24	0.04	0.13	0.06	0.19	0.05	0.07	−0.08	0.12	0.05	
26. Av. sources' proactivity	0.06	0.37	0.07	0.12	0.06	0.00	−0.03	−0.02	0.08	0.06	0.03	0.09	0.07	−0.01	−0.01	−0.07	0.05	0.14	0.07	0.06	−0.03	0.16	0.31	0.02	0.06	0.19	−0.01

Note: $N = 462$ directed unit dyads. Av. = Average. MK = metaknowledge. KMS = knowledge management system. TMS = transactive memory system. Seekers and sources refer to boundary spanning knowledge seekers and boundary spanning knowledge sources.

Table IV. MRQAP results predicting intergroup knowledge integration

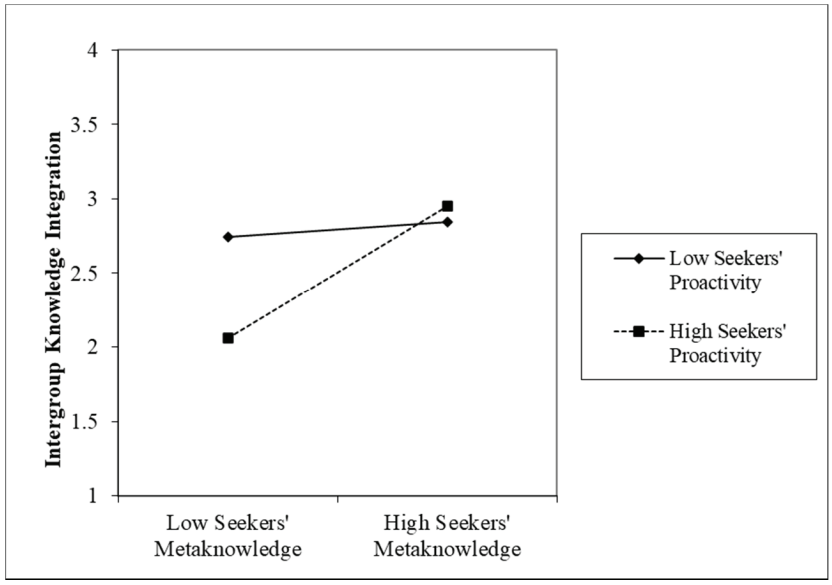
	Model 1		*Model 2*		*Model 3*		*Model 4*		*Model 5*	
	b	***p***	***b***	***p***	***b***	***p***	***b***	***p***	***b***	***p***
Intercept	2.68	0.00	2.65	0.00	2.63	0.00	2.63	0.00	2.65	0.00
Same sector	0.85	0.00	0.69	0.00	0.71	0.00	0.71	0.00	0.67	0.00
Received deliveries	0.20	0.00	0.13	0.01	0.13	0.01	0.13	0.01	0.14	0.01
Sent deliveries	0.18	0.00	0.12	0.01	0.12	0.01	0.12	0.01	0.13	0.01
Size of recipient unit	−0.01	0.79	−0.01	0.70	−0.01	0.70	−0.01	0.70	−0.01	0.71
Size of source unit	0.02	0.24	0.00	0.82	0.01	0.72	0.01	0.73	0.01	0.57
Av. MK of recipient unit	2.21	0.46	1.80	0.53	1.14	0.69	1.12	0.70	1.22	0.66
Av. MK of source unit	1.17	0.42	0.81	0.56	1.05	0.45	1.07	0.44	1.11	0.40
Knowledge exchange density of recipient unit	−7.56	0.29	−6.72	0.34	−5.40	0.43	−5.43	0.42	−5.96	0.37
Knowledge exchange density of source unit	2.93	0.42	1.89	0.58	2.58	0.46	2.61	0.45	3.18	0.34
Av. KMS use of recipient unit	−0.88	0.20	−0.95	0.15	−0.98	0.14	−0.98	0.14	−0.98	0.12
Av. KMS use of source unit	0.08	0.81	0.10	0.74	0.08	0.79	0.08	0.80	0.12	0.69
TMS of recipient unit	−0.30	0.72	−0.44	0.62	−0.42	0.62	−0.43	0.61	−0.35	0.67
TMS of source unit	0.30	0.50	0.23	0.57	0.20	0.63	0.19	0.64	0.22	0.58
Av. proactivity of recipient unit	2.80	0.15	2.99	0.11	3.06	0.10	3.11	0.09	3.33	0.06
Av. proactivity of source unit	−0.14	0.87	−0.15	0.86	−0.26	0.76	−0.27	0.76	−0.33	0.69

Table IV. (Continued)

	Model 1		*Model 2*		*Model 3*		*Model 4*		*Model 5*	
	b	***p***	***b***	***p***	***b***	***p***	***b***	***p***	***b***	***p***
Av. seekers' centrality	0.73	0.34	0.04	0.95	−0.91	0.34	−0.89	0.34	−0.67	0.46
Av. sources' centrality	1.90	0.02	1.25	0.11	1.05	0.23	1.05	0.22	1.29	0.14
Group leader proportion among seekers	−0.27	0.36	−0.17	0.53	−0.28	0.35	−0.27	0.36	−0.27	0.36
Group leader proportion among sources	0.12	0.62	0.23	0.31	0.22	0.35	0.22	0.37	0.28	0.24
Unit leader proportion among sources	0.86	0.16	0.97	0.10	0.95	0.11	1.03	0.10	0.79	0.21
Number of boundary spanning ties			0.08	0.00	0.08	0.00	0.08	0.00	0.08	0.00
Av. seekers' MK					0.79	0.03	0.80	0.03	0.89	0.01
Av. sources' MK					−0.20	0.53	−0.22	0.47	−0.41	0.21
Av. seekers' proactivity							−0.06	0.77	−0.40	0.09
Av. sources' proactivity							0.04	0.83	−0.27	0.16
Av. seekers' MK × Av. seekers' proactivity									1.98	0.03
Av. sources' MK × Av. sources' proactivity									1.93	0.01
R^2	0.34		0.38		0.39		0.39		0.41	

Note: p-values are based on 10,000 permutations. Av. = Average. MK = metaknowledge. KMS = knowledge management system. TMS = transactive memory system. Seekers and sources refer to boundary spanning knowledge seekers and boundary spanning knowledge sources.

(a) Knowledge Seekers



(b) Knowledge Sources

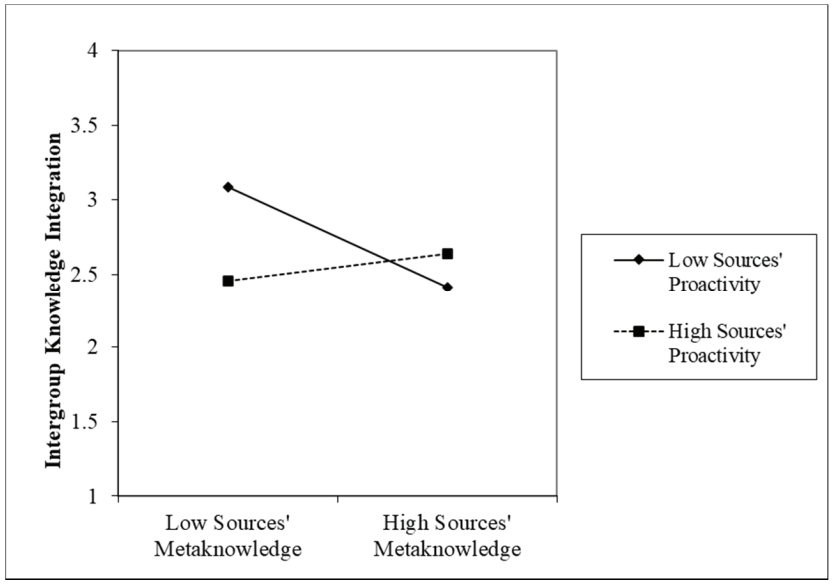


Figure 1. Interaction effects of boundary spanners' proactivity and metaknowledge on intergroup knowledge integration. *Note*. High and low levels of the variables correspond to +1 SD and −1SD, respectively

the effect of sources' metaknowledge is significantly positive. At proactivity levels between −0.14 and 0.79 sources' metaknowledge did not have a significant effect on intergroup knowledge integration.

DISCUSSION

Notwithstanding the critical importance of intergroup knowledge integration as a key source of competitive advantage for organizations (Grant, 1996b; Singh, 2008), our understanding of its micro-foundations has thus far remained limited. Our study contributes to a better understanding of the micro-level antecedents of intergroup knowledge integration by integrating boundary spanning research with group information processing research. Our finding that individual boundary spanning ties matter more for intergroup knowledge integration as the levels of metaknowledge and proactivity of the boundary spanners maintaining these ties increase has several implications for theory and practice.

Theoretical Implications

This study contributes a novel perspective on the role of boundary spanners in the process of intergroup knowledge integration by theorizing about boundary spanners' ability and motivation to stimulate collective processes of knowledge mobilization in the source group and knowledge integration in the recipient group. By integrating the group information processing perspective in our theorizing, our study puts forward propositions that are complementary to those presented in earlier boundary spanning research (Levina and Vaast, 2005; Roberts and Beamish, 2017). For example, while prior research emphasized peripheral participation in both groups as a key ability factor of successful boundary spanners (Levina and Vaast, 2005), our results suggest that a boundary spanner that is strongly embedded within his or her own group while connecting to another group can also make a critical contribution to intergroup knowledge integration.

Furthermore, while we have focused on the boundary spanner as the central cog of the intergroup knowledge integration process, we can also view our results from the vantage point of the boundary spanning tie. Where structural accounts of boundary spanning and intergroup knowledge integration focus on the number and structure of ties connecting two units, our study further suggests that some ties matter more than others: Boundary spanning ties that connect individuals high on metaknowledge and proactivity are particularly valuable for intergroup knowledge integration. In developing theory about how individual agency transforms individual-level boundary spanning ties into intergroup relationships our study furthermore answers calls to explicate bottom-up processes from individual to group level boundary spanning (Marrone, 2010) and contributes to a growing understanding of the multilevel nature of organizational knowledge networks (Moliterno and Mahony, 2011; Phelps et al., 2012).

This study furthermore contributes to literature on transactive memory systems by providing further evidence for the usefulness of considering the variation in group members' metaknowledge levels. While Mell and colleagues (2014) showed that the

presence of a member with a particularly high level of metaknowledge can have positive implications for intra-group knowledge integration and performance, the present work shows that such members can also have a critical influence on intergroup knowledge integration. In the present work we focused on boundary spanners' metaknowledge – that is, an aspect of their individual cognition that holds the potential to engage in productive knowledge retrieval and allocation processes – rather than on their position in the group's knowledge exchange network. On one hand, this represents a more direct test of the cognitive mechanism as implicit in, for example, recent theoretical work arguing that boundary spanners' involvement in transitive knowledge exchange triads would support interteam coordination through the development of the boundary spanners' metaknowledge (Olabisi and Lewis, 2018). On the other hand, disentangling the structural-cognitive and the behavioural components of transactive memory systems – that is, metaknowledge and communication processes (Wegner, 1987, 1995) – remains important given that, while they reciprocally enhance each other (Brandon and Hollingshead, 2004; Lee et al., 2014; Palazzolo et al., 2006), they do not necessarily imply each other.

In showing how individual proactivity affects outcomes beyond the proactive individual and beyond the proactive individual's immediate group, we also contribute to the literature on proactivity in organizations. Proactivity research has thus far primarily focused on outcomes for the individual – for example, performance, career success, and job satisfaction (Crant et al., 2016) – and, in much smaller volume, on outcomes of aggregate group members' proactivity for the focal group's outcomes (Harris and Kirkman, 2016; Williams et al., 2010; Zhang et al., 2021). Conversely, the present study provides evidence for the importance of individual proactivity both for the focal individual's group (when the proactive individual is in a seeker role) as well as – and especially – for other groups that rely on the focal individual's group's knowledge (i.e., when the proactive individual is in a source role). The latter point is particularly salient in the different patterns of results we find for the role of metaknowledge and proactivity on the recipient side and on the source side. While boundary spanning seekers' metaknowledge had a positive effect on intergroup knowledge integration even at moderate levels of proactivity, the effect of sources' metaknowledge was much more dependent on their proactivity. An explanation for this difference can lie in the starting point of seekers and sources in terms of their motivation to invest personal resources in contributing to intergroup knowledge integration. From the perspective of the boundary spanning seeker, investing resources into disseminating externally obtained knowledge in their own group is an activity that is directed towards enhancing the performance of their own group, thus carrying strong intrinsic and extrinsic rewards (Kanfer and Kerry, 2012). Conversely, from the perspective of the boundary spanning source, investing resources into mobilizing other members' knowledge on the seeker's behalf is an activity that is directed towards enhancing another group's performance. Thus, boundary spanning sources arguably start on a lower motivational footing than boundary spanning seekers and, therefore, proactivity becomes a necessary condition rather than an enhancing influence in this situation.

Managerial Implications

Knowledge integration across group boundaries is a critical activity for groups in knowledge-intensive organizations as well as for such organizations as a whole (Grant, 1996b; Hansen, 1999). The ability to combine knowledge stemming from different groups and fields of expertise often results in very tangible implications for the financial bottom line (Gardner, 2015). Our study shows that, in order to achieve productive knowledge integration, it is important to consider group-internal knowledge coordination in the form of members' metaknowledge about each other and group-external knowledge coordination in the form of informational boundary spanning simultaneously. Metaknowledge critically affects the effectiveness of individuals serving as knowledge coordinators in organizational networks (Garner, 2006). Accordingly, our results suggest that where high metaknowledge and boundary spanning activity coincide, groups are in a better position to benefit from each other's knowledge. Such alignment can be achieved via two routes. The first route involves groups' identifying their internal knowledge coordinators and encouraging these members to engage in informational boundary spanning, for instance by formulating boundary spanning as an explicit role of these members (Marrone et al., 2007). The second route involves identifying which members currently are engaged in boundary spanning and developing these members' metaknowledge in order to increase their effectiveness as intergroup liaisons.

At the same time, our results show that boundary spanners' metaknowledge alone can be insufficient to facilitate intergroup knowledge integration: boundary spanners also require the motivation to act upon the opportunity their metaknowledge provides. As indicated by our study, especially proactivity is an important element of boundary spanners' effectiveness, certainly for boundary spanners in recipient units but even more so in source units.

Limitations and Future Research

Despite its contributions, our study has several limitations and boundary conditions that call for future research. First, our theory primarily applies to groups than can be meaningfully linked by knowledge dependencies. These would be groups that form around knowledge intensive tasks – tasks 'requiring an extensive theoretical education and experience', and that 'call for some degree of creativity and adaptation to specific circumstances' (Alvesson, 2004, p. 1) – and between whose knowledge meaningful complementarities exist. Formal groups such as teams, units, departments, or divisions semiformal groups such as task committees, voluntary project teams, or advisory groups (Biancani et al., 2014) in knowledge intensive organizations will often conform to such a description. Informal groups forming around social rather than task-oriented foci will less commonly fall within this scope. Similarly, formal or semi-formal groups working in a less knowledge intensive environment or engaged in simple or routine tasks will likely see less benefit not only from boundary spanning per se, but also from boundary spanner metaknowledge and proactivity.

Second, the cross-sectional nature of our data collection does not allow establishing the causal direction of the found relationships. It is plausible that individual boundary

spanning activity and group-level knowledge integration influence each other in a dynamic interplay over time: While individual boundary spanning contributes to intergroup knowledge integration, such intergroup ties can encourage further interpersonal boundary spanning communication in the future. Future research employing longitudinal and experimental designs will be useful for extending our understanding of these dynamic processes.

Third, while our study setting allowed for collecting unique data on a complete network of interdependent groups on multiple levels of analysis that is well suited to study our research question, it remains a case study within a single organization. Such a study design, albeit typical in research on intra-organizational networks, presents questions of generalizability and strongly relies upon replication and extension in future research.

Lastly, in the present study we focused on the consequences of the alignment of metaknowledge levels and boundary spanning activity for intergroup relations. However, we also note that the suggestion that internal and external knowledge coordination may be most effective when carried out by the same persons may imply trade-offs for other group-internal processes or for the individuals finding themselves in these positions. Groups relying on the catalysing role of members with high levels of metaknowledge (Mell et al., 2014) might suffer when these members increasingly direct their time and attention to boundary spanning activities. The individuals in question might feel overloaded by the simultaneous demands from within and outside of the group (Marrone et al., 2007). In sum, more research is needed to further understand not only what characteristics make individuals effective as boundary spanners but also what factors at the individual, group, and network levels support or oppose them in carrying out this important role.

CONCLUSION

With this study, we advance our collective understanding of the antecedents of intergroup knowledge integration by integrating research on informational boundary spanning with theories of group information processing. We find that boundary spanners' level of metaknowledge about their groups and their levels of proactivity are critical variables affecting the extent to which informational boundary spanning ties contribute to intergroup knowledge integration. The conclusion that some boundary spanning ties matter more for intergroup knowledge integration than others furthermore implies a call for future research adopting a multilevel perspective on organizational knowledge networks. The better we are able to understand the interplay between interpersonal ties, group processes, and intergroup relations, the closer we will get to developing an understanding of the multilevel nature of knowledge coordination in organizations.

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