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The effect of perceptions of exploration and exploitation work activities on dynamic organizational knowledge networks

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ABSTRACT

We examine how perceptions of work activities regarding exploration (i.e., pursuit of knowledge for innovation) and exploitation (i.e., pursuit of knowledge for maximizing the benefits of existing resources) affects how individuals change their knowledge networks. We theorize how network choices regarding dynamic micro-network mechanisms of tie change and stability, reciprocity, and closure are influenced by perceptions of exploration and exploitation work activity. We test our ideas in a dataset comprising 135 employees at three time points in an R&D unit using the actor-based Simulation Investigation for Empirical Network Analysis (SIENA) modeling framework. We find that employees with perceptions of high versus low exploration work activity are more likely to change their network ties, make reciprocal knowledge ties, and have open triadic knowledge networks. Employees with perceptions of high versus low exploitation work activity also are more likely to change their network ties, however, they prefer unreciprocated knowledge ties, and closed triadic knowledge networks.

1. Introduction

Organizations are places in which work-related activities occur that can result in innovative exploration regarding new products, competencies, and processes as well as the exploitative utilization and improvement of existing products, competencies, processes (Hansen et al., 2001; March, 1991). In this paper, we examine whether individuals who perceive their work as having high versus low exploration opportunities as well as high versus low exploitation opportunities will make different choices regarding interactions with other colleagues (Barley and Kunda, 2001). These relational interactions occur within organizational structures that enable and constrain individual and organizational action (Lawrence and Lorsch, 1967; Scott, 1975). The interactions between individuals that create social networks structures have seen considerable research with first a structuralist approach (Mark, 1998; White et al., 1976) and then more recently a renewed consideration for individuals' agency, including the study of their motivation, personality, and behaviors (Casciaro et al., 2015; Kilduff and Krackhardt, 2008; Llopis et al., 2021). Despite this recent research interest in agency, what is still underexplored is the link between the different ways in which individuals engage in work related activities and the social relationships and network structures that they build around them in the workplace (Brass, 1981; Hansen et al., 2001; Kilduff and Brass, 2010; Llopis et al., 2021, are exceptions). The research question we address in this paper is how does the way in which employees engage in work-related activities influence how they change their networks. Specifically, we examine how perceiving work as having high versus low explorative or exploitative opportunities can influence the dynamics of knowledge networks within organizations.

Existing research provides us with some clues as to how people engage with their work from the perspective of exploration and exploitation opportunities, and how this is associated with interpersonal relationships. In a study of research scientists, Perry-Smith (2006) finds that weak ties lead to idea generation, while scientists who had few ties outside the organization were more creative if they occupied central positions within the network of scientists. It has also been shown that individuals who are network brokers—i.e., having network ties to people who themselves do not have a network tie between them—are more likely to hear about good ideas, which can lead to innovation (Burt, 2004). And, more recently, a study on R&D scientists has found that individuals can benefit from interacting with the same formal groups but different individuals within those groups, rather than from brokerage (Ter Wal et al., 2020). In addition, research has shown that a tertius iungens orientation shapes the relationship between research networks

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and innovation (Llopis et al., 2021). However, this line of research tends to neglect that the way in which individuals engage with work can be an antecedent to network position and more generally network change within organizations. One exception is research on how exploration and exploitation task differences influence the way in which individuals shape their networks, with an examination of network size, tie strength, and network density (Hansen et al., 2001). However, this research examined cross-sectional data and does not address network dynamics. Overall, what existing research lacks is an explanation of how individuals' perceptions of the characteristics of their work is associated with the dynamics of individual relational choices, albeit within the constraints of network and organizational structures.

This paper addresses the lack of research on how perceptions of the characteristics of work influences the dynamics of network choices. For characteristics of work, we take as our starting point exploration and exploitation in organizations (March, 1991). While the two concepts originally focused on the strategies of firms (Benner and Tushman, 2003; Ghemawat and Ricart Costa, 1993), business units (e.g., Gibson and Birkinshaw, 2004), and teams (Hansen et al., 2001), they are also relevant to how individuals engage with work in organizations. We define exploration as "the pursuit of new knowledge, of things that might come to be known" and exploitation as "the use and development of things already known" (Levinthal and March, 1993, p. 105). At the individual level, there is burgeoning research on how these two concepts contribute to the understanding of people's work activities and how they relate to patterns of action and interaction in organizational networks (Mom et al., 2007). From an intra-organizational network perspective, we examine the links between how individuals engage with work and the dynamics of individuals' knowledge networks (Argote and Ingram, 2000; Kogut and Zander, 1992; Phelps et al., 2012). We suggest different mechanisms linking the two work characteristics with the network dynamics of knowledge seeking in organizations. Knowledge networks are important in this context because individuals who perceive their work as having a high versus low opportunity for exploration see knowledge as a source of novel ideas (e.g., Burt, 2004); for those who perceive their work as having a high versus low opportunity for exploitation, knowledge is also important because it is associated with improved processes and communication, which are specially relevant in organizational contexts requiring interdependence across teams and departments (Thompson, 1967). We theorize, however, that the interpersonal knowledge network choices that employees make will be different for individuals who perceive their work as having high versus low exploration opportunities and for those who perceive their work as having high versus low exploitation opportunities.[1] We also take into account that in dynamic work environments where the nature of work changes over time an individual's perceptions of their work can also change.

In developing an understanding of how perceptions of work of influence network change, we hypothesize and empirically test how three micro-network mechanisms at the individual (tie churn versus stability), dyadic (reciprocity), and extra-dyadic (closure) levels, are influenced by exploration and exploitation work perceptions. We focus specifically on these three mechanisms because they are at the heart of important debates in the network literature that remain unresolved; they represent a structural topology (Burt, 1982) that illuminates the links between perceptions of work activities and network dynamics. From a social network topological perspective, social structure consists of the coexistence between multiple micro-structural layers of analysis. A structural topology consists of "interrelated sets of relational patterns in a system" (Burt, 1982, p. 63; see also Lewin, 1936), in which opportunities are generated by the intersection between individual network choices (such as choosing tie change compared to stability), dyadic relationships (such as reciprocity) and extra-dyadic configurations (such as triadic open and closed structures). Network ties have generally been considered as beneficial as they give individuals access to more knowledge (Cross and Cummings, 2004; Sparrowe et al., 2001), but the benefits have been brought into question with more ties being linked to relational overload (Cross et al., 2016) and the creation of social liability (Gargiulo and Benassi, 1999). Dyadic reciprocity is illustrative of ties between two individuals that allow for the transfer of complex knowledge (Caimo and Lomi, 2015; Tortoriello et al., 2012); however, reciprocal ties also create a degree of inflexibility in a network that can diminish access to new ideas from other individuals (McFadyen and Cannella, 2004). The benefits of closed and open network structures for knowledge flow revolves around open structures giving access to new ideas (Burt, 2004) and closed structures creating conditions of trust and cooperation that allow for the flow of complex knowledge (Coleman, 1988; Tortoriello et al., 2012).

We test our ideas on the perceptions of work activities and their effect on tie change compared to stability, reciprocated versus unreciprocated ties, and open compared to closed triadic network structures on 135 employees in the R&D unit of a Danish global industrial company. At each of three time points, approximately six months apart from each other, employees completed an online survey that included questions on their knowledge network and perceptions of work activities. As our data are dynamic, we analyzed it using the actor-based Simulation Investigation for Empirical Network Analysis (SIENA) modeling framework in the RSiena software package (Ripley et al., 2024). This stochastic actor-based model (Snijders et al., 2010) assesses whether the network change probabilities are explained by structural properties (such as reciprocity and closure), and individual attributes (such as individual tendencies to perceive work activities as being characterized by exploitation and exploration).

Our study contributes to theory and research on organizational social networks. First, we advance research on the micro-foundations of networking activity (e.g., Tasselli et al., 2015) by specifying the relationship between perceptions of work activity (e.g., Kilduff et al., 2008), and the three interrelated network mechanisms of tie change/stability, reciprocity, and open compared to closed network triadic structures. We clarify how these mechanisms represent a structural topology of individual, dyadic, and extra-dyadic patterns that is contingent upon how individuals perceive and interpret their work. Second, we contribute to the recent research on network dynamics (Cannella and McFadyen, 2016; Chen et al., 2022; Jacobsen et al., 2022; Parker et al., 2023; Sasovova et al., 2010; Soda et al., 2021; Tröster et al., 2019) by providing a relational account of how knowledge is mobilized and shared in organizational networks (Phelps et al., 2012).

2. Theoretical framework

Research suggests that within the same job, employees have different ways of perceiving and enacting work-related activities (Parker, 2007). This aligns with theories of job crafting whereby individuals perceive their jobs in a way that gives them a sense of meaning and identity in the workplace (Wrzesniewski and Dutton, 2001). Similarly, perceptions of work have been shown to include both tasks that are specified by the organization and emergent tasks that are forged by individuals in their role (Ilgen and Hollenbeck, 1991). We follow (Parker, 2007, p. 406) in defining the perceptions an individual has about their work activities as the way in which "types of tasks, goals, and problems they see as relevant to their role; and how they believe they should approach those tasks, goals and problems to be effective". As work consists of actions by individuals and interactions between them (Barley and Kunda, 2001), then individuals' perceptions about their work activities will influence the relational interactions they have. Studying perceptions of work in the context of dynamic social networks gives a clearer understanding of the nexus between patterns of actions and interactions in organizations (Tasselli and Kilduff, 2021).

[1] We examine exploration and exploitation independently. It is possible for an employee to simultaneously perceive their work as high or low on both constructs. We test for and discuss this later in the paper.

In organizations, one important conceptualization of the way in which work is done are the constructs of exploration and exploitation. March (1991, p. 71) describes exploration as being "captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation" and exploitation as "refinement, choice, production, efficiency, selection, implementation, execution." March and colleagues' ideas on exploration and exploitation (March, 1991; Levinthal and March, 1993), inspired organizational-level research on organizational learning (Crossan et al., 1999; Vera and Crossan, 2004), strategy (Rosenbloom, 2000) and technological innovation (Subramanian and Youndt, 2005; Tushman and O'Reilly, 1996), as well as research on teams (Hansen et al., 2001). Building on recent work at the individual level (Mom et al., 2007), we advance research on exploration and exploitation by showing that these constructs can be conceptualized with respect to how individuals perceive the work that they do within an organization. The need to search for and discover new knowledge is explicit in the definition of exploration and therefore it will affect how individuals with high versus low exploration work perceptions develop their knowledge networks. The exploitation of competencies and processes implicitly suggests that knowledge is critical for the development and improvement of these existing competencies and processes and will affect how individuals with high versus low exploitation work perceptions utilize their knowledge networks. However, the way in which individuals that have high versus low exploration and exploitation work perceptions utilize their knowledge networks is not necessarily the same and we develop a set of hypotheses that examine the changes in knowledge networks based upon different perceptions of an individual's work.

In seeking to understand the relationship between individuals' work perceptions and the dynamics of the knowledge network, we examine three mechanisms to help us develop a set of hypotheses. These mechanisms represent an integrated topology that starts from the analysis of an individual ego network to higher levels of structuration. First, a tendency for individuals to change their networks compared to not changing them. Second, a tendency for reciprocity whereby individuals choose to give knowledge to those they receive knowledge from (or they choose not to reciprocate) (Blau, 1964; Caimo and Lomi, 2015). Third, a tendency for closed triadic network structures where people develop knowledge ties with the colleagues of individuals they already have knowledge ties with (or they choose to have open network where they choose not to seek out knowledge from individuals their existing knowledge ties are connected to) (Agneessens and Wittek, 2012; Burt, 2004; Simmel, 1950). Each of these mechanisms relates to tendencies of individuals, but cumulatively they influence the overall position in the network of people with specific perceptions about their work and the topology of the network itself.

2.1. Dynamics of knowledge seeking ties

Having high exploration work perceptions suggests a continuous search for new knowledge. Individuals will undertake extensive search activities and will seek out new relationships for knowledge, i.e., their knowledge satisficing bar will be relatively high (March and Heath, 1994; Simon, 1955). However, these search activities take time and energy which is not in infinite supply. Therefore, in the search for new knowledge individuals who perceive their work as having high exploration opportunities will need to make decisions concerning the time and energy they invest in existing knowledge ties. We theorize that individuals with high exploration work perceptions make a trade-off by dropping some of their existing knowledge ties and by doing so this frees up more time and energy to pursue knowledge through the development of new knowledge ties. In contrast, individuals with low exploration work perceptions have less need for new ideas and will not change their knowledge ties. While knowledge may still be important these individuals will have a tendency to go to tried and tested sources of knowledge and they will be less likely to have a preference for changing their knowledge ties.

Hypothesis (H1). *Individuals who have higher exploration work perceptions will have a higher tendency to change their networks compared to those with lower exploration work perceptions.*

Individuals with an exploitation perception of their work activities value knowledge but also need to manage the amount of time and energy used in acquiring knowledge. Exploitation perceptions of work suggest that an individual perceives the opportunity to improve existing competences, processes, and products (March, 1991) and refining the use of existing knowledge (Levinthal and March, 1993). Therefore, an individual perceiving their work activities to be characterized by exploitation will focus on developing new knowledge resources to help them improve existing competences, processes, and products. This drive for improvement will lead them to change their knowledge networks in order to obtain new advice. Alternatively, individuals that do not perceive their work as being characterized by exploitation of existing processes and routines will be less likely to have a preference for changing their knowledge ties.

Hypothesis (H2). *Individuals who have higher exploitation work perceptions will have a higher tendency to change their network compared to those with lower exploitation work perceptions.*

2.2. Dynamics of reciprocal knowledge seeking ties

Individuals with perceptions of their work as having high exploration opportunities have a desire for new knowledge and ideas which leads them to invest time and energy into making knowledge-based relationships. They are themselves a source of knowledge and it is highly likely that some colleagues will seek them out for knowledge. Individuals with perceptions of their work as having high exploration opportunities will see an opportunity and will reciprocate these relationships and seek knowledge from those that already come to them, at least until they have maximized the benefits from these ties. Reciprocal ties entail an investment by each person involved in the relationship (Blau, 1964). This commitment increases the likelihood that the transfer of sticky and richer knowledge will occur which is beneficial for individuals with perceptions of their work as having high exploration opportunities. Prior research supports the idea that reciprocal ties are beneficial for the sharing of complex or tacit knowledge (Caimo and Lomi, 2015). However, reciprocal ties can result in over-investment in individuals as they may originally have been beneficial, but over time the benefits can wane while the commitment continues. Nevertheless, we hypothesize that individuals with perceptions of their work as having high exploration opportunities will have a tendency to form reciprocal ties as the initial benefits of accessing sticky tacit knowledge outweigh any potential drawbacks.

In contrast, individuals with perceptions of their work as having low exploration opportunities have less need to access sticky knowledge as they don't perceive their work requiring new ideas and innovation. Therefore, for those with perceptions of low exploration opportunities there is less need for reciprocal ties.

Hypothesis (H3). *Employees with a higher exploration work perception will be more likely to reciprocate knowledge ties than those with a lower exploration work perception.*

Individuals with perceptions of their work as having higher exploitation opportunities will focus on conducting tasks within the bounds of existing routines and processes (March, 1991). The knowledge that is needed is more likely to be explicit rather than sticky (Szulanski, 2002). This type of knowledge is likely to be freely exchanged without the need for reciprocal relationships being built. There is also less uncertainty regarding the quality of explicit knowledge (Gilsing, 2003) and it is relatively easy to access elsewhere as well as to verify its accuracy. Hence, there is little need for developing trust between individuals that

is often found in ties that are reciprocal.

In contrast, individuals with a lower exploitation work perception will still have a need for knowledge to do their work. As theorized in Hypothesis 2, they are likely to go to tried and tested sources of knowledge which over time are more likely to become reciprocated ties. Overall, we suggest that individuals who perceive their work as having high exploitation opportunities compared to low exploitation work perceptions are less likely to have a preference for reciprocal ties.

Hypothesis (H4). *Employees with a higher exploitation work perception will be less likely to reciprocate knowledge ties than those with a lower exploitation work perception.*

2.3. Dynamics of open and closed triadic knowledge networks

We theorize that individuals with higher exploration work perceptions will have a preference for open networks, expanding their knowledge seeking from colleagues belonging to new social groups. This aligns with the considerable amount of research on the exploration benefits of being in brokerage positions in the network (Burt et al., 2013). This is also supported by research indicating that triadic network structures originate from individual propensities and dyadic structural regularities (e.g., Brass et al., 2004). Specifically, brokerage positions increase the likelihood that individuals can access a diverse range of new ideas (Burt, 2004). Being in a brokerage position has also been shown to increase the attractiveness of an individual's ideas when discussing them with others (Nerkar and Paruchuri, 2005). Prior research on open compared to closed networks is not uniform. For example, implementation of new ideas has been shown to work better with closed networks (Obstfeld, 2005). However, without access to new ideas in the first-place implementation is of little benefit. In addition, network structures have been shown to change over time with the open networks that give brokers greater access to new ideas closing around them, but with the broker developing new ties to re-establish a more open network structure (Sasovova et al., 2010). Overall, we hypothesize that individuals who perceive their work as having high exploration opportunities compared to those who perceive their work as having low exploration opportunities will tend to make ties to individuals that are not connected to the people they already have a knowledge tie with, i.e., they will make fewer third-party ties within triadic network structures and hence will maintain open network-structures. We hypothesize the following:

Hypothesis (H5). *Employees with a higher exploration work perception will be less likely to make third-party knowledge ties than those with lower exploration work perception.*

The focus on exploitation of existing processes suggests that all individuals who participate in a specific work process should be operating with the same agreed upon knowledge. Therefore, it is expected that individuals with perceptions of their work having high exploitation opportunities will have a tendency for closed triadic networks where people share knowledge around a specific work process to improve the exploitation of existing processes related to the work that is being completed (Coleman, 1988; Gargiulo et al., 2009). With this type of work there is a need for knowledge similarity and confirmation within a cluster of people of what best practices are with regard to a given process. Here redundant knowledge is useful because it promotes a common understanding. Therefore, individuals who perceive their work as having high versus low exploitation opportunities will have a tendency to make ties to individuals who have ties to those they are connected to, i.e., to make third party ties, and hence to close network triadic structures around them. We hypothesize the following:

Hypothesis (H6). *Employees with a higher exploitation work perception will be more likely to make third-party knowledge ties than those with a lower exploitation work perception.*

3. Methodology

3.1. Research context and data

We tested our hypotheses in a research and development unit of a global industrial company. The R&D unit was located in Denmark. Employees include managers, engineers and technicians who collaborated on product developments and customer driven product adjustment. In many instances they developed tailor-made solutions based upon the specific needs of each customer. Examples of these projects include retrofitting large-scale industrial complexes with environmentally friendly cooling or refrigeration and providing smart-office automation using artificial intelligence. During the period of our study the unit was not subject to any notable organizational change initiatives or leadership change. In initial discussions with members of the unit about the work that they did, employees indicated that the network of knowledge relationships was critical in helping them complete their work. The work tended to be project-based with individuals moving from one project to another relatively frequently. As employees moved from project to project the perceptions of the type of work they did were likely to change as well as their needs for specific types of knowledge. This created a dynamic aspect to whom they reached out to for knowledge, with employees changing knowledge ties throughout the period of our study. In addition, the work that the managers, engineers, and technicians were asked to do incorporated tasks that were tailor-made for the customer, these emergent tasks also increased the opportunity for variation in individuals' perceptions of their work. Overall, the setting is an appropriate one for our study of how perceptions of work, notably exploration and exploration, influences the choices that individuals make regarding whom they reach out to for knowledge within a unit, and how these choices change over time.

Our survey instrument was administered to all members of the R&D unit at three time points, over a 13-month period. Each survey was approximately six months apart. The six-month time intervals were to allow enough time for network change to take place but not too far apart so that there was no relation between one time period and another. Similar time frames have been used in prior research (e.g., Agneessens & Wittek, 2012; Mirc and Parker, 2020; Schulte et al., 2012). Prior to being distributed the survey received university ethical approval. The survey instrument was administered via email that included a link to the questions. As part of the survey, we included a confidentiality statement indicating that individual responses would not be shared with the organization. The participants were first asked to read a participant information sheet. At the end of the information sheet, participants were asked to agree that they wished to proceed. Therefore, each participant had the opportunity to withdraw from the data collection. Each round of data was collected over a three-week period and after the initial survey was distributed employees were twice prompted to complete the survey.

The survey instrument consisted of social network questions and work environment questions. Our social network data were collected using the roster method, which we detail below, in the variables section (Marsden, 1990). We administered the survey instrument in Danish and then translated into English here. The organization provided us with additional HR information, including gender (female = 30 %, male = 70 %), education (2-year technical college = 42 %, 3–4 year university or above = 58 %), tenure (mean = 176 months), and assigned role (manager = 33 %, engineer = 55 %, and technician = 12 %). Employees were divided into 11 job functions, e.g., engineering, manufacturing, and logistics (average employees per job function = 12, with min = 2 and max = 24).

The R&D unit consisted of 135 individuals over the 13-month period of the data collection, with 118 employees at Time 1 (T1), 119 at Time 2 (T2), and 126 at Time 3 (T3). 109 individuals were in all three time periods, with 17 joining the unit and nine leaving the unit during the 13 months of our data collection. The response rate for the people surveyed in each of the time periods was 93 % (n = 110) in T1, 96 % (n = 114) in

T2, and 96 % (n = 114) in T3. Our network analysis consisted of 13,806 dyadic relationships in T1, 14,042 in T2, and 15,750 in T3, these counts exclude those that had not joined or those that had left prior to a specific data collection point.

3.2. Analysis

As our hypotheses examine the relationship between having higher versus lower perceptions of exploration and exploitation work opportunities and the network dynamics of knowledge seeking, we conducted our analysis using the actor-based Simulation Investigation for Empirical Network Analysis (SIENA) modeling framework in the RSiena software package (Ripley et al., 2024). The SIENA framework is appropriate for our analysis, as one of the key assumptions of this stochastic actor-based model is that individuals are presumed to control their relationship choices (Snijders et al., 2010). The model assesses the extent to which an individual keeps an existing tie, adds a tie, drops a tie, or does not add a tie. These individual actor-based decisions regarding relationships depend upon an individual's attributes, the attributes of others, an individual's position in the network, and their perceptions of the position of others in the network (Kalish, 2020; Snijders et al., 2010). The SIENA framework takes into account structural tendencies such as reciprocity and closure, and individual demographics and work attributes such as gender, tenure, and exploration/exploitation work perceptions. Other assumptions of the model include relationship change being continuous and being a function of a Markov process (Kalish, 2020; Snijders et al., 2010).

3.2.1. SIENA model

In a SIENA model two processes are simultaneously modeled; the actors change opportunity and change determination. The change opportunity is the expected rate of considering change in individuals' relationships (i.e., change frequency) and is modeled as a rate function. The change determination is the probability of individuals changing their network in a certain way and is modeled as an objective function using micro-steps (i.e., as one relational change at a time). For each micro-step, an individual is selected randomly and all possible changes to his or her network are simulated, e.g., dropping an existing tie, adding a tie, or doing nothing, with regard to maximizing his or her objective function.

The objective function for the network is as follows:

$$fi(\beta, x) = \sum_{k} \beta_k S_{ki}\,(x)$$

In the equation, i is the focal actor and $f_i\ (\beta,x)$ is the objective function for i with x being the network. The functions $S_{ki}\ (x)$ are the effects on the network from the perspective of the focal actor i, for example, the tendency of ties in a network to be transitive or the tendency of people with a certain individual characteristic, e.g., being female, to engage in a relationship (versus disengage from it). Finally, β_k is the statistical parameter in the model or the weight. The significance of a parameter is calculated by comparing the t-ratio (estimated parameter divided by standard error) to a standard normal distribution.

3.2.2. Missing data in SIENA models

Longitudinal network data are sensitive to missing data; therefore, we followed the accepted practice for SIENA models and allowed RSiena to manage missing data internally (Ripley et al., 2024). The missing data is imputed for the simulations during the parameter estimation but is not directly used for the parameter estimation. This method has been shown to best decrease bias in the estimates when there is missing data of less than 20 % (Huisman and Steglich, 2008; Krause et al., 2018). In addition, at T2, we have six new people and five who left the organization. Similarly, in T3, we have 11 new people and four people who exited the organization. These changes in employees in the R&D unit mean that in some instances it is not possible to have a tie between two individuals. To account for the employees joining and leaving we use the composition change method in RSiena as this is the preferred method for joiners and leavers (for further details see Ripley et al., 2024).

3.3. Variables

3.3.1. Knowledge network

Our focal network variable is the probability of observing change in the knowledge network. To measure knowledge ties employees were asked to answer the following question about each member of the R&D unit: "In the past 6 months, I have sought out this person for skills and knowledge that I need to perform my job well." The respondents could then choose from the following options: (0) never; (1) less than once a month; (2) a few times a month; (3) a few times a week; (4) daily. We dichotomized the responses at two and above in order to ascertain the knowledge ties based on importance (Marsden and Campbell, 1984) and to meet with SIENA model requirements for binary network data.

3.3.2. Exploration and exploitation variables

For exploration and exploitation, we used the scales developed by Mom and colleagues (2007). At each of the three time points we asked, "To what extent in the last 6 months did you engage in work related activities that can be characterized as follows." There were five items in the exploration scale including, "Searching for new possibilities with respect to solutions, products, processes or markets" and "Activities requiring you to learn new skills or knowledge." There were six items in the exploitation scale including "Activities which serve existing (internal) customers with existing services/ products" and "Activities which clearly fit into existing company policy." Answer options for both were (1) to a very small extent; (2) to a small extent; (3) to a moderate extent; (4) to a large extent; and (5) to a very large extent. We conducted a principal components analysis (PCA) and found that including all of the items did not result in a clear division into two factors. By utilizing four items from each of the scales there was a much clearer loading into two factors in two of the three time periods. The results of the PCA are detailed in Table A1 in the Appendix. We conducted a reliability analysis for the exploration scale with a Cronbach's alpha for the exploration items of $\alpha = 0.74$ at T1, $\alpha = 0.76$ at T2, and $\alpha = 0.75$ at T3. The four-item scale for the exploitation scale had a Cronbach's alpha score of $\alpha = 0.68$ at T1, $\alpha = 0.71$ at T2, and $\alpha = 0.63$ at T3.[2] The PCA and Cronbach's alpha scores for exploration are acceptable, those for exploitation could be stronger across the three time points. We discuss this further in the limitations section. Exploration and exploitation variables are included in the model as changing covariates. We include ego effects where individuals with a higher/lower level of exploration or exploitation are more likely to seek out more/fewer individuals for knowledge. We also include *alter* effects where individuals with a higher/lower level of exploration or exploitation are more likely to have more/fewer individuals seeking them out for knowledge. In addition, we include a *similarity* effect where a positive parameter indicates that individuals with similar levels of exploration or exploitation have a tendency to form knowledge ties. Details of the interaction variables included in our analysis for exploitation and exploration are below.

3.3.3. Structural network variables

We follow the suggested practice of having variables for outdegree, reciprocity, transitivity, and degree distributions (Ripley et al., 2024; Snijders et al., 2010). *Outdegree* accounts for the overall tendency for people to make knowledge ties to others in the network and is equivalent to an intercept in a logit regression model. Our measure of *reciprocity* accounts for the focal individual's tendency to obtain knowledge from

[2] In Table 3 only exploration and exploitation data from T1 and T2 are used in the model. In Table A2 in the appendix the T3 data is used in the behavioral part of the model.

the same colleagues that obtain resources from them (Blau, 1964). Our measures of transitivity are *transitive triplets* and *three-cycles*. In the case of *transitive triplets*, if individual *i* has a tie to individual *h*, and individual *h* has a tie to individual *j*, then there is a preference for the focal actor *i* to have a tie to *j* (Ripley et al., 2024). Our measure of *three-cycles* takes into account generalized exchange (Block, 2015), with ties from *i* to *h*, *h* to *j*, and *j* to *i*. Our degree distribution variables include *outdegree activity* which accounts for the tendency of people to seek out many colleagues—i.e., to become central in the network—and for this tendency to continue even when they have many network ties. As preferential attachment effects may determine how the network changes (Rivera et al., 2010), we include *indegree popularity* which accounts for the tendency of popular individuals to attract additional coworkers to them. Preferential attachment (Merton, 1968) can occur because an individual is known to have important resources, or for other reputational reasons. *Outdegree popularity* accounts for the tendency of actors to send ties to those who have many outgoing ties. We include two additional variables in *reciprocal degree popularity* (square root) and *inverse outdegree* (see Ripley et al., 2024, for details), which help with the goodness of fit of the model (see below for additional information on goodness of fit).

3.3.4. Covariate control variables

We also control for specific demographics and attributes of the individuals in the R&D unit. It has been shown that attributes of individuals such as tenure, affect network behaviors such as a tendency for seeking out more/fewer ties (ego effects) or attracting more/fewer ties from others (alter effects). Variables designated as *same* or *similar* account for the tendency for people with the same (or similar) attributes to have ties with each other. To control for whether an employee's assigned role influences their network tendencies we use the three categories that the firm divided members of the R&D department into. First, managers, which includes managers for products, production, R&D engineering, quality, and logistics. Second, engineers, which includes CAD engineers, design engineers, R&D engineers, project engineers, and software engineers. Third, technicians, which includes manufacturing assistants and technicians. We created two dummy variables for manager and technician and treat engineer as the reference category.[3] The *manager alter* and *manager ego* variables control for whether people form more ties with managers than with engineers or whether managers form more ties than engineers, respectively. The *technician alter* and *technician ego* variables control for whether people form more ties with technicians as opposed to engineers, and whether technicians form more ties than engineers. In addition, we include *tenure alter* and *tenure ego* since an individual who has greater tenure likely has more industry experience and could attract others to them while seeking out fewer colleagues. We include *education alter* and *education ego* since an individual who has more education may have more skills and could attract others to them while seeking out fewer colleagues. We include *gender alter* and *gender ego* since gender has shown to influence network choices (Ibarra, 1992). Since people are more likely to create or maintain relationships with people who are similar to them (McPherson et al., 2001) we account for homophily based on tenure (*tenure similarity*), gender (*same gender*), education (*same education*), assigned role (*same manager, same technician*), and for individuals in the same job function (*same job function*).

3.3.5. Interaction variables

To measure the extent to which employees change their networks compared to keeping them stable we interact *exploration ego* and *exploitation ego* with the rate function. The rate function accounts for the change opportunity in the knowledge network. In addition to hypothesizing the tie change effects of *exploration ego* and *exploitation ego* we also hypothesize how the ego variables interact with reciprocity and transitive triplets. A positive parameter indicates that an individual with a high level of exploration or exploitation has a tendency to form ties that result in reciprocity or transitivity. First, we include a measure of *exploration ego x reciprocity* to measure the extent to which employees with high/low exploration work perceptions tend to make more/fewer reciprocal ties. Second, we have a measure of *exploration ego x transitive triplets* to account for individuals with high/low exploration work perceptions having a tendency to create open versus closed networks. Each of these interactions are also included for exploitation work perceptions.

4. Empirical results

4.1. Descriptive statistics and network change

In Table 1 we detail the descriptive statistics and correlations for the three time periods. The exploration and exploitation variables do correlate with each other indicating they are not separate traits but as the PCA indicated they do in general load into two factors and are not the opposite ends of a single trait. The measure of reciprocity is in general not correlated with exploration or exploitation; the exception is for exploration T3. Constraint (Burt, 1992), which we have included in the correlation table as it is a frequently used measure of open versus closed networks, is negatively correlated to both exploration and exploitation in some of the time periods.

In Table 2 we include details of the tie changes over time in the knowledge network. We find that there is a decrease in newly created and maintained ties and an increase in terminated ties over time. We measure the network change over the three periods using a Jaccard coefficient. If all ties change it is zero and if no ties change it is 1 (Snijders et al., 2010). In the knowledge network, the Jaccard coefficient is 0.50 for T1 to T2 and 0.45 for T2 to T3. This is within the acceptable range for SIENA models (Ripley et al., 2024).

We estimate our model using the SIENA framework. In the model it is important to attain good convergence of the algorithm to ensure there are stable parameter estimates. Convergence is calculated from the t-ratios which examine the difference between the estimated parameter value and simulated parameter estimates, ideally the difference would be zero (Kalish, 2020). In our case, the convergence t-ratio are for each parameter are all less than 0.06, which is below the acceptable figure of 0.10 and the overall maximum convergence ratio (average deviation/-standard deviation) is 0.17, which is below the suggested maximum figure of 0.25 (see Ripley et al., 2024, for additional details). Therefore, we conclude that we have a model with acceptable convergence. We ran goodness of fit tests which examine the fit of the model compared to effects that were not directly modelled, such as the global structure of the network over time (Kalish, 2020). The goodness of fit test compares the observed data to the simulated data in the estimated model and calculates Monte Carlo Mahalanobis distance test p-values. An appropriate goodness of fit occurs when the simulated distributions are not significantly different from the observed distributions (Kalish, 2020). In our model we examined the distributions of four global network structure effects: indegree, outdegree, geodesic distances, and triad census, over time. We calculated the goodness of fit p-values for indegree (.589), outdegree (.480), geodesic distances (.458), of the network, the p-values are all above .05 and are considered acceptable for the goodness of fit of the model (Ripley et al., 2024). However, the triad census goodness of fit is .000. A close examination of the triad census indicates the only triad

[3] In additional analysis we used different categories as the reference category. There was no notable change in our variables of interest.

Table 1
Descriptive statistics & correlations.

	M	SD	1	2	3	4	5	6	7	8	9
1. Exploration T1	3.39	0.73									
2. Exploration T2	3.33	0.73	.468**								
3. Exploration T3	3.40	0.72	.542**	.633**							
4. Exploitation T1	3.85	0.59	.334**	.063	.120						
5. Exploitation T2	3.77	0.59	.212*	.485**	.417**	.369**					
6. Exploitation T3	3.77	0.59	.127	.224*	.284**	.368**	.568**				
7. Outgoing knowledge T1	24.25	17.59	.171	.206*	.121	.064	.084	−.029			
8. Outgoing knowledge T2	24.99	17.19	.079	.179	.219*	.144	.104	.077	.766**		
9. Outgoing knowledge T3	21.35	16.54	.020	.135	.114	.027	−.008	.044	.747**	.802**	
10. Reciprocity T1	0.38	0.18	−.091	.179	.141	−.128	.075	.076	.434**	.246*	.249*
11. Reciprocity T2	0.38	0.17	.006	.178	.197*	−.093	.093	.090	.368**	.479**	.293**
12. Reciprocity T3	0.32	0.17	.028	.118	.151	.026	.142	.130	.116	.206*	.278**
13. Constraint T1	0.21	0.18	−.219*	−.180	−.167	−.210*	−.183	−.093	−.294**	−.220*	−.166
14. Constraint T2	0.19	0.18	−.122	−.113	−.252**	−.225*	−.067	−.066	−.192*	−.431**	−.230*
15. Constraint T3	0.22	0.16	−.145	−.121	−.224*	.100	.057	.059	−.319**	−.449**	−.442**
16. Education (0 = tech, 1 = univ)	0.58	0.50	.169	.194*	.239**	−.030	.026	.098	.053	.134	.111
17. Gender (0 = male; 1 = female)	0.30	0.46	−.161	−.102	−.161	.058	.079	.091	−.209*	−.239*	−.136
18. Tenure	175.73	133.08	−.139	−.093	−.147	.160	.083	.182*	−.065	.022	−.026
19. Role (1 = technician)	0.12	0.32	−.189*	−.085	−.180	.081	.022	.025	−.248**	−.234*	−.184
20. Role (1 = engineer)	0.55	0.50	−.103	−.176	−.066	−.132	−.152	−.114	−.058	−.031	.021
21. Role (1 = manager)	0.33	0.47	.237*	.249**	.192*	.084	.149	.105	.234*	.197*	.104
	10	11	12	13	14	15	16	17	18	19	20
10. Reciprocity T1											
11. Reciprocity T2	.589**										
12. Reciprocity T3	.422**	.469**									
13. Constraint T1	.003	−.053	.030								
14. Constraint T2	.023	−.108	−.019	.231*							
15. Constraint T3	.034	−.167	−.137	.127	.487**						
16. Education (0 = tech, 1 = univ)	−.005	.004	−.031	−.065	−.081	−.090					
17. Gender (0 = male; 1 = female)	−.051	.004	.102	.069	.138	.164	−.234**				
18. Tenure	−.205*	−.152	−.081	.039	−.076	.056	−.224**	−.067			
19. Role (1 = technician)	−.184*	−.136	−.032	−.015	.007	.157	−.383**	.364**	.191*		
20. Role (1 = engineer)	.002	−.017	−.131	.208*	.150	.099	.038	.035	−.191*	−.404**	
21. Role (1 = manager)	.126	.110	.160	−.211*	−.166	−.208*	.223**	−.287**	.071	−.259**	−.779**

*p < 0.05
**p < 0.01

Table 2
Tie changes over time.

	T1 to T2	T2 to T3
Maintain tie	1816 (11 %)	1574 (10 %)
Create tie	991 (6 %)	804 (5 %)
Terminate tie	831 (5 %)	1130 (7 %)
Null tie	13262 (78 %)	12824 (79 %)
Jaccard Coefficient	0.50	0.45

that is not a good fit is 120 C which is transitive reciprocated triplets.[4] We conclude that the simulated networks are a reasonable fit with respect to the observed network data.

In Table 3, we detail the parameter estimates for our model. The significance of a parameter is calculated by comparing the t-ratio (estimated parameter divided by standard error) to a standard normal distribution. The rate parameter is marginally higher (30.206) in the first period compared to the second period (26.357) indicating that there was slightly more opportunity for change between T1 and T2 than between T2 and T3. In our network structure variables, we have a positive effect for the *reciprocity* parameter (β = 1.290; p < .001) indicating an overall preference for knowledge to be exchanged within dyads. Similarly, the positive *transitive triplets* parameter (β = 0.052; p < .001) indicates a preference for individuals to engage with others that have ties to similar third-parties. The positive *three-cycles* parameter (β = 0.035; p < .01) suggests a tendency for generalized exchange of knowledge. *Indegree popularity* (β = 0.022; p < .001) is positive and accounts for the tendency for actors that have many others seeking them for knowledge to attract additional others over time. *Outdegree popularity* (β = −0.054; p < .001) is negative indicating that actors with high outdegrees are less attractive to others as sources of knowledge than those with low outdegrees. *Outdegree activity* (β = 0.002; p < .05) is positive and accounts for the tendency for actors who seek many knowledge ties to continue with this tendency over time.

The results for our individual attribute control variables indicate a positive *same job function* parameter (β = 0.505; p < .001) indicating a preference for employees to seek knowledge from individuals within their own job function as opposed to from individuals in other job functions. This aligns with previous research (e.g., Lomi et al., 2014). *Same education* is positive and significant (β = 0.093; p < .01) indicating a preference for knowledge ties to people with the same level of education. *Same gender* is also positive and significant (β = 0.077; p < .05) indicating a preference for knowledge ties to people with the same gender. There is a positive gender ego parameter (β = 0.106; p < .05) indicating a preference for females to seek out knowledge ties when compared to males. *Education ego* is positive and significant (β = 0.078; p < .05) indicating people with more education have a higher preference for knowledge ties. There is a negative tenure ego parameter (β = −0.0004; p < .01) indicting that for employees with higher tenure there is a tendency to have fewer knowledge ties than those with lower tenure. *Manager alter* (β = 0.106; p < .001) is positive, indicating that individuals are more likely to come to managers for knowledge as opposed to the comparison category of engineers. *Manager ego* (β = −0.068; p < .10) is negative, indicating that managers are less likely to seek out

[4] If we include the triadic effect for transitive reciprocated triplets this improves our goodness of fit for the triadic census with a p-value above .05. However, it makes the interaction effects that we test in our model more difficult to interpret. As there is limited change in the hypothesized effects in the model, the exploitation on rate effect does become marginally significant, we have omitted the transitive reciprocated triplets effect from the final model.

Table 3
SIENA estimation results of the change in the knowledge network.

Effect	Parameter	Sig.	(s.e.)
Rate parameters			
rate parameter period 1	30.206		(1.265)
rate parameter period 2	26.357		(1.043)
Structural effects			
outdegree	−1.874	***	(0.109)
reciprocity	1.290	***	(0.055)
transitive triplets	0.052	***	(0.005)
three-cycles	0.035	**	(0.013)
indegree popularity	0.022	***	(0.004)
outdegree popularity	−0.054	***	(0.006)
outdegree activity	0.002	*	(0.001)
reciprocal degree popularity	0.101	†	(0.059)
inverse outdegree	3.003	**	(0.993)
Attribute effects			
education alter	0.010		(0.036)
education ego	0.078	*	(0.035)
same education	0.093	**	(0.032)
gender alter	0.065		(0.043)
gender ego	0.106	*	(0.045)
same gender	0.077	*	(0.038)
tenure alter	0.0000		(0.0001)
tenure ego	−0.0004	**	(0.0001)
tenure similarity	0.083		(0.074)
same job function	0.505	***	(0.045)
technician alter	−0.105	**	(0.034)
technician ego	0.069	*	(0.035)
same technician	−0.171	**	(0.057)
manager alter	0.106	**	(0.034)
manager ego	−0.068	†	(0.035)
same manager	0.051		(0.035)
exploration alter	−0.001		(0.012)
exploration ego	0.007		(0.022)
exploration similarity	−0.010		(0.090)
exploitation alter	−0.007		(0.015)
exploitation ego	0.028		(0.029)
exploitation similarity	0.303	**	(0.101)
Hypothesized effects			
exploration on rate	0.091	***	(0.020)
exploitation on rate	0.048	†	(0.027)
exploration ego x reciprocity	0.168	***	(0.046)
exploitation ego x reciprocity	−0.289	***	(0.063)
exploration ego x transitive triplets	−0.006	***	(0.001)
exploitation ego x transitive triplets	0.004	*	(0.002)

† $p < 0.1$;
* $p < 0.05$;
** $p < 0.01$;
*** $p < 0.001$

knowledge compared to engineers. *Technician ego* ($\beta = 0.069$; $p < .05$) is positive, indicating that technicians are more likely to seek out others for knowledge compared to engineers. *Technician alter* ($\beta = -0.105$; $p < .001$) is significant, indicating that individuals are less likely to come to technicians for knowledge compared to engineers. *Same Technician* ($\beta = -0.171$; $p < .01$) is significant, indicating that technicians don't have a tendency to go to each other for knowledge. The exploration and exploitation ego and alter effects are not significant. However, there is a positive and significant effect for exploitation similarity ($\beta = 0.303$; $p < .01$).

4.2. Hypothesized effects

As shown in Table 3, the interaction of the *rate* with the *exploration ego* parameter ($\beta = 0.091$; $p < .001$) is positive and significant which indicates that actors with higher exploration work perceptions have a higher tendency to change their knowledge ties than do those with lower exploration work perceptions. This finding supports Hypothesis 1. The *exploitation ego* parameter ($\beta = 0.048$; $p < .10$) is marginally significant, which indicates that actors with higher exploitation work perceptions have a higher tendency to change their knowledge ties than do those with lower exploitation work perception. Therefore, there is some support for Hypothesis 2 that actors with higher exploitation work perceptions tend to change their network ties more frequently than employees with lower exploration work perceptions.

There is a positive interaction effect between *exploration ego* and *reciprocity* ($\beta = 0.168$; $p < .001$), which lends support for Hypothesis 3. Individuals who have higher exploration work perceptions have a higher preference for reciprocated knowledge ties, compared to those with lower exploration work perceptions, allowing for a rich exchange of knowledge within the dyad. In contrast, there is a negative parameter for the interaction of *exploitation ego* and *reciprocity* ($\beta = -0.289$; $p < .001$), indicating that people with higher exploitation work perceptions have a lower tendency to reciprocate ties, compared to those with lower exploitation work perceptions. This finding supports Hypothesis 4 and suggests that those with higher exploration work perceptions prefer transactional non-reciprocated knowledge ties.

The findings for transitivity indicate a negative interaction effect between *exploration ego* and *transitive triplets* ($\beta = -0.006$; $p < .001$), indicating a tendency for open knowledge networks. This lends support to Hypothesis 5 that individuals with higher exploration work perceptions prefer open knowledge networks compared to those with lower exploration work perceptions. In contrast, there is a positive interaction effect of *exploitation ego* and *transitive triplets* ($\beta = 0.004$; $p < .05$). This provides support for Hypothesis 6 that individuals with higher exploitation work perceptions prefer closed knowledge networks compared to those with lower exploitation work perceptions.

4.3. Robustness checks and additional analysis

One alternative explanation for the relationship between exploration and exploitation work perceptions regarding knowledge networks is that the mechanism works in the opposite direction, i.e., position in the knowledge network increases or decreases exploration or exploitation work perceptions. We tested for this by simultaneously modelling whether networks bring about a change in exploration and exploitation work perceptions and vice versa. Specifically, we examined if the number of outgoing ties (*outdegree*), incoming ties (*indegree*), and reciprocated ties (*reciprocated degree*) predicted changes in exploration or exploitation work perceptions. To test for the effect of open versus closed we also included a *constraint* effect (Burt, 1992) as there is currently no measure of open versus closed networks available for the behavioral side of a SIENA model. There was no significant effect for *reciprocated degree* on either the change in exploration or change in exploitation work perceptions and only a marginally significant effect for *constraint* on exploration (see Table A2 in the Appendix). We conclude that the direction of the association between exploration and exploitation work perceptions and knowledge networks is generally from work perceptions to the knowledge network rather than vice versa, and that there is only limited support for the coevolution of knowledge network ties and exploration and exploitation work perceptions (Schulte et al., 2012; Tasselli et al., 2015).

Our measures of exploration and exploitation are separate scales as opposed to viewing exploration and exploitation work perceptions to be the two ends of a spectrum. This allows us to examine the association between network change and individuals who have both high exploration and exploitation work perceptions, i.e., individuals who have ambidextrous perceptions of work with regard to exploration and exploitation. While ambidexterity is normally examined at the firm level (Tushman and O'Reilly, 1996) it is also relevant at the individual level. We found no support for ambidexterity with respect to exploration and exploitation work perceptions influencing network change.

5. Discussion

Overall, our research highlights that individuals with high versus low exploration perceptions of their work do make different network

choices, as do those with high versus low exploitation work perceptions. Those with higher exploration perceptions of their work tend to change their network more than employees with lower exploration work perceptions. They also tend to have open networks, and to have reciprocal ties that allow for rich exchange of knowledge. Individuals with higher exploitation perceptions of their work tend to change their networks compared to those with lower exploitation work perceptions. They prefer unreciprocated ties and closed networks. These findings not only have implications for individuals, but also for the dynamics of the knowledge network itself. Taken together, the findings suggest that notable changes in the network are driven by whether individuals have high versus low exploration and high versus low exploitation work perceptions. Employees with high versus low exploration work perceptions benefit from the rich flow of knowledge in reciprocal ties. They also benefit from positions based on brokerage. Whereas individuals with high versus low exploitation perceptions of their work don't have a tendency to reciprocate knowledge ties and have closed networks giving them a less advantageous position for accessing knowledge as a form of social capital. The way individuals see the work they do, captured in this study by the two distinct work perceptions, affects network dynamics and, in turn, some of the benefits that network configurations provide (e.g., Burt et al., 2013).

5.1. Research contributions and implications for future research

We have developed an explanation of dynamic social networks with respect to the perceptions individuals have of their work, notably comparing the different network outcomes for those with high versus low exploration and exploitation work perceptions. By doing so we add to research on network dynamics that has examined how various factors impact network change, these factors include performance feedback (Parker et al., 2016), thoughts of quitting (Tröster et al., 2019), self-monitoring (Sasovova et al., 2010), emotional job demands (Parker et al., 2023), and team psychological safety (Schulte et al., 2012). As part of our explanation of dynamic social networks with regard to perceptions of work, we find that individuals with high exploration and exploitation work perceptions tend to change their knowledge networks which enables them to continually get access to new sources of knowledge. In addition, we specify from a structural topology perspective (Burt, 1982) how network mechanisms such as dyadic reciprocity and extra-dyadic patterns of brokerage and closure differ depending upon the extent an individual has high versus low exploration or exploitation work perceptions. We clarify the mechanism of reciprocity as to how individuals with specific work perceptions are likely to develop their networks. We also help to clarify the debate as to preferences for open networks that give access to diverse information (Burt, 2004) and closed networks that allow for the transfer of rich information (Coleman, 1988; Tortoriello et al., 2012). Our research findings highlight that individuals with high exploration work perceptions develop networks that maximize the benefits of both open networks and reciprocity in their knowledge network. In addition, our findings indicate that individuals with high exploitation work perceptions prefer closed networks and ties that are not reciprocated.

Specifically, we have made two contributions to theory and research on organizational social networks. First, we contribute to the micro-foundations of networking activities (e.g., Tasselli et al., 2015) by providing a dynamic examination of the effects of individuals' work perceptions on network dynamics. Micro-foundational research has injected agency into the study of social networks by shedding light on the extent to which psychological characteristics of interacting individuals, including their cognitions, motivations, and personalities, affect the network structures they forge (for a recent review, see Kilduff and Lee, 2020) and the organizational outcomes they can achieve through these connections (e.g., Tasselli and Kilduff, 2018). Previous research lacks an understanding of how the ways individuals enact and perceive their work—captured in this paper by exploration and exploitation work perceptions—explain the dynamic formation of those micro-structures that have been shown in turn to explain the very outcomes of individuals' networking activities in organizations. We combine structural emphasis on network configurations with individual focus on the way individuals interpret their work. Future research could investigate the extent and the process by which individuals' work perceptions coalesce at the firm level (i.e., organizational exploration and exploitation) that have been shown to explain relevant organizational outcomes, including firms' financial (Uotila et al., 2009) and innovative (Hoang and Rothaermel, 2010) performance. More research is needed to study the association between how people enact and perceive the work they do and the dynamic of work-based social networks to better understand how individuals influence the structure of the networks around them which in turn both enables and constrains their future opportunities.

Second, we advance research on network dynamics (Cannella and McFadyen, 2016; Chen et al., 2022; Jacobsen et al., 2022; Parker et al., 2023; Sasovova et al., 2010; Soda et al., 2021; Tröster et al., 2019), by providing new insights on the mechanisms by which knowledge is mobilized and shared by individuals in the organization. Network change may be a characteristic property of social networks, "something akin to the hum of a running engine" that produces "vibration and wiggle," and has consequences for the accrual of network advantage (Burt and Merluzzi, 2016, p. 370). However, previous research has largely failed to recognize the extent to which network dynamics are influenced by the ways in which employees perceive and enact the work they do. The possibility that we suggest here is that individuals' work perceptions affect the ways people develop and mobilize knowledge that in turn can explain organizational innovation and performance (e.g., Phelps et al., 2012). Typically, temporal network measures consider time and network mechanisms separately, which can be an issue because it can be hard to determine whether interactions depend on *when* they happen. The use of techniques, such as the ones used in this paper, that jointly consider both individual action and time provides a fine-grained understanding of how people enable and constrain the dynamic flow of knowledge in a network (see Falzon et al., 2018). Future research is needed to explore in more detail the nuanced relationships between individuals' work perceptions, inter-individual interactions, and the resulting dynamic patterns of knowledge transfer. Contemporary organizational arrangements offer opportunities for the exchange of knowledge and ideas among individuals who may never become a part of the longer-term network characterized by regular interactions. To properly model such dynamic events, future research is needed to develop and test measures of positions in social networks that allow for the simultaneous consideration of both time and sequence in interpersonal interactions (e.g., Amati et al., 2018).

5.2. Practical implications

Work in R&D units consists of the enactment of work related actions based upon perceptions of exploration relating to searching out new and innovative opportunities and exploitation of existing knowledge and resources. The need for both types of work is highlighted in the research on ambidexterity (O'Reilly and Tushman, 2008; Raisch and Birkinshaw, 2008), while generally at the organization level ambidexterity is also relevant to individuals. What our research shows is that individuals with high versus low exploration work perceptions tend to change their knowledge ties, to have open networks, and to have reciprocal ties that allow for rich exchange of knowledge. Individuals with high versus low exploitation work perceptions tend to change their networks, to avoid reciprocal ties, and to form closed networks. While these network tendencies may be beneficial for the work those with high exploitation work perceptions are currently engaging in, research suggests that they could be at a social capital disadvantage that results in fewer resources and opportunities for recognition and career progression (Burt, 1997; Cross and Parker, 2004). Therefore, there is an opportunity to make

individuals with high exploitation work perceptions aware of networking actions that may provide them with more long-term advantages for building social capital (Baker, 2000; Burt and Ronchi, 2007).

5.3. Limitations

As with all research, there are some limitations to our paper. First, all of the items of our measures of exploration and exploitation do not load as cleanly in the principal components analysis as they did for Mom et al. (2007). Although, when reduced to four items for each construct there is considerable improvement in the factor loading. Also, unlike for Mom et al. (2007) we do find that the exploration and exploitation variables are significantly correlated within each time period. There is opportunity to do further research to refine both measures, especially for exploitation. Second, we examine only one unit in a global organization, although we believe it to be representative of R&D units within organizations. Additional work could examine whether our findings hold within other business units or within organizations of different sizes. Third, we only examine ties within an organization. One way of broadening our findings would be to examine ties outside of the organization to see if there are differences. We suspect that networks outside organizations will be less densely connected and there will be less likelihood of transitivity occurring for individuals with high exploitation work perceptions. It is also likely that those with high exploitation work perceptions will have limited need for knowledge ties outside an organization. Fourth, another opportunity for additional research would be to examine the effects of personality traits such as self-monitoring or demographic characteristics such as gender on our findings (Brands and Mehra, 2019; Mehra et al., 2001).

5.4. Conclusion

In this paper we have developed an explanation of network dynamics that accounts for perceptions of work activity. We have theorized how work perceptions regarding exploration and exploitation affects how individuals change their knowledge networks. We show how three dynamic micro-network mechanisms—network change compared to stability, dyadic reciprocity, and triadic structure (closure)—are influenced by exploration and exploitation work perceptions. We advance existing research by bringing together ideas on social network dynamics and work perceptions to build an explanation of intraorganizational work-related social network dynamics.

CRediT authorship contribution statement

Parker Andrew: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing, Data curation, Methodology. **Waldstrøm Christian:** Conceptualization, Data curation, Writing – original draft, Writing – review & editing. **Tasselli Stefano:** Conceptualization, Writing – original draft, Writing – review & editing.

Appendix

Table A1
Items and factor analysis of exploration and exploitation work perceptions

Items	Factors (Time 1)		Factors (Time 2)		Factors (Time 3)	
	1	2	1	2	1	2
Exploration						
Cronbach's Alpha	0.74		0.76		0.75	
To what extent in the last 6 months did you engage in work related activities that can be characterized as follows:						
Searching for new opportunities in terms of solutions, products, processes or markets	0.82	0.25	0.82	−0.03	0.79	0.23
Evaluating various options in terms of solutions, products, processes or markets	0.68	0.41	0.73	0.26	0.78	0.23
Focusing on major renewal of solutions, products and processes	0.85	0.05	0.83	−0.05	0.79	0.20
Activities that require a lot of adjustment on your part	0.55	−0.11	0.55	0.18	0.59	−0.30
Exploitation						
Cronbach's Alpha	0.68		0.71		0.63	
To what extent in the last 6 months did you engage in work related activities that can be characterized as follows:						
Activities that cater to existing (possibly internal) customers in relation to existing solutions or products	0.02	0.62	0.57	0.41	0.36	0.52
Activities that you have a clear picture of how to manage	0.13	0.76	0.12	0.84	0.18	0.70
Activities that you can manage using your current knowledge	−0.02	0.75	0.05	0.87	−0.31	0.78
Activities that clearly fit into the firms strategy	0.43	0.62	0.56	0.43	0.41	0.60
Eigenvalue	2.36	2.17	2.86	1.92	2.62	1.96
Percentage of variance explained	29.53	27.06	35.73	23.98	32.70	24.51

Note: Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Table A2
SIENA estimation results of the coevolution of knowledge ties and exploration and exploitation work perceptions

Network effects (Knowledge)	Parameter	Sig.	(s.e.)
Rate parameters			
rate parameter period 1	6.634		(1.790)
rate parameter period 2	5.840		(1.572)
Structural effects			
outdegree	−1.891	***	(0.122)
reciprocity	1.295	***	(0.061)
transitive triplets	0.055	***	(0.005)
three-cycles	0.030	*	(0.013)

(continued on next page)

Table A2 (*continued*)

Network effects (Knowledge)	Parameter	Sig.	(s.e.)
indegree popularity	0.020	***	(0.004)
outdegree popularity	−0.053	***	(0.005)
outdegree activity	0.002		(0.001)
reciprocal degree popularity	0.112	†	(0.059)
inverse outdegree	3.189	**	(1.001)
Attribute effects			
education alter	0.009		(0.039)
education ego	0.096	*	(0.039)
same education	0.093	**	(0.032)
gender alter	0.045		(0.046)
gender ego	0.104	*	(0.048)
same gender	0.065	†	(0.039)
tenure alter	0.0000		(0.0002)
tenure ego	−0.0003	*	(0.0002)
tenure similarity	0.046		(0.078)
same job function	0.526	***	(0.050)
technician alter	−0.109	**	(0.037)
technician ego	0.063		(0.039)
same technician	−0.164	**	(0.060)
manager alter	0.110	**	(0.037)
manager ego	−0.062		(0.039)
same manager	0.047		(0.037)
exploration alter	−0.010		(0.018)
exploration ego	−0.004		(0.036)
exploration similarity	−0.047		(0.174)
exploitation alter	−0.020		(0.025)
exploitation ego	0.068		(0.051)
exploitation similarity	0.584	*	(0.244)
Hypothesized effects			
exploration on rate	0.090	**	(0.029)
exploitation on rate	0.103	**	(0.037)
exploration ego x reciprocity	0.253	***	(0.075)
exploitation ego x reciprocity	−0.432	***	(0.114)
exploration ego x transitive triplets	−0.008	***	(0.002)
exploitation ego x transitive triplets	0.005	†	(0.003)
Behavior effects (Exploration)	Parameter	Sig.	(s.e.)
rate parameter period 1	4.077		(0.889)
rate parameter period 2	3.007		(0.541)
linear shape	−0.392		(0.247)
quadratic shape	−0.123	***	(0.023)
indegree	0.004		(0.015)
outdegree	0.008		(0.014)
reciprocated degree	0.010		(0.035)
effect from constraint	1.505	†	(0.893)
Behavior Effects (Exploitation)	Parameter	Sig.	(s.e.)
rate parameter period 1	4.098		(0.838)
rate parameter period 2	2.779		(0.589)
linear shape	−0.240		(0.262)
quadratic shape	−0.196	***	(0.036)
indegree	0.002		(0.016)
outdegree	−0.005		(0.016)
reciprocated degree	0.024		(0.037)
effect from constraint	0.603		(0.857)

† $p < 0.1$;
* $p < 0.05$;
** $p < 0.01$;
*** $p < 0.001$

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