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**Individual Creative Performance in Social  
Networks: A Post-Structural Perspective**

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## DECLARATION

Hereby, I / *Anna Fedorova* / assure that this dissertation is original and that it has not been previously used to obtain any academic degree at any other academic institution.

A handwritten signature in blue ink, appearing to read 'Anna Fedorova', followed by a long horizontal line extending to the right.

*In loving memory of my grandfather*

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## TABLE OF CONTENTS

Introduction.....	3
CHAPTER I.....	9
Creativity in Networks: A Literature Review .....	9
Abstract.....	9
Introduction.....	10
Theoretical Background .....	11
Main Theories Overview.....	12
Strength of Weak Ties .....	13
Structural Holes.....	14
Core/periphery .....	14
Review of Creativity and Social Networks Research .....	15
Results.....	18
Dimension of Time: Creativity Continuum and Network Dynamics .....	19
Context: Diversity, Domain, Environment, and Alters .....	25
Ego: Personality, Knowledge and Skills .....	28
Suggestions for Future Research .....	31
Conclusion .....	32
REFERENCES.....	33
Tables .....	42
CHAPTER II.....	50
Not so social networks: Does solitude make us creative?.....	50
Abstract.....	50
Introduction.....	51
THEORY.....	54
METHODS .....	68
Discussion .....	74
Tables .....	87
Appendix.....	90
CHAPTER III .....	95
Network Cognition And Creative Performance.....	95
Abstract.....	95
Introduction.....	96
Social capital theory and individual creativity.....	98
METHODS .....	107

RESULTS .....	111
DISCUSSION .....	112
CONCLUSION .....	116
REFERENCES.....	116
Tables .....	125
Appendix.....	127
Conclusion .....	131

## **Introduction**

Firm performance is deeply rooted into creativity of its employees. In a constantly changing world, organizations need to react and strategize quickly to keep up with the progress and compete in the market. This requires constant flow of non-trivial solutions to problems, innovative vision and out of the box approach to business matters. Human resources play key role in this process, for they are responsible for finding novel and useful solutions (Amabile, 1983) that would benefit the organization on many levels, leading to short-term and long-term effects. But if such micro-level actions lead to macro-level consequences, then partially, future success of the organization breathes in every creative action of its employees (Hitt, 1975; George, 2007). In this vein, it is fundamental to understand and nurture individual creativity at workplace. Nowadays, creativity is more crucial than ever. In turbulent 2020s, creative thinking has become a competence the individual has to gain in order to daily face disruptive changes that take place in the world. So how do we do approach the topic effectively?

Social network analysis is widely used to explain creative performance of organization members, demonstrating how significant can be the effect of unseen mechanisms that are rooted into behavioural patterns (Kilduff and Brass, 2010; Perry-Smith and Mannucci, 2017). The field flourishes, and publications can be found nearly in every top journal in the domain of management. Insightful theories and thrilling findings do not cease to appear, unveiling surprising mechanisms and tendencies that remained hidden to creativity scholars before social network analysis stepped in. Contemporary research, however, pushes the knowledge even further. Post-structural approach to social network analysis leaves behind solely structural interpretation of individual creativity, inviting interdisciplinary research (Soda et al., 2019; Carnabuci and Dioszegi, 2015; Brands, 2013). In this vein, scholars agree that creativity in intra-organizational networks is facilitated not only by network properties, but also by series of other highly heterogeneous factors. Indeed, if we welcome the idea of seeking for complimentary explanans of creativity in networks, opportunities to expand the knowledge base are nearly limitless. For example, closer exploration of the literature reveals that creativity drivers can be searched for within the individual (Feist, 2010; Landis, 2016). Each person is a mosaic consisting of personality traits, cognition, knowledge, skills and experience. Curiously, scholars acknowledge that each of these characteristics potentially have notable influence on creativity (e.g., Feist, 2010). Not only internal, but also external factors can stimulate

creativity in people, for we are inseparable from our environment (Amabile, 1983; Csikszentmihalyi, 1988). In fact, very often it is interplay of the two that gives birth to creativity. Interweaving them together and viewing it through social networks lens has potential to discover the nature of creativity in modern organizations. Thus, my dissertation is built upon three streams of literature: social network analysis, personality studies, and cognitive social structures (CSS). To fulfil the goal of the dissertation, I posit three separate research questions. Thus, each chapter of the dissertation aims to assess a certain aspect of individual creative process in intra-organizational networks.

In the first chapter, I thoroughly study the field of individual creativity in intra-firm networks. This chapter aims to explore what network properties affect individual creativity in social networks, and what are the key dimensions of such creative process. As it turns out, publications in the field are scattered across many domains, including but not limited to management, psychology, social sciences, operations research and other. Such sufficient heterogeneity hinders integrated representation of the phenomenon, and research items exist in complete asynchronicity. Moreover, when it comes to individual creativity, classic network theories, such as strength of weak ties, structural holes or social capital theory, start clashing and acting as conflicting forces. As result, many empirical studies in the field are built upon opposite underlying principles. Therefore, it seemed crucial to bridge seemingly conflicting theories, explaining how they can coexist gracefully (Coleman, 1988; Granovetter, 1973; Burt, 2004). Satisfying such broad-scope research questions required a thorough investigation of all studies published in the domain, a goal that could only be reached by adopting a systematic literature review approach. I searched Web of Science database, conducted journal search in twelve most relevant editions and screened all references of studies included. The final dataset consists of 57 studies published in 22 academic journals.

The contribution of this study is multifaceted. In line with post-structural approach, I efficiently systematize contributions of findings that were previously scattered across various domains. As result of conducted analysis, I suggest an integrated interpretation of individual creativity in social networks as embodied by three-dimensional model of individual creative process in networks. Firstly, ego node's personality and knowledge are directly related to creative potential of the individual. People are driven by different intrinsic stimuli, have dissimilar talents and backgrounds, and all of the aforementioned influence the way they network and creatively express themselves. Secondly, work context and environment can have tremendous effects on networking patterns, pushing network agents into adopting dissimilar behaviour, not only dictating the overall network



structure, but also affecting individual agency. Thirdly, creative outcomes can have deterred effect, while short-term process consists of several consequent stages, during each of which dissimilar networking strategies are required. Proposed model represents the phenomenon in all its complexity, clearly unveiling driving forces and highlighting gaps and suggestions for future research.

The literature review conducted in first chapter of the thesis serves as theoretical basis for the rest of the work. By using the post-structural theoretical model proposed in the first chapter, I navigate consequent research towards those aspects of individual creativity in networks that are highly relevant but remain understudied. In the consequent chapters of the thesis, I am building upon prior research findings without the aim to replicate them. Instead, I take a step further and bring new variables to the field. In particular, I focus on individual dimension from the theoretical model introduced in the first chapter and investigate how personality traits and cognition are corresponding to certain network structures, and how such individuals can attain creativity at their workplace.

In the second chapter, I take a closer look at how one specific personality type behaves and attains creativity in intra-organizational network. Many studies in the field demonstrate how beneficial it is to be outgoing, sociable and embracing every opportunity to network (Baer, 2012). However, I draw attention to the fact that it is not the only possible scenario of how one can be creative in the network. In line with personality literature, I claim that for some, creativity can be facilitated in solitude rather than in company of others (Long and Averill, 2003). The research question in this chapter is, how do solitary individuals attain creativity in the context of intra-organizational network? Understanding this issue is particularly topical in 2021, at the age of digitalization, when notoriously large share of previously face-to-face interactions has shifted online. Global pandemic intensified this aspect even more, pushing many of us to experience solitude. Nowadays, we are all experiencing solitude and networking at the same time. Separated from our colleagues in smart working, we are more networked than ever. And while solitude indeed sounds anew, scholars in management field systematically overlook solitude.

Drawing on data obtained from an R&D department of a large gas machinery company located in Russia, I study how solitary individuals can become creative, given their preference for solitude, degree centrality and job rank. Data speak in favour of posited hypotheses, clearly indicating that solitary type of personality is more likely to be creative when their degree centrality is low. Interestingly, job rank as one of measures of professionalism can soften the aforementioned

negative effect of exuberant interaction caused by high centrality in the network. Novel model of interplay of personality traits and network position is the contribution of this chapter. I demonstrate how seemingly negative personality trait can turn out creativity stimulating if viewed from another angle. Yet again, I highlight how unique each individual endeavour is, and demonstrate how such well-studied and celebrated network property as degree centrality can become a limitation to some network agents. This chapter connects heterogeneous streams of research and entwines them into one larger theory.

In the third chapter of the dissertation, I take a step further and investigate the role of individual cognition in response to social settings as embodied by networks (Krackhardt, 1987). The dimension of cognition is tightly bounded with personality studies in social network literature. I start by proving that cognition is inseparable from creative manifestations at individual level, and continue by exploring the unequivocal association of cognition and CSS. Indeed, despite the fact that prior research explicitly demonstrates how significantly CSS can affect individual performance (Brands, 2013), not many scholars have entwined CSS and individual creativity. Thus, building arguments upon CSS and social capital theory, I propose a model of individual creativity as product of network position and cognition. The dataset used to test this research question includes 93 respondents employed to work in R&D department in a large company based in Russia. Results of the study suggest that indeed, both network position and network cognition can have significant independent effects on individual creativity at work. Findings of the third chapter speak in favour of social capital theory (Coleman, 1988), exposing how network density can stimulate creativity. Moreover, in this chapter of the thesis, I set boundary conditions to privileges of brokering position, showing how it can turn out malicious in specific settings.

By adopting post-structural approach, I study individual creativity in intra-organizational networks on conceptual and empirical levels. The aim of the dissertation was to demonstrate how multifaceted and unique each creative process is. In every chapter, I tried to show various mechanisms and perspectives of the phenomenon, borrowing theories from heterogeneous domains, but invariably grounding core arguments in social networks literature. I view creativity as extremely complex and multidimensional topic, and yet certain network patterns presume. As result, creativity appears as socially situated, contextually embedded, deeply personal, variegated and flexible phenomenon. Acknowledgement of existing boundary conditions to each network effect prevents oversimplified theorizing in the field and embraces diversity of creative manifestations at individual

level. Herein, ancient phenomenon continues flourishing nowadays and rises anew in intra-organizational network settings.

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# CHAPTER I

## **Creativity in Networks: A Literature Review**

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### **Abstract**

This review focuses on interdisciplinary complexity of individual creativity in social networks. First, the contributions of social capital, strength of weak ties, structural holes theories and core/periphery approach are overviewed and critically evaluated. Further, by adopting post-structural social network approach, this review suggests a novel multi-dimensional model of individual creative process in social networks, highlighting three key moderating factors: (a) time, (b) contextual characteristics, and (c) ego traits and knowledge. Thus the research agenda is forwarded, suggesting key opportunities for future research based on a three-dimensional model of creative process. The general purpose of this study is to encourage research to enrich structural network characteristics with complimentary explanations of individual creativity.

*Keywords:* creativity, innovation, social networks, review

## Introduction

Interpersonal networks have proven to be powerful drivers of individual creativity in organizations. Tapping into structural representations of interpersonal relations between colleagues revealed that some network positions expose individuals to opportunities and relevant information, some help to optimize the resources, some provide with the needed support, therefore facilitating creativity (e.g., Burt, 2004; Perry-Smith, 2006; Kijkuit and van den Ende, 2010). However, a selection of curious findings is overshadowed by vastness and ambiguity of the topic. The field of individual creativity in intra-organizational networks remains understudied, lacks integrated representation and is filled with conflicting theories and contradicting results (e.g., Perry-Smith, 2006; Teigland and Wasko, 2009; Donati et al., 2016; Jokisaari and Vuori, 2014). The confusion is redoubled by methodological complexity associated with primary data collection that constrains the focus of empirical studies to a certain aspect of the phenomenon or a specific and limited timespan of the creative process. As result, the integrated representation is missing, and the very essence of individual creative process in interpersonal networks remains obscure. To fulfil this gap, current work seeks to understand what network properties affect individual creativity in social networks, and what are the key dimensions of such creative process. Finding answers to these questions will result in distinct representation of sophisticated and interdisciplinary nature of individual creativity in social networks, ensuring profound understanding of the phenomenon. That would ease the conceptual navigation in the field and accelerate practical implications of the theory.

The purpose of this review is twofold. First, to gather and summarize the contributions of empirical and conceptual studies. This step allows to outline the field, deconstruct it to core components, recognize important findings, and explore the contradictions and gaps. Second, to follow post-structural social network research tradition (e.g., Landis, 2016) to critically evaluate and synthesize the findings. As result, a novel three-dimensional model of individual creative process in social networks is proposed. Adopting exploratory approach allowed to reveal the key factors that can compliment classical social network concepts and provide the reader with comprehensive knowledge of the subject. The results focus on three key factors affecting the relation between network properties and creativity: (a) time (creativity continuum and network dynamics), (b) contextual characteristics, and (c) ego node's personal traits and knowledge. Implications and promising directions for future research are discussed in the end of the paper.

## Theoretical Background

Creativity is typically defined as development of outputs that are novel and useful at the same time (Amabile, 1983). It took numerous sociocultural reconstructions and hundreds of generations, however, to arrive to this definition and this stage when creativity is seen as self-sufficient phenomenon and a separate research discipline. Creativity is ancient, and has aroused intellectual curiosity of thinkers for centuries, with early references stretching back to Plato and Confucius, through Renaissance and to modernity (see Runco and Albert, 2010, for a review). Despite such a rich history of the concept, the dynamism and shapeshifting pattern of creativity are such that it remains ever-topical, constantly leaving room to the unexplained. Spanning from psychology to art, from history of science to technology and innovation, creativity has indeed left its traces in countless domains. Nevertheless, scholarly research on creativity has started to boom only in the XX century, as the phenomenon has attracted attention of most prominent psychologists, such as Freud (1958), Rogers (1959), Eysenck (1995) and others. Since then, it was explored by scholars in many disciplines, and continues to accelerate even today (Feist and Runco, 1993; Runco and Albert, 2010; Zhou et al., 2019). In social sciences, academic thought has started to tackle practical implementations of creativity over 50 years ago (see Puccio and Cabra, 2010, for a review). For example, Hitt (1975) was one of the first authors to place creativity in organizational context, and to substantiate its strategic necessity, claiming that in a dynamically changing world, creative human resources are the means by which organizations keep up with the pace of the progress in order to not go extinct. Empirical studies have started to emerge, drawing more interest to creativity in organizational context whilst demonstrating that creative thinking is one of the key workplace skills that correlates with performance (see Puccio and Cabra, 2010; George, 2007, for a review).

The next important spin of research took place in 1980s, when systems approach to creativity have started to step up at conceptual level, putting major focus upon contextual influences on individual creativity (see Kozbelt et al., 2010, for a review). Thus in his seminal work, Csikszentmihalyi (1988) has switched attention from the definition of creativity to environment where it evolves. He theorized that creativity is constituted by interacting systems, being (a) the domain, representing the component of the culture where the knowledge is preserved and transmitted across generations, (b) the individual, who, by means of access to domain knowledge and personal skills produces novel solutions, and (c) the field, representing a part of society that receives and evaluates the contribution of the individual. In this vein, creativity is deeply rooted into the context, as it originates from professional domain, passes through the social field and then, if accepted and recognized, becomes

a component of the cultural domain. Almost simultaneously, Amabile (1988) developed her widely cited componential model of creativity and innovation in organizations, where environmental triggers promoting and inhibiting individual creativity in organizations were empirically derived and divided into three groups of sociocultural factors (Amabile et al., 1996). These theories, together with others, have drawn vast attention to individual creativity. Such spotlight gave rise to numerous consequent studies, attracted young scholars, and was concomitant to academic journals establishment (e.g., *Creativity Research Journal*, *Creativity and Innovation Management*).

Further conceptual advancements about the impact of various contextual factors on individual creativity have followed, giving credit to interrelations at workplace, such as relationship with co-workers and supervisors (see Shalley et al., 2004; Hunter et al., 2007, for a review), and recognizing their importance in shaping one's creative performance. The work of George (2007) was one of the first to distinguish social networks as a promising contextual driver of organizational creativity. In that paper, George has put networks on the one level with better established contextual factors affecting creativity, building the arguments, back then, on a very limited amount of studies. On this basis, interrelation between creativity and certain structural patterns of social interactions has become evident not only on conceptual (e.g., Granovetter, 1983; Perry-Smith and Shalley, 2003), but also empirical levels (e.g., Burt, 2004; Perry-Smith, 2006, Uzzi and Spiro, 2005), and finally there has become enough ground for creativity in networks to become an established field of research. Post-structural approach of assessing individual performance (including creativity) in social networks started to actively emerge after the work of Kilduff and Tsai (2003). This approach states that structural network features alone are not sufficient to explain large proportion of variation in individual creativity, since people are also affected by series of heterogeneous complimentary factors, be they introspective or extraspective (e.g., Stea and Pedersen, 2017; Tortoriello, 2014; Chua, 2018).

### **Main Theories Overview**

In social networks field, the context is the primary lens through which various phenomena are studied. The literature on creativity in social networks is heterogeneous indeed. It borrows from sociology, psychology, economics, and mathematics, and is published in very diverse subfields. Despite interdisciplinary nature of the topic, the majority of articles in the domain build arguments upon these fundamental theories: Social Capital Theory (SCT), Strength of Weak Ties theory (SWT), Structural Holes theory (SH), and core/periphery approach. A brief overlook is provided



below and aims to extract major advancements and spot the gaps and controversies in classic approaches to the phenomenon of individual creativity in social networks, before moving to results section and adopting the post-structural perspective.

### **Social Capital Theory**

SCT interbred of sociological approach that sees individual as a product of social system and its norms, and neoclassic economics that tends to represent an individual as a rational actor aiming to optimize the profit (Coleman, 1988). According to SCT, creative individuals are more successful when embedded into a supportive and understanding environment, that will be welcoming their creative efforts and will facilitate interpersonal collaboration to refine and promote ideas (Sibert et al., 2001). Such network typically establishes a set of norms facilitating collective action and coordination, so that individuals are genuinely willing to help each other (Ahuja et al., 2012; Burt, 2001). Associated system-level behavior pattern results in dense networks, characterized by closed social structures, presence of strong ties, and network closure (Lin, 1999; Kijkuit and van den Ende 2007). Creativity therefore originates from simplicity of essential knowledge transfer that is eased in a network of this kind, since network agents encounter emotional comfort in the organization, build on each other's knowledge base, lack competing interests, and share beliefs (Coleman, 1988; Lin, 1999; Brands, 2013). Strong ties and dense closed structures help maximize innovation potential (Grosser et al, 2017), facilitate creative idea elaboration (Perry-Smith and Mannucci, 2017; Kijkuit and van den Ende, 2010) and implementation (Donati et al., 2016), put work-related advices into effect by means of psychological safety (Li et al., 2018), and appear a particularly important creativity driver when supported by organizational culture (Soda et al., 2019). Nevertheless some authors argue that dense structures cause redundancy of information and set boundaries on diversity of insights and approaches in work, thus heavily constraining the scope of information at idea generation stage (e.g., Kijkuit and van den Ende, 2010). Moreover, dense networks are known to impose certain patterns of behavior that are rooted in high sense of belonging and emotional closure between colleagues, thus often disapproving of any divergent approaches and techniques that are essential to creative individuals (Soda et al., 2019; Fleming et al. 2007; Perry-Smith, 2006).

### **Strength of Weak Ties**

SWT suggests that network agents are typically embedded into closely connected clusters, where knowledge, beliefs and perspectives are homogeneous; while having very little connections to other

clusters of the larger network (Granovetter, 1973). Thus a weak tie represents a connection to a certain social circle through which non-redundant information dissimilar to ego's normal environment flows. Creativity is naturally stimulated by such experience, as network agent is being exposed to the necessary domain-relevant knowledge, diverse perspectives, enhanced knowledge base and encounters the sense of autonomy (Perry-Smith, 2006). Methodologically, strength of the tie can be measured in terms of interaction frequency (Wang et al., 2015), emotional closure (Donati et al., 2016), duration of acquaintance or a combination of the aforementioned (Baer, 2010b; Perry-Smith, 2006; 2014). Despite the elegance of the theory, empirical results are often discordant. Some findings show that the number of weak ties is positively associated with creativity (Perry-Smith, 2006; Jokisaari and Vuori, 2014), some prove inverted U-shape relationship (Zhou et al, 2009; Baer, 2010b), and some demonstrate a negative interaction (Donati et al., 2016). Heterogeneous results create confusion around SWT, inviting scholars to enrich the theory with novel variables and individualize the cases studied.

### **Structural Holes**

SH theory builds upon SCT (Burt, 2004; 1992). The core idea of SH theory is that behavior, opinion and information vary much more across groups than within a single group. Structural holes represent a lack of inter-cluster connections between two network elements, and network broker is the agent who casts a bridge between those, thus becoming an intermediate element between two various groups. Hereby when the ego holds a brokering position, they have earlier access to broad non-redundant information, ability to understand needs of the network, and experience to translate information across groups. A number of studies indeed find a positive relation between ego networks rich in structural holes and individual creativity (Carnabuci and Dioszegi, 2015; Zou and Ingram, 2013; Tang et al. 2017; Zhang et al., 2017). Some contemporary studies, however, explain that magnitude and direction of this association are significantly affected by external factors, such as collaborativeness of work environment (Soda et al., 2019) or levels of distraction (Stea and Pedersen, 2017); and internal factors such as a feeling of psychological safety (Li et al., 2018) or attention allocation (Rhee and Leonardi, 2018). In sum, these findings also urge scholars to see the association between SH and creativity from a novel angle and seek for complimentary explanations.

### **Core/periphery**

Core/periphery approach stands out from formerly described theories. According to Kilduff and Brass' (2010: 356) definition, core/periphery represents the degree «to which the network is

structured such that core members connect to everyone and periphery members connect only to core members and not to other members of the periphery». This approach is often used in studies set in open networks of notably large size, where dense core and sparse periphery are distinctively visible. The early prominent study in the field was written by Cattani and Ferriani (2008) and attracted major attention to the phenomenon. Location at the core provides creators with opportunities of easily gaining recognition and acceptance of their creative outputs by others. However, such firm embeddedness into a network can result in low inflow of fresh domain-relevant information and a risk of groupthink (Perry-Smith and Shalley, 2003). Scholars argue that individuals at the core of the network are most successful at incremental innovations (Maoret et al. 2020). Location at the periphery, however, stimulates groundbreaking ideas in creators due to exposure to different sources of inspiration, heterogeneous contacts outside of the network, and less pressure to conform to the established ways of doing creative work (Perry-Smith and Shalley, 2003). However, peripheral actors are not influential in the network, and struggle to gain legitimacy for their creative outputs. Described check-and-balance leads some scholars to conclusion that in fact these are intermediate locations in core/periphery structure that lead to highest levels of creativity (Dahlander and Frederiksen, 2012; Cattani and Ferriani, 2008).

Core/periphery approach has several notable features that distinguish it in the domain of social networks and creativity. Firstly, traditionally it focuses on the different level of analysis. Scholars acknowledge that core/periphery approach does not perfectly apply to intra-organizational networks (see Maoret et al., 2020) since its focus is usually the field network. Secondly, it usually uses longitudinal analysis and archival data (e.g., Sgourev, 2015; Whittington, 2018). Thirdly, it requires a different methodological treatment (Borgatti and Everett, 1999). Due to these reasons, evaluation of ego nodes' features and context is limited in such studies, making core/periphery studies stand aside from other studies in the domain, and creating difficulties to include this approach into the theoretical model proposed in the current literature review.

## **Review of Creativity and Social Networks Research**

### **Methods**

Articles discussing the interrelation between social network properties and individual creativity are published in journals across the domains of management, sociology, psychology, and other. Such notable diversity of sources required profound search strategy that would ensure the inclusion of all

relevant publications and a comprehensive overview of numerous possible sources. For this purposes, systematic approach to literature review was chosen. There were three data collection techniques that are customary in literature reviews in the field of interpersonal networks (e.g., Brands, 2013; Landis, 2016). Firstly, the search was conducted on Web of Science database, and it used key words relating to social networks, creativity and innovation (*centrality, degree, indegree, betweenness, brokerage, structural hole, weak tie, strong tie, closeness network, SNA, social network, creativ\** and *innov\**). The review primarily focuses on research articles appearing after Kilduff and Tsai's (2003) big call for post-structural approach to social network research, but some of the articles date back to earlier times. During Web of Science search stage, the focus was on publications falling within 1993 - 2021 time period. Initial theme search yielded over 5.8 million results due to the fact that a lion's share of publications belonged to the fields that are not relevant for the current review (i.e., science, medicine and psychiatry). Domains of interest were limited to management, psychology, business, and economics. The types of document included were article, review, early access, dissertation and book chapter. In several steps, research categories that were obviously detached from the focus of the research were excluded (i.e., industrial engineering, information science, geography). For this same reason, journals that were irrelevant for the topic were manually excluded (i.e., «Psycho Oncology», «Journal of Transport Geography», etc.). Further, the remaining results, over 900 studies, were transferred to a reference manager (EndNote). These studies were later thoroughly analysed, as described in the following section.

Secondly, in line with established research tradition (Short, 2009), journal search in twelve most relevant and prominent journals was conducted (*Academy of Management Review, Academy of Management Journal, Administrative Science Quarterly, Journal of Management, Organization Science, Strategic Management Journal, Journal of Management Studies, Organizational Behavior and Human Decision Processes, Journal of Organizational Behavior, Creativity and Innovation Management, Creativity Research Journal, Human Relations*). Titles and abstracts of over 7.000 articles were screened during this step. The technique allowed to spot more articles that were not included into the database. To ensure robust results, a third data collection technique was used. Adoption of the snowball approach allowed to carefully study all references of studies included in the sample in pursuit of publications that could be missed during prior two stages of data collection.

### **Selection of Studies**

Inclusion criteria was designed in order to rule out publications that mentioned selected key words but focused on topics marginal to the one of the current literature review. The criteria used for

studies selection was as follows. First, only the studies using an individual as unit of analysis were targeted. Studies that examined team creativity, dyadic creativity, creative project performance, and similar, were thus excluded. Second, studies had to assess both network measures and individual creativity (or individual innovation performance). By these means, studies focusing solely on creativity or on networks were not included into the sample. Third, selected studies had to use adult sample, which resulted in exclusion of a significant number of studies that focused on peculiar underage categories, such as adolescents and children.

As result, all of included studies investigate the phenomenon of individual creativity in social networks. Articles in the sample differ in degree of network openness. The majority of studies is set in intra-organizational environment, focusing on clearly defined and closed networks of organizations or departments. Semi-open networks, such as, for example, managers networks, or crowdsourcing platform users, are represented by several studies in the sample. The third category of articles was set in open networks, such as patent, co-author networks, and professional networks.

### **Data Analysis**

The process of data analysis included several steps. Web of Science search was conducted first. The initial step was to conduct the title analysis based on the aforementioned inclusion criteria in order to rule out the studies that did not focus on the topic of interest. Secondly, the abstracts of these studies were exported from the reference manager and underwent scrutiny, resulting in selection of over 250 potentially relevant publications. Thirdly, full texts of these publications were carefully studied in order to extract 34 articles that are now included in the literature review. Journal search was performed next, and after extensive scrutiny 16 more articles were included into the sample. In addition to that, the snowball review technique was adopted, which led to discovery of 7 additional articles that could be included into the sample of studies. Thus, the final selection incorporates 57 articles published in 22 journals. These studies are listed and described in *Table 1*.

In order to illustrate the data used, a brief general overview to the samples of studies included in the analysis is given in this section. Interestingly, research settings of articles were quite heterogeneous and related to very diverse industries. For example, 17 articles were set in R&D and tech settings. 13 other articles were set in the field of technology and science. Cultural and creative industries were represented by 9 studies. Furthermore, 3 papers were purely conceptual studies constructing novel theories and models and focusing explicitly on individual creativity in intra-organizational networks. The rest of the studies used such settings as agricultural processing, consulting, inter-

organizational governing teams, product development, municipalities, entrepreneurship, university students and in an experimental lab.

————— *Insert Table 1 around here* —————

## **Results**

One of the most interesting results of this review is the identification of dominating lines of reasoning according to which post-structural approach to creativity in social networks revolves. The analysis reveals that there are three main clusters, or dimensions, of complimentary explanans of individual creative process in social networks. Although these dimensions are deeply rooted into the literature, integrated interweaving of those is the contribution of current paper. In conceptual synthesis, interdisciplinary knowledge of phenomenon of individual creativity is used as basis and applied to intra-organizational networks field. Thus, the proposed three-dimensional model constitutes of time (creativity continuum and network dynamics), context, and ego (including personality traits and knowledge). It is important to note that the model responds to long-standing calls in the field. For example, in their literature review, Kilduff and Tsai (2010) discuss criticisms and controversies in social network research, referring to ego characteristics and network context as understudied factors that can have sufficient influence on performance outcomes. Similar longstanding calls can be found in the field of creativity (George, 2007) or psychology (Swann and Seyle, 2005). We briefly describe theoretical underpinnings of dimensions choice below.

The first dimension, time, consists of two separate components: creativity continuum that takes into consideration short-term effects, and network dynamics that usually focuses on long-term patterns. Creativity continuum originates from classic creativity studies (e.g., Amabile, 1988), and distinguishes between temporal stages of creative process, claiming that various behaviors and practices are natural to each stage. In this study, the focus is on four separate stages of creative continuum, namely, idea generation, idea elaboration, idea championing and idea implementation (Perry-Smith and Mannucci, 2017). The aim is to show what network properties are useful at each stage. The component of network dynamics is an actively evolving stream of network research that focuses on changes that take place on ego- and whole-network levels (Ahuja et al., 2012). Network dynamics take into consideration longer timespans, focusing not only on immediate and static network benefits, but also deterred and built-up effects of network features on individual creativity. The second dimension aims to embrace the variety of contextual characteristics that can intervene

in the relationship between network position and creativity (see George, 2007, for a review). It refers to numerous environmental factors, ranging from micro-level, such as default intensity of collaboration in the team (Stea and Pedersen, 2017), to macro-level triggers such as intercultural collaboration resulting from globalization (Chua et al., 2012). Lastly, the third dimension addresses to the role of ego's traits and competences in creative process. Herewith personality literature is used in order to assess the fragment of creativity that is rooted in personal traits of individuals and that has long been an object of interest for psychology researchers (see Feist, 2006; Zare and Flinchbaugh, 2018, for review). The final model represents multiple perspectives. Taken alone, each of these perspectives can shed light on a given dimension of individual creative process in the network. Yet only when integrated, these dimensions construct a profound portrayal of the phenomenon.

*Table 2* demonstrates the summary of core positive interactive effects of network properties and creativity. Network properties are clustered in accordance with supporting network theories described above. Thus weak ties and network size refer to SWT; strong ties, closeness centrality and network density are in line with SCT; and structural holes and betweenness centrality are related to SH. Lastly, degree centrality, network constraint diversity and Simmelian ties are located on interception of classic theories and therefore stand apart, as it is incorrect to affiliate them with any of the three main theories solely. Since no interactive effects of core/periphery construct with creativity continuum were detected in selected studies, it is included into the table as blank line. Columns stand for three stages of creative process and overall creative performance, correspondingly. *Table 3* switches the focus to the three dimensions interaction by digging into previously studied constituting components of context and ego. Later in this section, aforementioned conceptual twists are discussed in detail.

————— *Insert Tables 2 and 3 around here* —————

## **Dimension of Time: Creativity Continuum and Network Dynamics**

### **Creativity Continuum: Idea Generation**

Idea generation is perhaps the most attractive topic for creativity researchers with regard to the number of studies published, and yet it remains the most cryptic phenomenon. Idea generation usually involves gaps recognition, current state of art challenging, and complex variation processes. This phase is considered finished once a novel and useful idea is defined and selected by the creator

among alternative options, after which the idea can be passed to elaboration phase (Amabile, 1983; Kijkuit and van den Ende, 2007; Perry-Smith and Mannucci, 2017). In this section, the literature is systematized based on structural features, network composition and ego traits.

Creativity literature suggests that information diversity is crucial during idea generation phase. In social network research, access to diverse information is typically captured by number of ties and their strength and density. Weak ties imply less frequent interaction, shorter duration of relationship, arm-length emotional closure and lower maintenance efforts. According to SWT (Granovetter, 1973), weak ties are viewed as connections to certain social circles that ego is not firmly embedded into. Unlike strong ties, weak ties are not associated with emotional comfort and shared vision of network members. On the contrary, weak ties embrace the diversity of perspectives, practices and backgrounds. Heterogeneous sources expose an individual to pockets of information with previously unattainable domain-relevant knowledge and information that is likely to be fundamentally different from what the creator already knew (e.g., Perry-Smith and Shalley, 2003). Non-redundant information accessed via weak ties affects cognitive structures in creators' mind and encourages them to think more broadly, fostering recombination processes and fresh vision, and finally resulting in higher levels of creativity. In line with this logic, in their conceptual papers, Perry-Smith and Mannucci (2017) and Kijkuit and van den Ende (2007) theorize that number of weak ties is positively related to creativity of ideas. Aforementioned arguments are supported by empirical findings. For example, Perry-Smith (2006) demonstrate on the sample of a large research laboratory that the number of weak ties is indeed positively associated with creativity. Recent study by Mannucci and Perry-Smith (2021) further confirms the positive relation between weak ties and idea generation. Similarly, Kijkuit and van den Ende (2010) show that creative idea acceptance is more likely if was generated in large and sparse networks. Qualitative study of Ling and O'Mahony (2010) supports this logic, explicitly explaining what networking strategies creators adopt to increase their network size by reaching out to new people in the industry.

Another important aspect is skills and expertise heterogeneity of network contacts. It is helpful to have connections to alters coming from different backgrounds and therefore being able to view the creative issue from a different angle (Perry-Smith, 2006). Network knowledge from prior close collaborations alongside with connections to decision makers during idea generation phase give cues to current needs of organization and available instruments and resources, that helps creator focus on promising directions at work (Kijkuit and van den Ende, 2010). Culturally diverse networks help creator shape non-redundant frames and facilitate novel ideas generation, reaching



higher prominence and amplitude for creators working on tasks that draw on multicultural knowledge (Chua, 2018). The famous study of Burt (2004) explains how structural holes in the network act as source of diverse information, exposing ego to insights and exclusive information needed to originate outstanding ideas.

However, even the most promising network connections will not grant ego with truly creative ideas unless they are willing and able to work in this direction. Post-structural network literature highlights many aspects that can affect the way ego used network opportunities. Rhee and Leonardi (2018) enrich network research by bringing in the attention allocation variable. Thus, ability to divide attention among information arising from various network sources is beneficial in sparse networks rich in structural holes since it allows ego synthesize diverse information. On the contrary, when network is dense and lacks structural holes, divided attention results in superficial knowledge, while focused attention allows creator to concentrate on in-depth information coming from a particular tie, and make the best use of it.

### **Creativity Continuum: Idea Elaboration**

By far less attention has been drawn to an intermediate stages of creative process, idea elaboration and idea championing, that in some studies are united into the one stage (Kijkuit and van den Ende, 2007). Perry-Smith and Mannucci (2017: 56) define idea elaboration as «the process of systematically evaluating the novel idea's potential and further clarifying and developing it». At this point of time, it appears crucial to develop a concept, dive into the relevant literature, seek for professional consultations and advices from trusted contacts. Knowledge transfer is particularly important at this stage due to its potential to polish up the idea. According to Lingo and O'Mahony (2010), creative project boundaries are being defined at this stage, and creators actively engage into introducing analogies to better connect the work to the current state of art. Unlike idea generation phase, idea elaboration requires strong rather than weak ties in the network structure. Strong ties are associated with trust, availability and understanding. Network members feel comfortable and safe discussing yet fragile idea with people they feel emotionally close with. For example, Perry-Smith and Mannucci (2017) and Kijkuit and van den Ende (2010) theorize that strong ties facilitate idea development by means of support.

Effects of the network size density and size are more controversial. Donati et al. (2016) claimed that network density will stimulate idea championing -- that authors refer to as suggestion making -- by means of support and psychological safety. Kijkuit and van den Ende (2010), on the contrary,

suggested that lower density is beneficial at this stage due to diversity of network members and freedom of action. Kijkuit and van den Ende (2010) find that large networks stimulate creativity at idea elaboration stage, while Mannucci and Perry-Smith (2021) discovered that large networks prevent actors from activating the ties that stimulate creativity at this stage of creative process. These contradictions in the literature leave room for explanation and interpretation, inviting scholars to fill the gaps by exploring other dimensions of creative process.

### **Creativity Continuum: Idea Championing**

At the stage of idea championing the idea is being actively promoted for the sake of obtaining legitimacy and gaining influence. Such actions allow to reach out to powerful agents, anticipate the reaction of the network and build the appropriate climate (e.g., Kijkuit and van den Ende, 2007; Lingo and O'Mahony, 2010). In sum, it increases the chance of idea to survive to the next stage of creativity continuum, where it can turn into a final output.

Scholars tend to agree that network density is a driver of creativity at idea championing phase, since it facilitates information flow, making it faster and more reliable for network members embedded (Kijkuit and van den Ende, 2010; Donati et al. 2016). Kijkuit and van den Ende (2007) propose that strong ties to decision makers increase probability of idea acceptance, since decision makers have clear view of organizational current needs and resources available. Similarly, Wang et al. (2015) claim that close relations with the team leader result in more innovative behavior, as supervisor has capabilities to convert information to innovation. In addition to having access to the necessary resources, supervisors are perceived as powerful, thus they are likely to convince the rest of the network that the idea is worthy. Further, Kijkuit and van den Ende (2010) find that strong ties to senior personnel positively affect the success of innovative idea. Senior employees are likely to receive information from higher echelons of organization. Quite like decision makers, seniors are aware of what idea evaluation criteria might be. Additionally, due to their expertise seniors are good at spotting opportunities and encouraging people to take risks. Perry-Smith and Mannucci (2017) also show that connection to powerful network agents, proposing that links to alters located in structural holes are most useful at the stage of idea elaboration.

### **Creativity Continuum: Idea Implementation**

Idea implementation is the last stage of creativity continuum. This phase typically remains out of focus in classic creativity studies, while capturing attention of innovation scholars (Alves et al., 2007). Idea implementation is also often considered apart from creativity continuum and is referred

to as innovation or creative success (e.g., Sarooghi et al., 2015), thus creating confusion in the literature. During idea implementation stage, the final creative output is produced and introduced to the relevant field for the first time, and the field decides whether to accept and recognize it (Csikszentmihalyi, 1988). The crucial aspect regarding this period is that idea implementation gets access to the field where it can be understood, supported and accepted, and from where it can later be promoted to much larger networks. In this vein, for idea to be smoothly implemented, ideally it should have access to dense networks of strong ties, as suggested by SCT (Coleman, 1988). Shared vision and mutual understanding that are customary in such networks will likely encourage network agents to act hospitable and supportive, thus soothing creativity adoption. In this vein, Perry-Smith and Mannucci (2017) argue that access to dense network structures is most beneficial for successful idea implementation. This access can be embodied either by ego's own network structural closure, or by outside ties embedded in dense structures. Similarly, Donati et al. (2016) empirically find that indeed team network density is positively related to idea implementation behaviour. In line with these findings, qualitative study of Lingo and O'Mahony (2010) demonstrates that at the final stage of creativity continuum creators tend to exclude certain network members from decision making process, while clearly defining the roles of included network members.

To sum up, studies on creativity continuum suggest that there are no network features universally helpful for the entire length of creative process. *Table 2* clearly illustrates these findings. In ideal scenario, creators will have many weak ties, large networks and access to structural holes at the stage of idea generation, but at consequent stages of creative process, these network features are not needed anymore. Instead, successful idea elaboration, championing and implementation structurally require strong ties and dense networks. The main outtake here is that for individual to be creative, their network should evolve with time. The availability of such switching and limitations associated with it were scrutinized in the study of Mannucci and Perry-Smith (2021). In the following subsection, more attention is dedicated to changes in networking strategies of individuals.

### **Network Dynamics**

This passage is dedicated to the topical phenomenon of network dynamics (see Ahuja et al., 2012, for a review) that was addressed by several studies in the sample. With the wide-scope view and by the means of longitudinal analysis and archival data, selected articles explore what leads to creative career success in the long-run, how creative strategies can change overtime, and how enduring creative benefits of some network properties are. For example, the conceptual study of Perry-Smith and Shalley (2003) proposes the famous creativity-centrality spiral model, aiming to explain how

creators' intra-firm network position can change overtime. According to authors, creativity of a creator located in a peripheral position will boost their status in the network, eventually making them central actors, that, in turn, would constrain their creativity. Seibert et al. (2017) investigated what affects the research productivity of university professors in the US in the long-run and found that strong ties lead to higher number of citations, while heterogeneity of co-authors stimulates publications in first-tier journals. Similarly, Aubke (2013) studied career trajectories and creative productivity of Michelin-starred chefs and found that such chefs are prone to maintaining high extent of heterophily in professional networks. In addition to that, Aubke (2013) discovered that even though network ties do stimulate creativity at early stages of career, overtime, they become costly, leading to the conclusion that overtime, fewer network ties become more beneficial to individual creativity. Aforementioned issue is the core focus of a recent study by Dunn (2019). She analyzed what properties of early career development networks stimulate future knowledge creation by individuals, and found positive effects of network reach, density, and connections to prominent members in the network. In a longitudinal study set in industrial design industry, Liu et al. (2018) aimed to understand what collaborative strategies make star inventors, and found that links to other creative stars, embeddedness into dense star networks, and expertise similarity with the stars are all increasing the likelihood of becoming a star in the future. The celebrated study of Fleming and colleagues (2007) uses archival data on utility patents and career development of inventors to explore how new combinations are created. The study demonstrates that new combinations are likely to be created in cohesive networks, especially if ego or collaborators bring rich experience to the collaboration. Authors also find that even though more ideas are generated in brokered collaborations than in cohesive networks, such ideas are by far less successful in the future in comparison to ideas originating from cohesive networks. The latter result is in line with Burt's (2004) article about structural holes who was the first to find that despite high quality of ideas originated in structural holes, the distribution of such ideas is constrained by the clash between diverse social worlds.

The study of Sgourev (2015) tells the story of Sergei Diaghilev, explaining what strategies, connections and actions made him an immensely prominent broker in Parisian art world in the first part of XX century, and what unforeseen macro-level consequences were triggered by the work of Diaghilev. Explorative study of Beretta and Søndergaard (2021) set in a crowdsourcing platform, too, tackles the response of the network members to ideas produced by their colleagues. The results show that the public is most actively engaged into supporting and elaborating ideas that are less

elaborated than others, indicating important role of intrinsic motivations to support creators. The latest study by Soda et al. (2021) assesses the dimension of time from a different angle. Authors claim that network stability hinders creativity, as the content becomes rigid and redundant, and suggest that for creators to be able to maintain creativity, network should be reconfigured.

The impact of networking strategies on individual creative performance is not necessarily so deterred, and can span a much shorter period of time, too. Thus, the issue of network activation was also raised in the work of Mannucci and Perry-Smith (2021), where authors explain how mistakes in creators' networking strategies along the creativity continuum can lead to unwanted results. Thus, activating only strong ties in idea generation and elaboration stage leads to developing low quality ideas. Activating only weak ties at these stages of creative process, on the contrary, is likely to lead to proposing very good ideas but dropping them later.

This section, despite limited amount of studies included, leads to several important conclusions. We found that some well-studied network features can have obvious benefits in the short-run, such as brokerage, but become less effective in the long-run; while seemingly more subtle effects of network density are likely to come to fruition with the passage of time. The studies in the sample also show how significantly networks change overtime, and how some network properties, such as network size, are useful for creator at some point of time, and lose its benefits in the other, once again showing that network rejuvenation is crucial to maintaining creativity.

### **Context: Diversity, Domain, Environment, and Alters**

In classic creativity studies, context typically stands for physical and social environment surrounding the individual (Amabile, 1996: 125), and the organizational climate (Hunter et al., 2007). According to investment theory, the environment can facilitate individual creativity by means of inspiration, support and constructive evaluation (Zhang and Sternberg, 2011). Studies in social network domain keep up with the established tradition. The importance of the contextual characteristics on the relationship between network position and creativity has long been recognized by scholars in the field (e.g., Perry-Smith and Shalley, 2003). In this section, a novel way of systematization of contextual moderators of the phenomenon is suggested. Interestingly, even though the variety of potential contextual influences can indeed be vast (George, 2008; Amabile, 1988; Kristensen, 2004), there exists a pattern according to which an efficient synthesis can be performed. Thus the highlights are on the role of network diversity, task, work environment, and alters, correspondingly.

Potential effects of network diversity on creativity improvement have been conceptualized long ago (Perry-Smith and Shalley, 2003). In classic creativity studies, it has been widely accepted that heterogeneity of knowledge stimulates individual creativity (e.g., Amabile, 1983), and that such heterogeneity can be best reached by means of brokering network position (e.g., Burt, 2004), but the detail that for some time remained overlooked in the literature is that even cohesive network structures can be constituted by very diverse agents. In this vein, intra-organizational network diversity can compensate groupthink that is common in cohesive networks and even stimulate the ability to reach the consensus (Kijkuit and van den Ende, 2007). As already mentioned, Kijkuit and van den Ende (2010) find that creative networks characterized by diversity of agents' organizational roles produce ideas with higher acceptance rate. In very deed, Baer (2010b) finds that higher levels of creativity are reached by those network agents who not only hold advantageous network positions, but also are embedded in networks where diversity is high.

Another contextual characteristic that can intervene into network position — creativity relation is the job task of the network agent. Domain specificity versus domain generality of creativity has long been a debate in the literature (see Baer, 2010a, for a review). Some pieces of research from social networks field provide support of domain specificity of creative tasks. For example, surprising finding is reported in a relatively early study of Teigland and Wasko (2009). Their data from a large company demonstrates that in different departments, various behaviors facilitate creativity. Thus employees of Commercial and Support department were found to be creative when they were central in the advice network; and employees of System and Software department encountered no affiliation between centrality and creativity, but were more creative when relied on explicit, rather than tacit, knowledge transfer for information sharing. While such finding may seem intuitive from the diversity of the nature of tasks of these two departments, in social networks literature, it is one of the few to empirically address the relation between network position, task and creativity. Similarly, by focusing solely on science and technology domain, Tang and colleagues (2020) draw readers' attention to how degree centrality can drive creativity given the peculiarity of tasks and work routines in these fields. Another interesting point to consider is the international focus of work. Thus, Chua et al. (2012) explored intercultural creative collaboration and discovered that it can be triggered by strong affect-based ties. In the late article, Chua (2018) finds that for tasks drawing on knowledge arising from multiple cultures, individual creativity can also be stimulated by cultural diversity of network contacts.

Similarly to domain, work environment is known to interplay with network features and creativity (Perry-Smith and Shalley, 2003). Interestingly, contemporary studies demonstrate that certain environmental factors can sufficiently affect the magnitude and even reverse the direction of seemingly well-studied network effects such as brokerage. Thereby Stea and Pedersen (2017) discuss decreasing returns of brokerage and the role of contextual characteristics in it. They find that in uncertain and unpredictable environments, brokering position causes distraction and cognitive overload, hereby hindering creativity, while in less chaotic environments such effect is much milder. Soda et al. (2019) push the idea of possible drawbacks of brokerage forwards. They argue that in collaborative networks where conflicting strategic interests are not present, what positively affects creativity is collective goals prioritization and sense of belonging, both usually reached in closed rather than brokering position. In non-collaborative environments, on the contrary, opportunistic behavior associated with brokerage enhance knowledge acquisition and hence stimulate creativity.

An alter-centric approach to creativity in networks is another interesting phenomenon. The core idea of alter-centric network perspective is to consider network position and expertise domain of direct contacts of an ego, and by these means to evaluate the quality, quantity and sort of resources that ego receives through them. Studies have shown that there may be several factors that make alters catalysts of ego's creativity. Such factors are very different in nature, and go far beyond classic social networks perspective. The study of Rodan and Galunic (2004) was one of the first to assess this phenomenon, showing that heterogeneity of knowledge of alters facilitates ego's innovation performance independently from structural network features. Curiously, similar pattern can be traced in some studies set in open networks using patent data as individual creativity measurement. Thus, Fleming et al. (2007) provide similar arguments, proving that patenting activity is driven by collaborators' relevant experience. The study of Liu et al. (2018) explains that innovators are by far more likely to become stars in case that at some point of their career they collaborated with creative stars. Authors explain that learning experience attained from such cooperations is fundamental for synthesis knowledge assessment. Alters can also impact creators psychologically. For example, Grosser et al. (2017) demonstrate that one's connections to alters with high levels of creative self-efficacy is associated with more innovative behavior, as their skills personality and conduct help ego maximize innovation potential and to adopt the corresponding pattern of behavior. Later Gong et al. (2020) find that tie diversity also indirectly stimulates individual creative performance by boosting self-efficacy. An interesting point of view about

brokerage was suggested by Li et al. (2018). Instead of focusing solely on the benefits of the very broker, authors discuss why it is advantageous for ego to be connected to broker alters. Here, the superior information acquired by the means of bridging position is transmitted via direct ties, and is enriched by broker's own cognitive recombinations and vision. This idea is mirrored in the study of Perry-Smith and Mannucci (2017). Alters' position in the organization can also play an important role. For instance, Kijkuit & van den Ende (2010) show that having links to decision makers and seniors increases the likelihood of creative idea to be accepted. Such alters help ego better match the needs and requirements of the organization. Benefits of connectedness to the leader was further developed and tested by Venkataramani et al. (2014) and Wang et al. (2015).

This subsection briefly overlooks the impact of network context on the association between network features and individual creativity. The studies mentioned in this section highlight several important aspects that are known to affect network mechanisms. Well-studied mechanisms can be altered, facilitated or even reversed, based on what we do, where we do it, and most importantly, with whom we do it. Outtakes from this overview highlight several important aspects. Firstly, network diversity in all its forms has positive influence on meso- and micro-levels, since both overall network structure and our direct connections. Secondly, domain of work can significantly modify networking strategies and overall behavior patterns of creators. Thirdly, work environment, too, dictates certain behavioural patterns that interfere into the work routine of an individual, therefore affecting creative process in social networks. Limitless heterogeneity of contextual factors that influence individual creative process in networks leaves room for numerous alternative explanans. In this case it is not gap in the body of knowledge, but rather opportunity and potential for future research.

### **Ego: Personality, Knowledge and Skills**

In psychology, personality stands for «relatively enduring unique ways that individuals think, act, and feel» (Feist, 2010: 114). It subsumes both cognitive and social traits that significantly affect everyday life of people. Broad empirical evidence shows that personality traits shape creative thought and behavior and can even statistically predict creative success in certain fields (e.g., Feist, 2006), thus there is no surprise in personality psychology scholars having interest in the topic. But what happens when we entwine personality and social networks in a chase of cracking individual creativity?



Recent research advancements adopt such interdisciplinary approach. Complimentary fit argument emphasizes that individual creativity can be facilitated when network structure properties are matching certain personality traits, thus drawbacks of the former can be compensated by the latter and vice versa. For example, Carnabuci and Dioszegi (2015) claim that even though individual creativity is known to be limited in constrained networks, high levels of creativity can be reached when network structure is complimented by innovative cognitive style of the individual. Similar scenario evolves when potentially disadvantageous adaptive cognitive style, when met by beneficial network structure. Analogous line of reasoning was proposed by Rhee and Leonardi (2018) who discuss on optimal combinations of types of individual attention allocation and network structure that would be most beneficial for individual creativity. Authors find that ego's focused attention best fits in constrained networks, while divided attention is needed in networks rich in structural holes.

Curious findings arise from studies that focus on how personality facilitate certain creative behaviours in the network. Thus, Baer (2012) analyzes effects of networking ability, implementation instrumentality and ego's network position on success of a creative idea in the organization. Likewise Zhou et al. (2009) demonstrate that low conformity values facilitate positive effects of weak ties on creativity, as ego is not prone to act strictly according to established social norms. Similarly, openness to experience is found to compliment ego's network position in a way that facilitates individual creativity (Baer, 2010b). Self-monitoring trait adds up to network benefits granted by betweenness centrality position and improves innovation performance (Mehra et al., 2001). Grosser et al. (2018) explain how political skill of the creator together with structural holes can amplify innovation involvement.

It is important to highlight that not only creators' personality, but also their patterns of interaction with colleagues and perception of work environment affects creativity. For instance, Li et al. (2018) find that psychological safety facilitates positive brokerage effects on individual creativity, since ego feels that the network is not dangerous for those taking interpersonal risks. The study of Chua et al. (2010) explore what effects can different kinds of trust have on creators' tendency to discuss new ideas in the network, and find positive impact trust developed on socio-emotional basis makes individuals feel safe to open up and involve in discussions. Recent study of Gong et al. (2020) suggests that diversity of network ties boosts self-efficacy of the individual, thus raising the motivation and leading to better creative performance. Wong and Boh (2014) find that behavioural strategies, such as ambassador activities engagement, can facilitate positive effects of degree

centrality on innovativeness of managers. Finally, Cangialosi et al. (2021) demonstrate that voice behaviour positively mediates the relationship between degree centrality and innovative work behaviour.

Not only personality, but also ego's knowledge and experience can positively interact with network structure and creative performance. Prior literature shows that knowledge is a fundamental building block of individual creativity (see George, 2007, for a review). In network context, this idea finds support. For instance, Kijkuit and van den Ende (2007) make a proposition regarding the importance of domain-relevant knowledge for creative idea implementation in social networks, Tang (2016) demonstrates that diversified and reliable external knowledge positively interplays with ego's centrality and creativity, and Tang et al. (2017) prove that diversified knowledge intensifies the relationship between strength of ties, structural holes and radical creativity. Obstfeld (2005), too, finds that individual innovation involvement, is stimulated by technical and social knowledge, alongside with tertius iungens orientation and dense networks. Similarly, Wang and colleagues (2014) discovered that diversified knowledge of the employee of the firm are likely to be more innovative. In a study about absorptive capacity, Tortoriello (2014) shows that structural holes positively moderate the relationship between external knowledge and innovation generation, allowing the individual to act as internal broker of external information in intra-organizational networks. Lastly, Fleming and colleagues (2007) use patent data to prove that experience is the factor that increases the likelihood of creating new knowledge combinations in dense network structures.

A few studies have focused specifically on effects of demographics on creativity in networks. For example, Whittington (2018) analysed gender differences in network positioning of science inventors and her findings revealed that women are less likely to become brokers and are more prone to staying in peripheral positions than men.

As it can be seen from this subsection, ego node's personality, perceptions and knowledge influence individual creative process in social networks very significantly. Classic creativity studies suggested that creativity of an individual is related to knowledge. It is not surprising that in the network context, this association prevails, and a number of studies in the sample empirically prove that domain-relevant knowledge drives creativity in networks. More heterogeneity of findings arise from intersections of social networks and personality literatures. We know that certain personal traits, such as openness to experience or low conformity values, and certain social skills and

abilities can improve not only the overall performance (e.g., Fang et al., 2015), but also creative performance of an individual. But regardless ego's personality and knowledge it is also crucial how they feel and desire to act at work. This finding is extremely curious, since it shows to what extent creators are responsive to external environment at a deep personal level, and how much potential people have to make their colleagues flourish or suffer.

### **Suggestions for Future Research**

As it stems from *Table 3*, there are plenty opportunities for future research. A few promising directions that have potential to contribute to our understanding of individual creativity in networks are spotted below. Thus in creativity in networks studies, the number of context and ego constituting variables remains small, giving room for new research opportunities. For example, demographics (Feist, 2006), Big Five personality traits (Zare and Flinchbaugh, 2018), motivation (Amabile, 1988), affect (Zhou et al., 2019) are known to affect creative outcomes, and yet these concepts have not been put together with social networks yet. Interestingly, while data unequivocally claim that contextual characteristics and ego's traits can indeed significantly affect creative process and outcomes, in social networks domain, there is almost no evidence regarding the interplay of personality and context. An established line of research has proven that individual creativity varies depending on the task (Baer, 2010a), and that certain kinds of tasks attract and grant creative success to certain kinds of personalities (Gotz and Gotz, 1973). Thus Feist (2006) in a meta-analytical study has found that curiously, scientific creativity in different domains can be triggered by opposite traits, so that mathematicians were more creative when introverted, and social scientists were more creative when extraverted. Therefore it is surprising that up to date, the research on interplay of profession, personality and social networks is underdeveloped. Hereby a joint effect of such characteristics could help soothe the conflict between major theories, and uncover novel mechanisms of creative work.

Another prospective idea concerns further development of social network structure and network dynamics relation. Network formation, genesis, and decay have been a topical stream of interpersonal network research, but yet only minor attention has been payed to how this phenomenon affects -- or is affected by -- creativity. Some existing pieces of research acknowledge the importance of individual agency in shaping and reshaping networks along the stages of creative process (Kijkuit and van den Ende, 2007, 2010; Mannucci and Perry-Smith, 2021; Donati et al., 2016). Nevertheless empirical results are rare and therefore even conceptual picture is still lacking

clarity in details. Interesting findings arise in the area of employees turnover, proving that organizational change associated with creativity in networks can move beyond and away from organizational boundaries. For example, Zhang et al. (2017) discuss on the interdependence of network position, turnover rates and individual innovation performance. Authors suggest that ego's centrality and embeddedness in stable network components create favourable conditions that an inventor would not want to give away, thus network will be more stable. Low turnover rates, in turn, positively interact with innovation performance, since high-performers are typically satisfied with their job. Some other studies set in open networks (Soda et al., 2021; Seibert et al., 2017) analyse prolonged impact of network dynamics, but do not take into consideration such important factors as ego and context.

### **Conclusion**

Research in the domain of individual creativity in social networks is diverse and arises from dissimilar fields. By following post-structural social network research tradition, this review has sought to systematize the findings of published studies. By means of such synthesis, a novel three-dimensional model of creativity in social networks was proposed, thus deepening the academic knowledge of creative process. Contradictions existing between main established theories in the field were resolved in the process of deconstruction and synthesis of empirical results and conceptual propositions of 57 articles. Despite the high heterogeneity of studies included into the literature review in terms of sample size, industry setting, and analytical approaches, this work provides a complete interpretation of individual creative process in social networks that can be universally used by researches and practitioners. The proposed model can be widely used both by scholars interested in organizational behavior, creativity, or networks, and by practitioners interested in understanding of creativity at work and determined to apply this knowledge in organizations. Key opportunities for future research are described, and it can help push knowledge further and use contemporary methodological advancements together with classic theories. The main call that this review is supposed to transmit is that creativity should be understood and interpreted as complex multidimensional phenomenon, and only by these means can academia unravel the mystery of creativity of a human.

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## Tables

*Table 1. Articles reviewed*

Study	Network features	Creative process dimension	Key findings
Ibarra (1993)	aggregate network centrality	-	In a study about the influence of power on innovation involvement in organizations, discovered a mediating role of network centrality.
Mehra, Kilduff & Brass (2001)	betweenness centrality network size	Ego: Self-monitoring	Found support for additive positive effects of self-monitoring and betweenness centrality and negative effects of network size on innovation performance.
Perry-Smith & Shalley (2003)	strong ties closeness centrality outside ties core/periphery	Context: Work environment	Suggested a dynamic model of intra-organizational creativity, where individuals initially reach highest levels of creativity when holding a peripheral position with a large amount of outside ties, and by these means ego gradually becomes more central, thus risking to constrain creativity.
Burt (2004)	structural holes	-	Fundamental study explaining how structural holes lead to good ideas.
Rodan & Galunic (2004)	network diversity network sparseness	Context: Alters	Discussed the differences between network sparseness and heterogeneity of knowledge present in the network, and showed how they separately and jointly influence innovation performance.
Obstfeld (2005)	network density	Ego: Tertius iungens orientation, Knowledge	Found that involvement in innovation is stimulated by tertius iungens behavioural orientation, dense networks and ego's technical and social knowledge.
Perry-Smith (2006)	weak ties closeness centrality outside ties	-	Showed that weak ties are associated with creativity. Discussed the positive effects of interplay of closeness centrality and outside ties on individual creativity.
Kijkuit & van den Ende (2007)	network density network size weak ties strong ties	Creativity continuum; Context: Alters	From idea generation through idea evaluation, increasing level of cohesion, decreasing network size increase probability of idea acceptance. Ties to decision makers are helpful during initial and medium stages of creative process.
Fleming, Mingo & Chen (2007)	network density brokerage	Ego: Experience; Context: Alters; Network dynamics	Demonstrated that in cohesive networks, new combinations are more likely to be created if ego or alters have rich experience. Discovered that ideas originating from dense networks are more likely to be used in the future than ideas generated in brokered collaboration.

Study	Network features	Creative process dimension	Key findings
Cattani & Ferriani (2008)	core/periphery	-	Studied the impact of core/periphery phenomenon using the archival data in Hollywood motion picture industry and found that individual creative performance is enhanced in intermediate positions between periphery and core.
Teigland & Wasko (2009)	closeness centrality	Context: Task	Proved that for employees of different organizational departments, effects of network centrality and network sources of information on creative performance vary.
Zhou, Shin, Brass, Choi & Zhang (2009)	weak ties network density	Ego: Conformity value	Substantiated a curvilinear relation between number of weak ties and creativity and the negative moderating role of ego's conformity value.
Baer (2010)	network diversity network size weak ties	Ego: Openness to experience	Claimed that weak ties, moderate network size, high network diversity are proper to creativity, and these network properties can best be put to use by individuals scoring high on openness to experience.
Kijkuit & van den Ende (2010)	network density network size strong ties network diversity	Creativity continuum; Context: Alters	Discovered that large sparse networks are beneficial at idea initiation and development stages, strong ties and network diversity are advantageous during idea development, dense networks are beneficial for idea refinement stage. Ties to decision makers are advantageous throughout entire creativity continuum.
Tortoriello & Krackhardt (2010)	Simmelian ties	-	Argued that Simmelian ties (e.g., reciprocally connected to one another and a third party) across organizational units are associated with number of patents filed by individuals.
Lingo & O'Mahony (2010)	brokerage	Creativity continuum	By using qualitative methods, explained what practices creators use to overcome ambiguity along the four stages of creative process.
Chua, Morris & Ingram (2010)	network embeddedness	Ego: Trust	Explored diverse effects that affect- and cognition-based trust have on the relation between network embeddedness and tendency to discuss new ideas.

Study	Network features	Creative process dimension	Key findings
Baer (2012)	strong ties	Ego: Networking ability and Implementation instrumentality	Proved that success of creative idea depends on ego's skills to develop and use social networks, and determination to realize creative ideas.
Chua, Morris & Mor (2012)	strong ties	Ego: Cultural metacognition	In a study about cultural metacognition, found significant correlation between strength of ties and creative collaboration.
Dahlander & Frederiksen (2012)	core/periphery	-	Explained that user innovation is facilitated by access to multiple online communities and by median positions along core/periphery continuum.
Aubke (2013)	network diversity small networks	Network dynamics	Studied creative productivity of Michelin-Starred chefs and discovered high degree of heterophily in terms of experience, skills and creativity. Explored ego network evolution overtime and found that creativity is stimulated in smaller ego networks.
Zou & Ingram (2013)	structural holes	-	Studied network effects on job performance, and proved that structural holes across the organizational boundary boost creativity.
Perry-Smith (2014)	strength of ties	Ego: Nonredundant framing	Based on balance theory, demonstrated how nonredundant framing effects on creativity vary based on strength of the tie.
Jokisaari & Vuori (2014)	network density strong ties	Restricting condition: Newcomers	Newcomers are innovative when embedded in sparse networks or when having high incoming tie strength, but not simultaneously.
Venkataramani, Richter & Clarke (2014)	betweenness centrality external ties	Context: Alters	Explored the relationship between employee's network position and radical creativity based on team leader's network position.
Tortoriello (2014)	structural holes	Ego: External knowledge	In a study about individual absorptive capacity, demonstrated that structural holes positively moderate the relationship between ego's external knowledge and innovation generation.
Wang Rodan, Fruin & Xu (2014)	structural holes degree centrality	Ego: Knowledge	Found that structural holes and degree centrality make researchers more and less innovative, correspondingly.
Wong & Boh (2014)	degree centrality	Ego: Ambassador activities	Central actors are innovative when they use benefits of their position to engage in ambassador activities.



Study	Network features	Creative process dimension	Key findings
Tortoriello, McEvily & Krackhardt (2014)	diverse knowledge clique	-	Explained why embeddedness into a diverse knowledge clique helps employees become catalysts of innovation to boost their creativity of their colleagues.
Carnabuci & Dioszegi (2015)	structural holes network constraint	Ego: Cognitive style	In brokering networks, adaptive cognitive style facilitates innovative performance; while in closed networks, innovative cognitive style is beneficial.
Hirst, Van Knippenberg, Zhou, Quintane & Zhu (2015)	reach efficiency	-	Links to nonredundant actors, as embodied by reach efficiency, are positively associated with creativity.
Sgourev (2015)	brokerage core/periphery	Network dynamics	In a qualitative study about Diaghilev, explains what conditions can facilitate catalytic functions of brokerage and to what micro/macro level results in can lead in the long-run.
Wang, Fang, Qureshi & Janssen (2015)	strong ties outside ties	Context: Alters	Showed how individual innovative behavior depends on interplay of ego's prominence in intra-team network and leader-member relationship.
Donati, Zappala & Gonzalez-Roma (2016)	network density strength of ties	Creativity continuum	Strength of ties and density in advice network and friendship networks are positively related to individual innovative behavior.
Dolfsma & van der Eijk (2016)	network distance	-	Investigated effects of ego's increased network distance to informationally important alters facilitates ego's creative performance.
Seibert, Kacmar, Kraimer, Downes & Noble (2017)	strong ties network diversity	Network dynamics	Found that success of academic publications in terms of citations, quality and number is driven by coauthoring heterogeneity and number of strong ties in support network.
Perry-Smith & Mannucci (2017)	weak ties strong ties outside ties structural holes structural closure	Creativity continuum; Context: Alters	Conceptualized optimal network positions for four stages of creative continuum, stating that weak ties and structural holes trigger idea generation; strong ties jog idea elaboration; direct and borrowed structural holes facilitate idea championing; and structural closure and outside ties push idea implementation.
Zhang, Duan & Zhou (2017)	closeness centrality degree centrality	-	Found that brokering or central positions prevent ego from turnover and are related to better innovation performance.

Study	Network features	Creative process dimension	Key findings
Stea & Pedersen (2017)	structural holes	Context: Work environment	Discussed decreasing returns of brokering position and demonstrated a negative role of distracting environment and cognitive overload.
Tang, Zhang & Naumann, S. E. (2017)	structural holes strong ties	Ego: Knowledge	Suggested that strong ties and access to structural holes, together, facilitate radical creativity, and studied what role ego's external knowledge plays in this association.
Li, Li, Guo, Li & Harris (2018)	betweenness centrality	Context: Alters; Ego: Psychological safety	Discussed the relationship of borrowed structural holes, perceptions of psychological safety in the organization, and creativity enhancement.
Grosser, Obstfeld, Choi, Woehler, Lopez-Kidwell, Labianca & Borgatti (2018)	structural holes	Ego: Political skill	Innovation involvement is stimulated by ego's political skill, and this relationship is positively moderated by structural holes in the network.
Whittington (2018)	brokerage  core/periphery	Ego: Gender	Investigated effects of gender on collaboration positioning and characteristics in STEM field and found significant differences in levels of brokerage, relations to alters and patent performance.
Liu, Mihm & Sosa (2018)	network density	Context: Alters	Inventor is likely to become a star when embedded into a dense co-star network, but in a non-star networks, the effect is opposite.
Rhee & Leonardi (2018)	network constraint	Ego: Attention allocation	Found that ego's focused attention fosters innovative behavior in constrained networks, while diversified attention is more beneficial in unconstrained networks.
Chua (2018)	network diversity	Context: Task	Culturally diverse networks facilitate culture-related novel ideas and enhance creativity for tasks that build on multicultural knowledge.
Soda, Stea & Pedersen (2019)	structural holes	Context: Work environment	Linked collaborativeness of work environment to brokering position and showed that in collaborative networks, brokerage does not enhance knowledge acquisition and thus does not drive individual creativity.
Gomez-Solorzano, Tortoriello & Soda (2019)	Simmelian ties	-	Revealed that embeddedness into an affect- or knowledge-based clique boosts innovative performance, but embeddedness into both kinds of cliques is more challenging than beneficial.
Dunn (2019)	network reach  network density	Network dynamics	Analyzed developmental networks of novice professionals to find what future knowledge creation depends on.

Study	Network features	Creative process dimension	Key findings
Gong, Kim & Liu (2020)	network diversity strong ties	Ego: Self-efficacy; Context: Alters	Demonstrated that tie diversity stimulates creativity via employees' creative self-efficacy, and that strong ties facilitate this effect.
Ter Wal, Criscuolo, McEvily & Salter (2020)	dual networking degree centrality	-	Introduced a concept of dual networking — connecting to different individuals in same groups — and showed how it affects innovation performance.
Maoret, Tortoriello & Iubatti (2020)	core/periphery	-	Investigated how formal and informal intrafirm networks interplay and how core/periphery positions in them affect the productivity of incremental innovation.
Tang, Zhang & Reiter-Palmon (2020)	degree centrality	Context: Task; Ego: External knowledge searching	Drew attention to creativity in the domain of technology and science and demonstrated that team degree centrality enhances creativity and also facilitates positive effects of external knowledge searching.
Beretta & Søndergaard (2021)	degree centrality	Network dynamics	Explored behaviour of employees on internal crowd-sourcing platform and distinguished five kinds of participants dissimilar in their levels of centrality and idea productivity.
Soda, Mannucci & Burt (2021)	network stability open networks	Network dynamics	In a longitudinal study, explored how the association between open networks and creativity changes overtime.
Cangialosi, Oboardi, Battistelli & Baldaccini (2021)	degree centrality	Ego: Voice behaviour, Tenure	Investigated positive impact of degree centrality on innovative work behaviour and the role of voice behaviour and organizational tenure.
Mannucci & Perry-Smith (2021)	weak ties strong ties network size	Creativity continuum, Network dynamics	Experimentally studied how individuals switch ties along creative process and what consequences it can trigger. Discussed negative impact of large networks on idea generation and elaboration.

Table 2. Core positive interactive effects of network properties, context and ego on creativity continuum and creative performance

Theory	Network properties	Creativity continuum stages				
		Idea generation	Idea elaboration	Idea championing	Idea implementation	Creative performance
SWT	weak ties	✓				✓
	network size	✓	✓			
SCT	strong ties		✓	✓	✓	✓
	closeness centrality					✓
	network density		✓	✓	✓	
SH	structural holes	✓				✓
	betweenness centrality	✓				
core/periphery						
No specific SN theory	degree centrality					✓
	network constraint					✓
	network diversity	✓				✓
	Simmelian ties	✓				✓

Table 2. Three-dimensional model of creativity drivers in networks

		Dimension: Creativity continuum			Creative performance
		Idea generation	Idea elaboration and championing	Idea implementation	
<b>Dimension: Context</b>	Diversity	Weak ties			
	Non-distracting environment				Structural holes
	Competitive environment				Structural holes
	Collaborative tasks				Closeness centrality
	Connection to leaders		Network density	Network density	
	Knowledge of alters				Network density
	Technology and science domain				Degree centrality
	Task based on diversity				Network diversity
<b>Dimension: Ego</b>	Knowledge	Weak ties			Strong ties Structural holes Degree centrality
	Experience				Network density
	Gender				Structural holes
	Political skill				Structural holes
	Self-monitoring				Betweenness centrality
	Low-conformity value				Weak ties
	Implementation instrumentality				Strong ties
	Cultural metacognition				Strong ties
	Trust				Network embeddedness
	Self-efficacy				Network diversity Strong ties
	Voice behaviour				Degree centrality
	Ambassador activities orientation				Degree centrality
	Tertius iungens orientation				Network density
Focused attention				Network constraint	

## CHAPTER II

### **Not so social networks: Does solitude make us creative?**

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#### **Abstract**

This exploratory paper seeks for novel explanans of individual creativity in intra-organizational networks. Building upon emerging interdisciplinary theory of social networks and personality, this study introduces a new variable and potential driver of creative performance as embodied by preference for solitude. In particular, we claim that solitary individuals shape their creative process in a different way, and that in the context of intra-organizational network, such people would benefit from seemingly constraining network properties. We test the theory in R&D department of a large company operating in gas machinery industry in Western Russia. The findings support our hypotheses. Implications for theory and practice are discussed.

*Keywords: social network analysis, creativity, personality, preference for solitude*

## Introduction

Creativity has captured the minds of thinkers of numerous backgrounds for centuries, with first references stretching back to ancient times (see Runco and Albert, 2010, for a review). Intuitively, this phenomenon seems to be at its highest potential in the world of cultural and creative industries, nevertheless creativity emerges in any context where original solutions must be searched for. It can be defined as the organized process through which an agent, both individually and collectively, creates a novel and useful idea (Amabile, 1983). Fundamental theories argue that individual creativity is firmly grounded in the social environment and is constantly affected by it (Csikszentmihalyi, 1988; Amabile, 1983). Social network literature supports this logic while representing the structure of human interactions more systematically: pictured as a set of nodes that stand for people, and links that connect them, capturing interactions that take place, network approach allows researchers to put the complexity of communication patterns on one graph (Kilduff and Brass, 2010). Social network researchers have discovered novel exciting facets of individual creative process in organizations. Studies reveal that certain network patterns are affiliated with larger pool of opportunities for creators, and that some network agents hold advantageous positions exposing them to more domain-relevant information, power to pursue legitimacy, attract the needed resources and positively affect the decision-making process (Kijkuit and Van den Ende, 2007; Burt, 2004; Perry-Smith and Shalley, 2003; Baer, 2010). Indeed, researchers can derive a lot of significant inferences from a given network structure. For instance, recent studies explicitly demonstrate that degree centrality can prove very beneficial for individual creativity in the context of intra-organizational network. It helps spark creative ideas (Donati et al., 2016), facilitates creative exploration (Hanh et al., 2015), ensures creator with ability to transform knowledge into plausible creative outcomes (Tang, 2016), and sufficiently improves overall innovation performance (Zhang et al., 2017). In this vein, efficient networking and active interaction associated with it appears to be a necessary prerequisite to individual creativity.

But while research in organizational behavior and interpersonal networks literature claims the aforementioned, literature in psychology has another point to make. Personality studies remind us that creative tasks are not all alike, and for different kinds of those, various personality traits and communication patterns are beneficial. For example, extraversion is majorly expected to be a creativity trigger, as extraverts are outgoing and enthusiastic (Zare and Flinchbaugh, 2019). However, when we contextualize this personality trait to the field of expertise, we find that for certain fields, such as science or art, introversion is essential (Feist, 2006; Gotz and Gotz, 1973). If

we look back in the history, it is not rare that highly talented creative people were in some way prone to lower extents of socialization, if not offishness. Reasons behind this vary from high levels of introversion to mental disorders (Silvia and Kaufman, 2010), and in any case, from network perspective, the outcome is smaller networks with less power (Kaufman, 2001; Feist, 2006). Moreover, we find that for some creative tasks that require deep concentration networking may be a hindrance (Feist, 2006, 1998; Wolfradt, 2001), while solitary activities may be triggers. Interestingly, this idea is partially mirrored in organizational behavior literature, showing, for example, that brainstorming sessions negatively affect the quality of creative ideas in comparison to isolation (Putman and Paulus, 2009).

Although employee creativity is generally known to be fundamental for firms (e.g., Anderson et al., 2014; Perry-Smith and Mannucci, 2017), recent disruptive events associated with the global pandemic revealed that at time of dramatic change in work routines, creativity can be a crucial tool for survival (Kapoor and Kaufman, 2020). Scholars' attention is now drawn to creativity more than ever, and we start to notice not only its new dimensions, but also problems relating to those. Thus, pandemic clearly exposed and intensified problems relating to the social side of creativity. Under conditions when physical proximity to colleagues has become a life threat, with a massive shift to smart-working and overwhelming feelings of distress that people faced (Nitschke et al., 2020), it has become crucial to explore how -- and if -- creativity can be attained in solitude.

In this article, we focus on interrelation of creative individual and solitude, adopting the concept of preference for solitude as an explanans for intra-organizational creativity. Preference for solitude (PFS) is conceptualised as «desire to be alone in order to become engaged in an activity that has intrinsic appeal» (Marcoen and Goossens, 1993, p.198). Voluntary chosen solitude is an appropriate condition for enlightenment, known for unfolding creative potential, and helping to find the clarity of thought (e.g., Long et al, 2003; Nguyen et al., 2018). In a way, solitude as condition and PFS as behavioral predisposition have always been essential to the lone genius type (e.g., Schumpeter, 1942; Storr, 1988). In the context of organization, such lone geniuses are usually those workers who produce innovative outputs independently, without much external stimuli or active networking (Shaffer et al., 2016). While we are well aware that sociable, active, outgoing people who are good at managing their social capital and establishing the needed contacts have means to be highly creative and successful at work (e.g., Baer, 2010; 2012; Fang et al., 2015; Mehra et al., 2001), we do not really know much about potential benefits of employing solitary people. Notwithstanding



solitary people -- or people with high PfS -- have tendency to fall into category of people who are expected to be distinctively creative. In this vein, it is crucial to study their creative process and what is their mechanism of putting networks to use. In psychology literature, solitary individuals remained understudied for decades since Burger's (1995) scale, but in last years the interest to the topic increased significantly, once again proving the relevance and topicality of the phenomenon (Wright and Silard, 2021; Ren and Evans, 2021; Lay et al., 2019; Coplan et al., 2019a; Coplan et al., 2019b; Hill and Zheng, 2017).

When it comes to PfS, scholars in the field tends to draw the line between solitary and non-solitary individuals. Indeed, these two categories of people usually demonstrate directly opposed reactions to external stimuli, have different communication strategies, and are even perceived and treated differently by peers (Burger, 1995; Coplan et al., 2019; Ren and Evans, 2021). The findings from prior literature allow scholars to place solitary individuals into a separate cluster and study them separately from non-solitary individuals. In this vein, it becomes difficult to treat PfS as a linear variable in theory building and data analysis. Therefore the optimal empirical strategy is to break respondents into two groups, namely, from low to median, median to high values on PfS scale, instead of rating the variable as continuous (e.g., Ren and Evans, 2021; Coplan et al., 2019). This approach is common in personality field. For example, a similar strategy is used in studies about extraverts and introverts who, like solitary and non-solitary individuals, represent two poles of one continuum. Thus, classic studies in the field distinguish between extraverts and introverts when it comes to theory building and empirical analysis (e.g., Gray, 1970; Landis, 2016). To sum up, in line with the prior research, we follow the established approach and focus solely on solitary individuals.

Our interest in this study is to integrate the contributions of interpersonal networks and personality streams of research in order to assess individual creativity. Hence the research question of the paper is the following: *what affects creativity of solitary individuals in the intra-organizational network?* Answering this question is important because it shows how seemingly undesirable personality trait in the context of intra-organisational network can have considerable positive outcomes in terms of creative performance. It also has the potential to advance our understanding of creativity in social networks by suggesting a novel explanation to a paradox of why advantageous network positions do not always have positive effects on individual creativity, and what it has to do with one's personal needs and abilities. Lastly, it can support organizations to better design the work process and

modify organizational routines, given the interplay between the dimensions of network and personality, in order to exploit the creative potential of workers.

We test the theory in the R&D department of a large gas machinery company where creativity is part of the technical process of finding novel and useful solutions in terms of new products to satisfy the market. Here the creative dimension has two characteristics: it is a collective condition (Hargadon and Bechky, 2006) where the complexity of issues requires solutions that combine knowledge, efforts, and abilities of people with different expertise and abilities (Eisenhardt and Brown, 1998; Eisenhardt 1990), and it is also connected with the individual ability for searching, focusing on the problem and organizing attention for individual creativity. Our findings support the proposed theory and demonstrate that solitary individuals are more likely to be creative when their degree centrality is relatively low, and that this relation is affected by their job rank.

The paper proceeds as follows. In the next section, we overview interdisciplinary theoretical background on creativity embedded in social networks, on the one hand, and creativity rooted in personality traits, on the other. Our interest is to understand what makes solitary individuals creative, thus we posit five hypotheses about the nature of their creative work in intra-organizational network, given their PfS, degree centrality and job rank as engineers. Further, we describe the research setting, participants and their creative process in the organization. We give a brief overlook to data collection procedure, explain the measures and the statistical model. Lastly, we provide results and discuss the findings.

## **THEORY**

### **Social side of creativity**

Creativity is a phenomenon of crucial importance. Analyzed as a source of innovation and economic development (Pratt and Jeffcutt, 2009), as goal and result (Oldham and Cummings, 1996), as a moral imperative (Osborne, 2003), and as a collective process (Weick and Roberts, 1993; Hargadon and Bechky, 2006; Perry-Smith and Shalley, 2003), creativity emerges as a key concept both in the domain of cultural and creative industries and in any organization striving to exploit its potential in terms of production of new ideas, processes, and products. Systems view of creativity (Csikszentmihalyi, 1988) urges scholars to contextualise the phenomenon of creativity, claiming inseparability of creative individuals from the social structure they are embedded in, as it appears to be a source of information and mutual influences. Creative outputs undergo series of

evaluations and judgments of the field (Zhou et al., 2019) that pick out the true creative from «statistically improbable or bizarre» (Csikszentmihalyi, 1988, p.48). In this vein, the very existence of phenomenon of creativity is deeply rooted in the fact of social agreement and, consequently, the society (Sgourev, 2015). In modern organizations, creativity is seen from a broad perspective and takes diverse forms. Thus, contemporary research often assesses individual creativity through such variables as patents (e.g., Li et al., 2018; Whittington, 2018), innovation productivity (Maoret et al., 2020), innovative work behaviour (Cangialosi et al., 2021), academic articles (Forti et al., 2013) and more, in addition to more classic approaches (e.g., Mannucci and Perry-Smith, 2021; Gong et al., 2020). However, the essence remains unshaken: despite existing heterogeneity all scholars seem to agree that distinctive feature of creativity is that outputs in question should be both novel and useful (Amabile, 1983). For example, as George (2007) notices, individual-level problem solving that is necessary in every organization can be viewed as creativity in case that solutions used to tackle the problem are not only useful, but also novel. Moreover, Csikszentmihalyi and Sawyer (1995) suggest that problem identifying and solving are integral parts of individual creative process.

Not only the receiving side of creativity (Zhou et al., 2019), but the creative process, too, is rooted deeply into human relations. Elaborating on that, organizational behavior literature stresses that creativity is triggered by social contexts and networking, proving that even initially creative individuals need support and incur into positive impacts of such aspects as the presence of inspiring and encouraging supervisors (Oldham and Cummings, 1996), creativity prompts (George, 2007), and help and acceptance of colleagues (Amabile, 1998). Talking about how networking contributes to individual creative performance gradually takes us to social networks domain that structurally represents traces of interactions as a graph of nodes — people — and links that connect them. Social networks and creativity field has been unfolding lately and has significantly contributed to our understanding of individual creativity. Hereby Perry-Smith (2006) has shown that network ties stimulate creativity by means of linking an individual to heterogeneous contacts that provide one with non-redundant information. Professional domain-specific knowledge of that kind is an essential component of creativity (Amabile, 1988), since it urges deliberate pondering process that results in creative performance enhancement (George, 2007). In this vein, degree centrality that is conceptualized as the number of direct ties to network agents is supposed to be a powerful driver of individual creativity. It facilitates creativity in intra-organizational networks by means of providing creator with power of masterly exploitation of the social capital (Perry-Smith, 2003; Tang, 2016). For example, Wong and Boh (2014) theorize that since central network agents are often in position

of power and social influence (Ibarra and Andrews, 1993), their ideas are typically perceived as high quality, which attracts resources and social support. Recent studies, too, suggest that central positions in the network expose individuals to relevant professional information necessary for improving innovative behaviour (Cangialosi et al., 2021).

However, centrality does not necessarily guarantee better creative performance. From prior literature, we know that networks are not completely static (e.g., Soda et al., 2021). On the contrary, they are dynamic (see Ahuja et al., 2012, for a review), and yet that some established patterns tend to preserve (Burt, 2012). But what does it really represent? Are network shifts driven by changes on macro or micro level? In other words, are network structures imposed by the organization itself, thus reflecting its global goals, culture and strategy; or are they a collective product of a group of people and their agencies, personalities and skills?

We fundamentally believe that it is in fact a delicate balance between the two. For example, the network structure as «given» is predefined by macro-level factors, such as organizational culture that can promote certain work-related ideologies and create an environment that would reflect overall network pattern (Stea and Pedersen, 2017; Soda et al., 2019; Hahn et al., 2015). Organization-level goals relating to creativity, too, would usually dictate a certain work routine, resulting in established network structure (Chua, 2018; Soda and Zaheer, 2012). In addition to that, prior literature shows that certain categories of employees naturally draw in attention of their colleagues, thus attaining structurally prominent positions in the network. For instance, managers and supervisors tend to attain central positions in the network, as their daily tasks require direct coordination of many subordinates (e.g., Perry-Smith and Shalley, 2003; Venkataramani et al., 2014; Wang et al., 2015). Hence the very essence of work routines of workers would nudge them to reach out to superiors whenever advice, clarification or instructions are needed. Similarly, senior staff usually happens to gain prominent positions in the network, since they are commonly perceived as knowledgeable and trustworthy, due to their notable experience and history of relations within the company (e.g., Kijkuit and Van den Ende, 2007; Landis, 2016). In this vein, one can say that network pattern is largely affected by formal procedures and the hierarchical structure of the organization (e.g., Soda and Zaheer, 2012). In a way, prior literature leads us to assumption that, first, more employees placed high in organizational hierarchy often carry the responsibility of navigating their colleagues, and second, that network agents would naturally flock around those colleagues who appear objectively superior in certain aspects.

But regardless, when it comes to networks formation and use, one cannot neglect the role of individual conscious agency (e.g., Kilduff and Brass, 2010). Individual-level factors are at the core of post-structural approach to social networks (e.g., Landis, 2016) that invites complimentary explanans to effectively interpret processes taking place in interpersonal networks. Post-structural approach can be viewed as an advancement to the social networks theory, where pioneer studies tend to focus solely on structural network features when exploring the multitude of its potential effects on individual creativity (e.g., Ibarra, 1993; Perry-Smith, 2006; Cattani and Ferriani, 2008). In contrast to that, post-structural approach, while heavily relying on structural network features and contributions of the classic studies in the field, emphasizes that the association between network structure and creativity can be heavily influenced by third factors, such as, for example, personality or cognition (e.g., Cangialosi et al., 2021; Soda et al., 2019; Rhee and Leonardi, 2018). In this vein, post-structural approach provides opportunities of entwining social networks literature with diverse disciplines, sufficiently enriching the field. Burt et al. (2013) mentions that it is not networks that take actions, but people. People are not utterly rational and they do not always use — or cognize — available opportunities. One can have all the network tools to be more creative and yet not use them (e.g., Wong and Boh, 2014). Empirical evidence illustrates that even those individuals who hold powerful network positions do not always make perfect use of it, and do not always perform better than the rest (see Burt et al., 2013, for a review). This, of course, may be due to the fact the perception of self-position in the network is usually biased (Brands, 2013), which constrains the agency. But another reason for this phenomenon may be hiding in a set of conscious choices made by each individual in the network. Prior research proves that individuals do tend to recreate networks of similar structures under different circumstances, demonstrating surprising consistency (Burt, 2012). This finding allows us to suggest that people indeed have power to deliberately form their networks based on their personal qualities. So what are these choices driven by? The literature on networks and personality is rich in examples of interdependence of traits network patterns, repeatedly proving that certain aspects of our personalities can dictate network patterns that we are likely to be engaged in (see Landis, 2016, for a review). Personality traits tend to affect one's goals, perceptions, values and behavior, a collective of which is responsible for social manifestation. For example, people who normally long for new and original experience are by far more likely to become brokers in the network (Baer, 2010). Interestingly, the size of ego network, too, is affected by personality traits. Thus outgoing and active individuals enjoy taking part in social interactions at work and engage in those rather easily, which results in big amount of network contacts (Casciaro, 1998; Pollet et al., 2011). Other people, on the contrary, are prone to avoiding active network

interaction. Neurotic and shy people, for instance, tend to occupy peripheral positions in the network (Clifton et al., 2009; Klein et al., 2004). In other words, it is apparent in prior literature that some people can be less or more willing to get involved in a certain model of interaction due to a set of psychological traits or contextual characteristics (e.g., Kim et al., 2016; Baer, 2012).

In the following subsection, we aspire to explore this relation further. We undertake a modest attempt to adopt the post-structural approach to interpersonal networks and turn creativity and networks stream of research away from the *homo economicus* scenario by proposing a complimentary explanans to individual creativity in interpersonal networks, based on a given network structure and personal agency.

### **Preference for Solitude as creativity fount**

As we turn to creative individual as human being having an established set of aspirations, talents, and psychological traits, we discover a brave new world of personality studies (see Feist, 2006). These characteristics show who we are and give a hint of how we are likely to behave in social networks (see Landis, 2016, for a review). Previous research has demonstrated that creativity is rooted deeply in such personal capacities and abilities as creative thinking skills, intelligence, intrinsic motivation, passion, out-of-the-box approach, curiosity and other (e.g., Amabile, 1998, 2005; Sternberg, 2006; George, 2007). Beyond doubt, such powerful drivers of creativity can shape one's success. But even a person possessing all of these outstanding qualities would still need to facilitate their natural abilities and take some time pondering in order to understand how to apply them correctly. Intense thinking associated with it requires sufficient cognitive effort and deep concentration, a condition that usually happens when people encounter solitude (Storr, 1988; Long et al., 2003; Nguyen et al., 2018).

Solitude is known for its controversial standing in the field of social psychology. On the one hand, it is often associated with highly negative effects, such as depression, boredom and loneliness and sometimes is attributed to consequences of those (Larson, 1990). Historically, coercive solitude has been applied as punishment (Suedfeld, 1974). In this vein, one can masterfully derive that being alone is an undesirable condition that one should never desire. But on the other hand, however, solitude leads to a number of positive outcomes. Storr (1988) has provided numerous examples of religious leaders, famous writers and other historical figures belonging to various historical epochs who experienced solitude — on their free will or under compulsion — and benefited from it. For example, Fyodor Dostoevsky has developed three ideas for novels during the short period of time at

the very beginning of his imprisonment when he was not allowed to read and write (Storr, 1988). These ideas and experiences have later become the basis and plot of «The House of the Dead», and further several ideas from this one were extrapolated to one of his most celebrated novels, «Crime and Punishment» that has unprecedented cultural influence. But would Dostoyevsky discover his inner genius if he never experienced confinement? Would he be able to devote enough time to mentally decompose events of his life and then merge them up in a completely different way, to see them from another angle, — and to write about it in a way that he did?

Despite the fact that solitude is commonly experienced by people when they are alone, physical separation from others is not a necessary condition. Unlike isolation, solitude can actually happen in the presence of other people (Burger, 1995; Long et al., 2003), in the form of, for example, feeling alone in the company (Long and Averill, 2003), or online social networking (Hill and Zheng, 2017). Not scared off by the pessimistic mainstream image, Long et al. (2003) list functions of solitude, mostly positive, naming problem solving, inner peace, self-discovery, and creativity. While the first three functions set overall favourable psychological environment for productivity, the latter one is the very focus of the current paper. As Long and Averill (2003) explain, condition of solitude stimulates imagination, leading to novel ideas and insights. In solitude, creators are more sensitive to their thoughts and feelings, thus understanding themselves better and embracing their unique approach to creative tasks at hand. Moreover, solitude is the way to escape disturbance and noise arising from external sources and focus all the attention and effort on creative output production -- that, while also experiencing nourishing and relaxing effects of solitude (Lay et al., 2019; Storr, 1988).

All of the aforementioned may be true to most individuals but the intensity and preferred regularity of solitude experience varies significantly (Burger, 1995), constituting a standalone personality trait. In other words, there are people who often long for solitude and mostly benefit from it, and there are people who try to avoid solitude as they mostly suffer from it. For example, extraverted individuals whose personality is characterised by openness to social interaction, talkativeness and joviality do not appear to desire solitary activities often. On the contrary, they long for active communication as it charges them with energy (Fang et al., 2015; Burger, 1995). Introverts, on the other hand, lose energy when interacting with other people, and to them, solitude is an essential way to unwind, avoid distractions and enhance their creativity, therefore they seek for it (Nguyen et al., 2018; Ren et al., 2015; Furnham and Allas, 1999; Burger, 1995). The empirical evidence also

demonstrates that when solitude is forced upon individual, it triggers negative outcomes, such as feelings of loneliness, boredom and decreased life satisfaction, while people who voluntarily choose to spend time in solitude do not encounter these feelings (Chua and Koestner, 2008; Nguyen et al., 2018). In this vein, while certain kind of personality is consistent in having a need to spend time in solitude and reaps its fruits, being facilitated thinking, rejuvenation, unfolding intellectual capacities, imagination spring (Storr, 1988; Long et al., 2003; Nguyen et al., 2018); other kind of personality undergoes a completely different and opposed scenario.

To our knowledge, up to date the narrow personality trait best captures individual's free desire to spend time in solitude is preference for solitude (PFS). The scale measuring it was initially developed by Burger (1995), and has recently gained more attention in the literature (Ren and Evans, 2021; Coplan et al., 2019). PFS is conceptualised as the extent to which people prefer to spend time alone. People with higher levels of PFS that we refer to as solitary individuals, do not have a strong need to be around other people; time spent with other people is often boring and uninteresting to them, while time spent alone appears productive for them (Burger, 1995; Lay et al., 2019). Our aspiration in this study is to open the black box of creativity of solitary individuals in social networks.

Entwining these two fields is not easy. Solitary individuals remained majorly understudied after the initial academic spark of interest to the topic in 1980-s and 1990-s (Burger, 1995; Storr, 1988; Cramer and Lake, 1998). But several recent studies in the field of personality addressed the issue of solitary individuals, exploring not only their motivations, traits, but also their social functioning (Coplan et al., 2019a; Coplan et al., 2019b; Lay et al., 2019; Ren and Evans, 2021; Wang, 2015). These studies clearly demonstrate several things. Firstly, even though PFS is known to be strongly associated with introversion (Burger, 1995), these traits do not overlap, and solitary individuals are not perceived and treated by others as introverts are (Ren and Evans, 2021). Likewise, existing interrelation between PFS and shyness does not imply identical outcomes (Wang, 2015). It proves that even though PFS is a narrow personality trait, it deserves special attention and careful investigation, as there is much space for exploration. Secondly, solitary individuals are not rare, yet notably distinct from others. For this reason, scholars study individuals with low and high PFS separately, dichotomizing samples (Ren and Evans, 2021; Lay et al., 2019). This is not surprising, as such practice is traditionally used with other personality traits, too, such as introversion and extraversion (e.g., Landis, 2016), innovative or adaptive cognitive style (Carnabuci and Dioszegi,



2015) and other. Following the established tradition in relation to PfS, we split the sample to solitary and non-solitary individuals.

On the one hand, solitary people are less willing to make use of the social environment they are embedded in, and just long for quiet time spent alone, thus they are expected to have smaller ego networks (Lay et al., 2019). In the context of the network, it might imply counter-intuitive associations between networking and creativity. On the other hand, from what has been written above, we have reasons to expect solitary individuals to be creative on their own, in a more individualistic and introverted way. Indeed, recent empirical findings show that on average, solitary individuals are perceived as highly competent (Ren and Evans, 2021). Taking these points into consideration, we claim that when assessing individual creative performance, it is not enough to give characteristics of overall social network structure or one's position in it, because one must also consider how personality can affect the networking (e.g., Sosa, 2011; Perry-Smith, 2006; Kim et al., 2018; Landis, 2016).

Interestingly, personality of network agents involved is not the only factor that intervenes into network position -- creativity interplay. The context, too, can play a game-changing role. For example, personal traits that can drive individual creativity in one field, can become a burden in another. Indeed, empirical evidence shows that in various professions, creativity is driven by different traits (Feist, 1998, 2006). Our interest here is the industry that disposes people to concentrate on sophisticated material objects rather than interpersonal relations, typically attracting thing-oriented rather than people-oriented professionals (Little, 1972). The very nature of such work outputs invites a certain extent of workplace solitude, since calculations and visualisations do not superpose with talking. However, sophistication of work outputs also makes networking inevitable, since work-related information is usually very heterogeneous, and in addition, teamwork is essential to complex projects. One of professions matching aforementioned criteria is engineering. Historically, engineering creativity is the source of technological progress and a lion's share of innovations in the world (Cropley and Cropley, 2005). Engineers combine pragmatic consecutive approach characterised by extensive set of rules to follow with inalienable aim to create something that has never existed before, at least in a certain form. On the one hand, engineers are known to be introverted (Feist, 2006), therefore, naturally seeking more solitude (Burger, 1995) than extraverts. In a way, it corresponds with the purpose of coming up with a novel product, be it mechanical object, software or a prototype. Without workplace solitude, it would be impossible for

engineers to dive deep into creation process in all its complexity. On the other hand, engineers' projects are usually vast and enduring, which makes it impossible to fulfil the task alone. Team work or other form of collaboration is networking by definition, therefore social network analysis is an appropriate tool to analyse the social side of engineering creativity. In the following section of the paper, we exploit the aforewritten theory to investigate the factors that have potential to increase the likelihood of solitary individuals to be highly creative in intra-organizational networks.

### **Constructing hypotheses**

Our first hypothesis aims to assess the interplay of PfS and creativity. Solitary individuals are comfortable spending time in aloneness, generally perceiving it as productive and pleasant (Burger, 1995). Solitary individuals naturally seek for solitude and comfort that it provides them with. They heavily rely on intrinsic resources when working on creative task. Empirical evidence shows that solitude, when voluntary encountered, leads to a set of aforementioned positive outcomes (Nguyen et al., 2018) and has strong nourishing effect (Lay et al., 2019). In addition, solely generated creative ideas and outputs usually are more original, as they are unsmudged by the viewpoint of others (Putman and Paulus, 2009). In the contrary, highly focused attention would encourage solitary people to make the best of the information already available, dig deeper into it to analyze it at profound level and run numerous mental recombinations to finally come up with most creative solutions (Rhee and Leonardi, 2018). As result, engineers with high PfS would be able to demonstrate excellent creative performance due to their cognitive flexibility and ability to concentrate on the creative task. Therefore we suggest:

*Hypothesis 1: Higher levels of PfS are positively associated with creative performance.*

When we talk about different personalities embedded into the network, it is interesting to consider how certain traits would interact with the overall structure of interactions in the organization. In the context of social networks, high PfS best matches with low degree centrality, since in that way the behavioural «request» for solitude is fulfilled by the network structure. People with high PfS are more comfortable when they can spend time being by themselves, thus through their agency, they would deliberately tend to avoid central positions. In case of lower network centrality, solitary individuals will spend less time interacting and more time by themselves, which, in the context of

organisation, implies more independent work, such as individual tasks to contribute to the team project. Conversely, when solitary individuals find themselves occupying central positions in the network, they may face negative consequences. Intense interaction associated with high degree centrality affects solitary individuals' creative performance negatively. Emotionally, exuberant interaction with a big amount of people causes tiredness and boredom to solitary individuals, and it often appears a source of disturbance and confusion. Interestingly, recent study by Ren and Evans (2021) finds that solitary individuals are seen as willing to avoid unpleasant social interactions. As per R&D settings and social networks, some pieces of prior research provide curious insights about negative impact of exuberant interaction at work. For example, Stea and Pedersen (2017) prove that engineers who have to deal with large amount of highly heterogeneous information on a daily basis, such excessive networking negatively affects creative performance, appearing a powerful environmental stressor. Similarly, Rhee and Leonardi (2018) demonstrate that in constrained networks of R&D setting, creators are better off when focusing their attention on just a few ties rather than dividing it between many ties, since intense interaction requires much effort and time, which can draw attention away from the creative task. Moreover, Wang et al. (2014) found that degree centrality can have negative effect on researchers' innovative activity due to cognitive constraints and prevailing paradigms it brings. We suggest that this effect is likely to be even more apparent in case of solitary individuals who tend to express themselves in a more unique manner when it comes to creativity (see Storr, 1988, for a review) and do not normally seem to need to belong (Ren and Evans, 2021). Objectively, exuberant interaction caused by high degree centrality tends to wash away the originality of creative ideas developed by individuals with high PFS. Hence we suggest the following:

*Hypothesis 2: There exists a negative association between degree centrality and creative performance.*

Empirical evidence demonstrates that formal hierarchical structure of the organization has an impact on the structure of interpersonal networks formed (e.g., Soda and Zaheer, 2012). Ergo high degree centrality can also be interpreted as inevitable consequence of higher job position in the organizational hierarchy or professional excellence. As we have seen above, certain job positions are positively associated with more prominent positions in the network. Managers essentially attain

central positions in the network since their job implies supervising subordinates (Wang et al., 2015), and seniors are central due to their knowledgeability and rich history of network relations (Kijkuit and van den Ende, 2007). Curiously, Perry-Smith and Shalley (2003) propose that highly creative employees, too, tend to become central agents in the network. Managers, senior personnel and radically creative individuals might be rather diverse in nature, but one can also say that what truly distinguishes them among the rest is the high extent of professionalism that they demonstrate.

But what happens if degree centrality of a solitary creator is driven by their job rank? Interestingly, here we face a paradox: on the one hand, people with high PfS are known to be more creative when they are less central in the network; but on the other hand, highly creative individuals are likely to be high in rank and attain central positions in the network due to their excellent expertise. In this vein, there is a possibility that job rank can alter the way degree centrality and creativity interact in a sample of solitary people. This idea is also developed in the seminal paper of Perry-Smith and Shalley (2003) where authors propose a dynamic model of creativity in intra-firm networks. They theorize that highly creative people tend to gradually become more central in the network, since their outstanding performance attracts the attention of the management and advice-seeking colleagues. In this vein, the professionalism of such individuals is noticed on organizational level, and sooner or later they get a promotion with higher responsibility that also requires more intensive networking.

If we follow this logic we can conclude that in such professions where creativity is crucial, as it is in R&D departments, people who are explicitly creative and professional will often hold higher positions than mediocre colleagues. Therefore the interaction that these employees will be involved in will be strategically directed and useful rather than chaotic and casual. By definition, it would be by far less distracting for solitary people. Thus, we believe that job rank can be a factor that has potential to soften the possibly negative effect of degree centrality on creativity of people with higher levels of PfS.

Another interesting point about the diversity that job rank can bring to work routine and interaction patterns of engineers in R&D department is that the higher one's position in the organization, the higher is their proximity to the management. Prior literature demonstrates that connections to decision makers can be very beneficial for individual creativity in organizations. It eases the sensemaking process, since employees have clearer vision of organizational goals and how to fulfil them (Kijkuit and van den Ende, 2007), and helps gain support in high echelons and bring creative

idea to life (Kijkuit and van den Ende, 2007; 2010). Naturally, job rank interplays with number of connections to decision makers. Engineers with high job rank are often in charge of large projects that would be of central prominence in the organization. Additionally, highest job ranks imply managerial positions at the level of subdepartment, ensuring the access to top management. Therefore we take a step forward and state that engineers with higher job rank can be more creative not only because they are involved into strategic communication, but also because they are in direct contact with the leaders.

Besides outstanding technical skills and proximity to management, employees with high job rank are also very likely to have a strong curriculum in terms of completed projects and performance record. In the context of large R&D department where team work is essential, the capacity to transform ideas to outputs generally implies knowing how to put social networks to use. Even a person whose creativity is firmly rooted in solitary activities and ability to run numerous mental recombinations in order to create something truly worthy, would need to collaborate with colleagues, at least to communicate their findings and discuss the further work that needs to be done. This idea is supported by the prior literature. For instance, Baer (2012) has demonstrated that in intra-firm network context, individuals are more creative not only when they have a beneficial network position, but also when they are highly determined to bring their creative ideas to life. In this vein, being an excellent engineer with good job rank would be impossible without the ability of dealing with wide range of complex situations at work for the sake of pursuing work-related goals. We believe that due to their level of expertise, solitary creators with high job rank would have the skill of overcoming the possible discomfort that networking can cast upon them, and commit to the project they are working on, even if such work is associated with degree centrality increase. After all, in this scenario, centrality can even become a tool to spread the unique knowledge of the individual (Tang, 2016; Wong and Boh, 2014).

To sum up, we propose that job rank can partially compensate the negative effects of degree centrality of creativity of solitary individuals for following reasons. First, job rank ensures more strategic and goal-oriented communication that would bound together individual and collective aspirations, thus bringing less distraction to an individual with high PfS. Second, the higher the job rank, the more opportunities the engineer has to gain support and useful feedback from decision-making management. Third, job rank signals the ability not only to generate truly creative ideas, but also put those into practice -- a process that is collective by the definition. Therefore we posit:

*Hypothesis 3: Job rank positively moderates the association between degree centrality and creativity.*

### **Additional hypotheses**

To enhance theory building in this exploratory paper, we propose an additional set of hypotheses establishing the relationship between independent variables. Explaining the mechanism of association of degree centrality with PfS and job rank is necessary to construct an overarching theory and ensure the clarity of reasoning, especially when it comes to variables majorly understudied in the literature. Firstly, we focus on the nature of association between degree centrality and job rank. Following the line of reasoning of the former hypothesis, we propose that job rank invariably affects one's position in the network due to advice giving, seniority and managerial roles creators occupy. Empirical findings from prior literature speak in favour of this argument. For example, Burt (2004) demonstrated that highest-ranked managers cannot be social isolates in the network, and that they naturally have better network reach. Moreover, many studies in the field that used seniority or job rank as control variables found statistically significant correlations with network size and coreness in the network (e.g., Maoret et al., 2020; Tortoriello et al., 2015), allowing us to assume that a certain structural pattern tends to preserve. In this vein, we suggest that a positive correlation should exist between job rank and degree centrality. To test the described interplay between variables, we advance the following hypothesis:

*Hypothesis 4: For all individuals in the sample, there exists a positive association between degree centrality and job rank.*

Secondly, we discuss the fundamental differences between degree centrality and PfS. It might seem intuitive that solitary individuals will be prone to use their conscious agency to avoid central positions in the network due to discomfort it brings. Nevertheless it would be naive to assume that degree centrality only depends on one's personality and is completely independent from the overall corporate canvas, as we have seen with the job rank. On the contrary, we fundamentally believe that degree centrality is a complex concept that is affected both by endogenous and exogenous factors.

There are reasons to expect inconsistencies between behavioural predispositions arising from personality traits such as Pfs, and actual network position of individuals. For example, literature review about the role of personality in interpersonal networks by Landis (2016) notes the surprising lack of coherence between network centrality and some personality traits, showing that individuals naturally seeking to actively socialize with others (i.e., extraverted individuals, the trait strongly and negatively associated with Pfs: Burger, 1995) do not necessarily become central in the networks. Similarly, meta-analysis performed on the sample of 2,242 individuals by Fang and colleagues (2015) finds no proof that extraverts are statistically more central than others. Finally, Lay and colleagues (2019) tried to connect propensity to have positive solitude experiences to network size, and came up with statistically insignificant results.

Using these findings from prior literature as hints, we suggest that at workplace, individuals have but limited capacity to choose the structure of their network due to the following reasons. First, given the intense work interaction that traditionally takes place in R&D contexts (e.g., Stea and Pedersen, 2017) and specificity of team work in general (Klein et al., 2004), the work routine of individuals often deprives them of opportunity to adjust ego networks according to their own taste and behavioural preferences. Since solo work is not common in such environments, the necessity to complete assigned tasks would push creators to collaborate and collectively solve issues at hand, therefore setting the degree centrality at the needed level. As result, the context of work requires individuals to take network structure for granted. Second, work practices are affected by organization-level variables. For instance, organizational policy can promote collaborative or non-collaborative culture (Soda et al., 2019), inviting employees to conform and network in the suggested manner, normalizing the degree centrality distribution. Lastly, certain job positions (e.g., managers) are associated with high centrality, while other positions (e.g., newcomers) are essentially peripheral (Jokisaari and Vuori, 2014; Venkataramani et al., 2014), regardless individuals' personality traits. In this vein, solitary individuals' desire to not be engaged into intense interaction at work will not be enough to prevent them from becoming central due to the impact of meso-level factors. Similarly, individuals who are not naturally solitary will not be able to attain high centrality if the organizational structure and culture do not stimulate it. We propose that there should be no significant differences between individuals with high and low Pfs in terms of their degree centrality. Hence we posit:

*Hypothesis 5: Degree centrality and Pfs are not associated.*

## METHODS

### Research setting

This study uses primary empirical data gathered from a company called here GasMach. The case study company is located in Western Russia and operates in gas machinery industry. The main target market is Russian Federation, where GasMach's market share equals 30%. GasMach produces a wide range of production, including but not limited to meter stations and its components, high and low pressure gas machinery, equipment used for gas extraction and transportation, alongside with equipment necessary for maintenance of these products. Most of the activities are co-located in the same area, with separate offices and production sites across the city.

Prior to starting data collection authors contacted GasMach top management and explained the purpose of the study. Both sides were preliminary interested, and after thorough investigation authors agreed that GasMach indeed matches the criteria selected for the case study. The objectives and research question posited in the study required a peculiar setting where employee creativity would have a vast strategic value, where networking would be necessary, and where such personality trait as PfS could be beneficial. Our preliminary research showed that R&D department in GasMach could satisfy the criteria. The department is formally divided into sub-departments and coordinated by two managers. The function of the R&D department in GasMach is to prototype tailor-made novel products according to clients' unique needs and requirements. Therefore all projects run by the company and all products developed would be generated by the R&D department. The outcome of the work of these employees would directly affect company's ability to win tenders, to enter new markets and to meet customers' expectations in the broad sense.

From the interviews with R&D department managers it has become apparent that they see fundamental strategic value in creativity of their subordinates. For example, one of R&D department managers says: *«Creativity is important! When an enterprise is looking for new markets, there is no way to make it without creativity».*

Further investigation also showed that micro-level employee creativity is highly appreciated and nurtured in the organization. Another R&D department manager explains the reason behind it in the following way: *«There is always an opportunity to solve [a task] in many ways. It will affect the economy of the product, its cost, some user characteristics, etc. And when a person approaches it in a creative manner... they seek for good solutions. They let it flow through their mind and find an*



*answer. And it is magic! A miracle that actually happens, an act of intrinsic creation performed by a person».* Regarding the freedom for creative experimentation and risk-taking that is so crucial for individual creativity (e.g., Perry-Smith, 2006; Kijkuit and van den Ende, 2007), he continues: *«The worst thing that you can do to creativity is to cut the initiative. You would then discourage the person to make such decisions again. Therefore I allow them to give it a try, even if I disagree».* Based on these arguments, we concluded that R&D department in GasMach would be an appropriate setting to study individual creativity.

We are also convinced that this setting is suitable for network studies. The department is of appropriate size (e.g., Wong and Boh, 2014; Rodan and Galunic, 2004), and employees working there would intensively collaborate within and across sub-departments, as they often work in teams on certain projects. Such team working would be facilitated by the fact that engineers have expertise in different domains. Thus, the development of the final output would require combination of diverse fields of knowledge. The company practice is such that employees do not work in fixed teams. Instead, teams are constructed and reconstructed for each new project. Such approach naturally ensures active networking and information exchange. We find it encouraging that the prior research in the field tends to use similar settings to tackle research questions relating to individual creativity and social networks (e.g., Stea and Pedersen, 2017).

To our knowledge, in management research, there are no studies about PfS. Therefore we take experimental approach and are first to test in intra-firm setting. Nevertheless we see a lot of potential in high extent of technological sophistication of tasks performed by engineers in R&D department. Prototyping requires profound immersion into the topic. The nature of the work in such settings requires very deep concentration on the outcome (Stea and Pedersen, 2017). As we know from the theory, this ability is facilitated in the condition of solitude (Long et al., 2003). Moreover, the setting choice is in line with established research tradition in the field of personality and network studies (Landis, 2016; Mehra et al., 2001; Rhee and Leonardi, 2018).

### **Participants and procedure**

Quantitative data was collected in May 2019. After agreeing to run the survey, we guaranteed confidentiality and accorded to share results of the research with GasMach top management and the head of design engineering department. At the time of data collection, GasMach had 894 employees mainly involved in engineering and production. The design engineering department consisted of

eight sub-departments and employed 83 engineers. Daily tasks of most of the engineers in the sample was to work on blueprints and 3D drawings for gas machinery prototyping. The gender breakdown was 32 percent female and 68 percent male. With 78 out of 83 employees agreeing to participate in the survey, we have obtained 94% response rate.

Questionnaires used in the study were translated into Russian with translation–back translation procedure (Brislin et al., 1973). Respondents received paper sheets after plenary meeting and were asked to fill them in straightaway in author’s presence, so that all sorts of respondents’ misunderstandings regarding the questionnaire were clarified immediately. Each of employees filled in questionnaires including three blocks: PfS scale (Burger, 1995), roster of intra-firm advice network (Soda and Zaheer, 2012) and a set of demographic questions. It took up to 15 minutes to complete the survey for respondents. Two managers of R&D department were asked to evaluate creative performance of their subordinates, an activity that required up to 2 hours.

After the analysis was completed, authors reached out to GasMach management to discuss the results and run interviews. This was done to comprehensively interpret the survey data and ensure the fundamental understanding of the case study company. Qualitative data collection took place in September 2020. We have run three on-site interviews in total, one with the commercial director and the other two with R&D department managers. Interviews were initially run in Russian language, recorded on a voice memo, and later carefully transcribed and translated into English. Interviews lasted 23 minutes on average and mainly focused on the nature of individual creative process and the organizational environment that exists in the R&D department. Such mixed method is widely used both in classic studies in the field of social network and individual creativity (e.g., Perry-Smith, 2006), and in contemporary studies adopting a post-structural approach to the phenomenon (Li et al., 2018; Soda et al., 2019).

## **Variables**

### ***Creative performance***

To measure the dependent variable, we asked supervisors to evaluate their employees with a classic creative performance rating scale, Oldham and Cummings’ (1996) Integrated Creativity (Cronbach’s Alpha was equal to 0,723). With three-items scale, supervisors evaluated the degree to which each of the employees in the sample produces output that is novel and useful to the organization. Seven-point Likert scale was applied, and for each employee, the results were

averaged to form a unitary creative performance index (e.g., Sue-Chan and Hempel, 2016, Shin et al., 2016).

### ***PfS***

PfS was measured with classic scale developed by Burger (1995) (Cronbach's Alpha was equal to 0,638). In over two decades, this scale has been explicitly used and validated by scholars in psychology and social sciences (e.g., Cramer and Lake, 1998; Ren et al., 2015). PfS scale consists of twelve pairs of contradicting statements capturing behavioral preference in particular situations or contexts. For each of the questions, respondents were suggested to select one statement that described them better. These are examples of statements indicating positive PfS:

- 1) After spending a few hours surrounded by a lot of people, I am usually eager to get away by myself.
- 2) I like to vacation in places where there are few people around and a lot of serenity and quiet.

For every answer indicating willingness to encounter solitude rather than be accompanied by others respondent receives one point, otherwise zero. Thus the closer the overall score is to twelve, the higher is PfS. Scores closer to zero, on the contrary, indicate low levels of PfS.

Since the interest of this study was to investigate creativity of people with high levels of PfS, the sample was split correspondingly. Split sample approach is quite common for studies set on samples of solitary individuals (Ren and Evans, 2021; Coplan et al., 2019) and in the field of social networks and creativity (e.g., Stea and Pedersen, 2017). Thus, solitary individuals are people with PfS value equalling six and above. The choice of this value was supported by robustness checks that are reported below.

### ***Centrality***

Degree centrality captures individual's position in the whole advice network within the R&D department (Soda and Zaheer, 2012). In order to calculate it, we adopted network roster approach. In this section of the questionnaire, each respondent was given a list with names of all employees of the R&D department and was asked to mark those to whom they refer for work related advice. For the sake of simplicity, this section was split to eight blocks corresponding to eight sub-departments where employees work on the regular basis. The final value of degree centrality for each

respondent was represented by numeric value computed by merging individual questionnaires into one matrix and summing up the rows. Thus for employee  $i$ , degree centrality value reflects average value of the number of  $i$ 's colleagues who have marked  $i$  as their advice giver, and the number of colleagues to whom  $i$  reaches out for an advice.

### ***Job rank***

We have gathered the information about employees' job ranks from R&D department managers. Job rank variable was categorized with respect to objective engineer ranking system adopted on the territory of Russian Federation. Hence in accordance with Russian laws and GasMach corporate policy, engineers's skills and qualifications can have several levels of objective gradation. This rank is not only fixed in work contract, but also has official status everywhere in Russian Federation regardless of engineer's current employment. In order to receive a certain rank, engineers must satisfy a number of requirements, such as, for example, higher education specialization, work experience in the field, and prior qualifications. When all requirements are met and the engineer is willing to receive a rank, they can volunteer to undergo a formal attestation procedure. In case that the attestation is successful, an engineer receives a rank that cannot ever be degraded. In our sample, given a sufficient number of respondents, all of seven possible qualifications were present. Thus, we had, correspondingly, engineers with no category, third, second and first category engineers, leading engineers, vice-heads of subdepartments and heads of subdepartments. To each of these ranks, we gave a number varying from «1» for no category engineers, to «7» for heads of subdepartments.

### ***Control variables***

We used demographic data from questionnaires to constitute control variables for statistical analysis. We controlled for age, gender and tenure.

—————*insert Table 1 here*—————

### **Model selection**

We used OLS regression to test hypotheses. This model is commonly used in the field of creativity and interpersonal networks (Cangialosi et al., 2021; Wong and Boh, 2014; Tortoriello et al., 2014). To test hypotheses 1, 2 and 3 about solitary individuals, we used half of the sample and dependent

variable was creativity. To test additional set of hypotheses 4 and 5, we used full sample and dependent variable was degree centrality.

### **Robustness tests**

In order to check the validity of sample split according to PfS values (Burger, 1995), we have conducted optimal binning procedure. The analysis has shown that indeed, in the sample studied, respondents have formed two sets of discrete values that subsumed PfS values [0; 6) and [6, 12], respectively. Interestingly, the cut value of 6 overlaps with the mean value of PfS that equals 5,96. As result, our sample was split in two equal parts with respect to PfS variable distribution. To ensure the correctness of this choice we have tried alternative split sample strategies and found a sufficient decrease in F-value when cut value in PfS scale was 7 out of 12 ( $F = 3.954$ ,  $P < 0.05$ ), and an insignificant F-value for 5 of 12 points on PfS scale. Full regression results are reported in the appendix.

We display pairwise correlations alongside with descriptive statistics in *Table 1*. As it can be seen from the table, there are some modest correlations between predictor variables. Nevertheless we wanted to ensure that multicollinearity was not present in the sample, thus we have calculated variance inflation factors (VIF) for independent variables. This method is commonly used as robustness test in the field of creativity in interpersonal networks (e.g., Dolfisma and van der Eijk, 2016). As expected, VIF values were well below critical levels (minimum value 1.142, maximum value 6.673), thereby disproving possible multicollinearity concerns (Cohen et al., 2003).

### **Results**

The correlation matrix and descriptive statistics for all variables included in the analysis are shown in *Table 1*. For most of independent variables, multicollinearity does not appear to be a problem, as correlation values remain far below the accepted threshold of .4 (e.g., Stea and Pedersen, 2017). However, we have found correlations between job rank and two control variables, being age ( $r = .45$ ,  $P = .000$ ) and tenure ( $r = .49$ ,  $P = .000$ ). The association between these variables is natural, as higher job rank by definition requires more experience, and the latter is impossible without tenure and certain age. Perhaps not surprisingly, we have found tenure and age to be strongly correlated, too ( $r = .55$ ,  $p = .000$ ).

—————*-insert Tables 2 & 3 here*—————

*Table 2* reports the regression results for hypotheses 1, 2 and 3. Model 1 is run for control variables only and tests effects of age, gender, and tenure on creativity. We find that respondents' gender affects creativity, with women being less creative than men. Model 2 adds PfS, degree centrality, job rank into the equation. Hypothesis 1 suggested that for solitary individuals, there will be a positive association between PfS and creativity. This hypothesis holds ( $\beta = .251$ ,  $SE = .122$ ,  $P < 0.05$ ). Hypothesis 2 stated that for solitary individuals, degree centrality would negatively affect creativity. The data supports this claim ( $\beta = -.209$ ,  $SE = .055$ ,  $P < 0.01$ ). Hypothesis 3 predicted that for solitary individuals, the relationship between degree centrality and creativity will be positively moderated by job rank. This hypothesis was supported, too ( $\beta = .041$ ,  $SE = .010$ ,  $P < 0.01$ ). In Model 2, none of the control variables were statistically significant, proving that neither of tenure, gender or age play an important role in predicting creativity.

*Table 3* contains results of regression analysis for hypotheses 4 and 5 tested on the full sample of 78 respondents, as captured by Model 3. Hypothesis 4 suggested that PfS and degree centrality will not be interrelated. Indeed, no significant correlation between the variables was found. Hypothesis 5 proposed that job rank will be interrelated with degree centrality and the data proves it right ( $\beta = 1.491$ ,  $SE = .599$ ,  $P < 0.05$ ).

## Discussion

A rich body of knowledge of creativity in interpersonal networks has promoted the idea that individual creativity is affected by the position in the network, claiming, among the rest, that central agents typically demonstrate higher levels of creativity, as they essentially have more means for such performance. But while organizational behavior line of research has emphasized the overall importance of embeddedness into the social structure for creative performance, personality literature viewed the phenomenon from another angle, concentrating on individual differences as creativity drivers.

The empirical results from prior studies in the field of intra-organizational network properties, personality and creativity are encouraging and inspiring (e.g., Zhou et al., 2009; Carnabuci and Dioszegi, 2015), which stimulates scholars to seek for additional variables to enrich the field. Hence our interest in this study was to continue applying a post-structural perspective to individual creativity in social networks. We approach the explanandum of individual creativity from a novel,

surprising angle. We believe that PfS has potential to help us understand the mystery of individual creativity. Recent studies about PfS underline that solitary individuals are understudied, but genuinely dissimilar to others, constituting a separate cluster that deserves scholars' special attention (Lay et al., 2019; Ren and Evans, 2021; Coplan et al., 2019). Therefore our focus in this study was on particular category of respondents, namely, solitary individuals, and we investigated what would make them creative in intra-organizational environment. With a view of taking an integrated approach to this issue, we conceptualized that solitary individuals are less creative when they are central in the network, and that this relationship is smoothed by job rank. We also stated that, under such circumstances, the highest levels of PfS would be most beneficial for individual creativity.

The results of our exploratory study are encouraging. We find that solitary individuals indeed are creative when their PfS score approach the extreme, meaning that these people prefer to detach from interpersonal interactions whenever possible. This finding can seem surprising at first glance, as contemporary research promotes the idea that sociability and openness are the qualities that normally make people most successful at work, be it creative work or else (e.g., Baer, 2010; 2012). Nevertheless in some domains, creativity is impossible without deepest concentration on work outcome, and this process can be cognitively challenging to such extent that even work-related interaction can bring unwanted distraction. This idea is in line with prior research on domain specificity of creativity that shows that, for example, scientific creativity in science and physics -- two fields most closely related to engineering -- is driven by introversion (Feist, 2006). Some studies also show that introversion and solitude are positively correlated (Burger, 1995), and findings of our study support these data. Here, we are back to the well-known myth of a lone genius, a person who does the creative work alone: envisions alone, enhances the idea alone, digs deeper and deeper into topic, to finally come up with something truly unique and outstanding. This romanticized image can be easily extrapolated to the organization context. For example, in our sample, some of those people would be those engineers who work on most complicated technological solutions and aspire to come up with tailor-made outputs that would be most efficient and convenient for the needs of a particular customer. This work naturally requires sufficient internalization that is vastly facilitated in the condition of solitude. Individuals with higher PfS are empowered by such ability and skill thanks to their behavioral predispositions.

Our next finding is intuitive from the former one. Whenever people with high PfS encounter degree centrality in the network, they suffer it. Naturally, such individuals find time alone pleasant as it makes them feel undistracted and quiet (Burger, 1995; Coplan et al., 2019), while degree centrality pushes them to engage in active communication. As result, they feel exhausted, distracted, bored and irritated. In this vein, it would take them time and effort to immerse into creative problem solving again. This finding is in line with the theory developed in the study, but it somewhat contradicts the mainstream research that tends to view degree centrality as ultimately beneficial network position (e.g., Ibarra, 1993; Cangialosi et al., 2021). Our aim here was not to attempt to degrade the literature that promotes degree centrality as individual creativity driver. Instead, we propose a boundary condition to a well-studied and celebrated phenomenon. While accepting that degree centrality can be profitable in many situations, we claim that it can choke the creativity of those individuals who are less comfortable communicating with others and are better off when in solitude.

Further, we find that job rank can soften the aforementioned negative effect. This result supports our claim that high professionalism that is captured by job rank can transform not only the narrative of professional interactions at workplace, but also the way an individual feels about it. In this vein, solitary people are skilled at overcoming their behavioral preferences for the sake of increasing the efficiency of creative work. This finding helps us not only balance the impact of PfS on individual creativity in intra-organizational networks, but also reconsider the quality and usefulness of workplace interactions based on the job rank of creators involved.

Hence we come up with a novel model of interplay of personality traits and network position. By doing so, we bridge very heterogeneous streams of research and demonstrate that they represent several pieces of one big puzzle that represents individual creativity in organizations. The suggested theoretical model is in line with post-structural tradition in social network research (e.g., Mehra et al., 2001). Our findings are valuable to the young discipline of social networks and personality. Prior research has shown that personality traits affect ones network position and structure (Landis, 2016), but less attention has been paid to outcomes of such consequences (Fang et al., 2015), and how those can affect one's creative performance. We introduce a new personality trait to the field to the domain, and prove that it can sufficiently alter the nature of individual creative process. Besides that, PfS can reverse the well-studied positive effects of degree centrality on individual creative performance. In other words, our attempt here was to draw attention to the fact that network effects



have different magnitude and direction under various circumstances, and that sometimes non-mainstream variables can intervene into the well-studied mechanism and change it completely.

Managerial applications are foreseeable. In a way, our findings encourage employers to appreciate and make use of employees' personal predisposition to solitude, acknowledging its role as creativity driver. This issue is very topical considering universal pressure network (Casciaro et al., 2016). We claim that it is crucial to consider employees' willingness, ability and comfort to network, and therefore to estimate the aftermath of the pressure to engage into undesired interactions. In many cases, networking can indeed trigger individual creativity, but for a certain category of people, as it is shown in our study, active networking can dramatically decrease the likelihood of becoming highly creative.

This study is not free from limitations. One of the drawbacks is that in this quantitative we did not explore the content and quality of interaction taking place between solitary individuals and others. Nevertheless there are reasons to assume that solitary people are perceived in a peculiar way. For example, Ren and Evans (2021) found that solitary individuals are likely to be ostracized by others because communication with them can be unpleasant, and that on average, people scoring high on PfS scale are perceived as cold and not belonging to the group. In this vein, there is an untested possibility that degree centrality hinders solitary individuals' creativity not only because *they do not want to be central*, but also because *colleagues prefer to avoid them*. Another limitation is the sample size. Although the number of respondents in the full sample is consistent with other studies published in top journals in the field (e.g., Wong and Boh, 2014), we had to split it in two parts to test some of our hypotheses, and it has affected the significance of results.

This article uncorks a bottle of opportunities for interdisciplinary research. Firstly, as degree centrality in intra-firm networks is often associated with managerial position that often constrains individual creativity in a dynamic perspective (e.g., Perry-Smith and Shalley, 2003), it is crucial to make a note on the aspect of PfS, as it can provide an advanced explanation behind complex processes of network evolution in their relation to creative performance. Further, it is worth to test the model in the context of another industry, where creative outputs are more social in nature and less thing-oriented (Graziano et al., 2011), and to draw comparisons between the two settings. Here, it is quite likely that advantages of PfS will have different magnitude or direction. Another interesting aspect to consider is work routine of creative solitary people. Despite the fact that this question was out of scope of the current piece of research, it is important to understand qualitatively

the core difference of solitary vs. non-solitary individuals in the organizational context. Thus one of the future directions of research can be a close-up on how solitary people work, how do they perceive and direct their interactions, how do they react to extrinsic stimuli and what are the levels of their responsiveness. In particular, we find it promising to investigate the relationship between age, PFS and networking. This direction is promising and crucial to explore, if we consider the fact that PFS interplays positively with age (Cramer and Lake, 1998). Thus a following question arises: how does age alter the relation between PFS and creative performance? In the era of ubiquitous digitalization, solitude gets a novel and surprising shade. Curiously, it has been shown that desire for social media interplays with longing for solitary activities (Hill and Zheng, 2017). How does preference for solitude affect our social lives in a broad sense, considering the realities of 21st century? Do solitary people prefer to shift their communication to online platforms? What is online communication to them, a hindrance to fulfilling social life or an opportunity to get engaged into communication while experiencing solitude? What does it imply for employers? Answering all of aforementioned questions is very important both for academic research and practice in the field of management. It may help to navigate organizational processes in such a way that highly creative people with strong predisposition to solitude are placed in a comfortable environment where they optimize their inner resources. We fundamentally believe that the dimension of PFS can also complement those streams of social networks research that do not focus solely on creativity. In this vein, innovation, individual and team performance, cognitive networks and more can take the phenomenon of PFS into consideration.

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## Tables

Table 1. Descriptive statistics and correlations

Variable	Mean	S.D.	Min.	Max.	1	2	3	4	5
1 Creative performance	4.39	1.52	1.00	7.00					
2 PfS	5.96	2.54	0.00	11.00	.030				
3 Degree centrality	16.69	8.86	1.50	43.50	.058	-.107			
4 Job rank	3.92	1.96	0.00	7.00	.426**	.080	.327**		
5 Age	38.47	12.08	22.00	72.00	.080	-.001	-.028	.450**	
6 Tenure	7.26	5.61	0.00	22.00	.172	.022	.223*	.493**	.553**

notes:  $N=78$ ; gender: «1» female, «0» male

significance: \* $p < 0.05$ , \*\* $p < 0,01$

Table 2. Regression results estimating the effects Pfs, degree centrality and job rank on creative performance

*Dependent variable: Creative performance*

	<i>Model 1</i>	<i>Model 2</i>
Pfs		.251* (.122)
Degree centrality		-.209** (.055)
Degree centrality x Job rank		.041** (.010)
Age	.002 (.023)	-.009 (.019)
Gender	-1.193* (.537)	-.326 (.529)
Tenure	.024 (.052)	-.070 .054
Constant	4.325	3.599
R-sq	.132	.481
F	1.769	4.941**

*N=38, notes: gender: «1» female, «0» male*

*significance: \*p < 0.05, \*\*p < 0.01*

Table 3. Regression results estimating the effects of Pfs and job rank on degree centrality

**Dependent variable: Degree centrality**

	<i>Model 3</i>
Pfs	-.518 (.369)
Job rank	1.491** (.599)
Age	-.214* (.097)
Gender	-2.145 (2.088)
Tenure	.374 (.213)
Constant	20.175
R-sq	.206
F	3.741**

*N*=78, significance: \**p* < 0.05, \*\**p* < 0.01

## Appendix

### Preference for Solitude Scale

Ref.: Burger, J.M. (1995). Individual Differences in Preference for Solitude. *Journal of Research in Personality*, 29, 85-108.

For each of the following pairs of statements, select the one that best describes you. In some cases neither statement may describe you well or both may describe you somewhat. In those cases, please select the statement that best describes you or that describes you more often.

1. a. I enjoy being around people.  
b. I enjoy being by myself.

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2. a. I try to structure my day so that I always have some time to myself.  
b. I try to structure my day so that I always am doing something with someone.

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3. a. One feature I look for in a job is the opportunity to interact with interesting people.  
b. One feature I look for in a job is the opportunity to spend time by myself.

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4. a. After spending a few hours surrounded by a lot of people, I usually find myself stimulated and energetic.  
b. After spending a few hours surrounded by a lot of people, I am usually eager to get away by myself.

---
5. a. Time spent alone is often productive for me.  
b. Time spent alone is often time wasted for me.

---
6. a. I often have a strong desire to get away by myself.  
b. I rarely have a strong desire to get away by myself.

---
7. a. I like to vacation in places where there are a lot of people around and a lot of activities going on.  
b. I like to vacation in places where there are few people around and a lot of serenity and quiet.

---
8. a. When I have to spend several hours alone, I find the time boring and unpleasant.  
b. When I have to spend several hours alone, I find the time productive and pleasant.

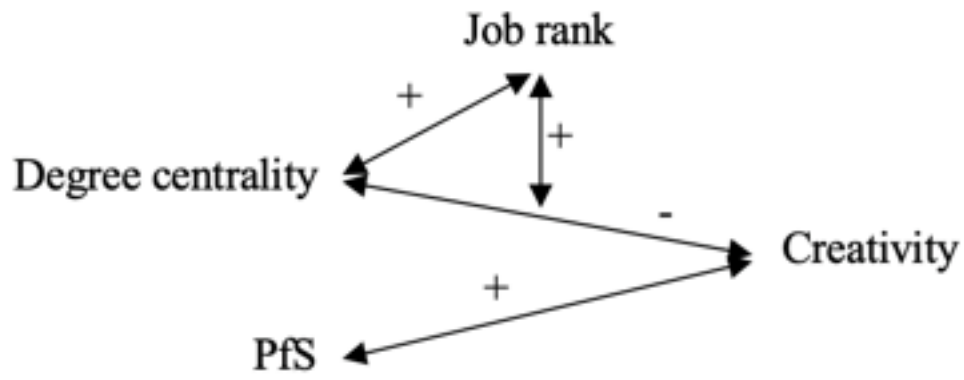
---
9. a. If I were to take a several-hour plane trip, I would like to sit next to someone who was pleasant to talk with.  
b. If I were to take a several-hour plane trip, I would like to spend the time quietly.

---
10. a. Time spent with other people is often boring and uninteresting.  
b. Time spent alone is often boring and uninteresting.

---
11. a. I have a strong need to be around other people.  
b. I do not have a strong need to be around other people.

---
12. a. There are many times when I just have to get away and be by myself.  
b. There are rarely times when I just have to get away and be by myself.

Theoretical model



## Random sample splitting-1

Table 4. Regression results reporting the effects the effects of PfS, degree centrality and job rank on creative performance with random sample splitting: cut value on PfS scale equals 5

**Dependent variable: Creative performance**

---

	<i>Model 4</i>
PfS	-.010 (.112)
Degree centrality	-.104 (.052)
Degree centrality x Job rank	.022* (.010)
Age	-.011 (.022)
Gender	-.352 (.527)
Tenure	-.007 (.055)
Constant	3.866
<hr/>	
R-sq	.174
F	1.654

---

*N=53, notes: gender: «1» female, «0» male  
significance: \* $p < 0.05$ , \*\* $p < 0.01$*



## Random sample splitting-2

Table 5. Regression results reporting the effects the effects of PfS, degree centrality and job rank on creative performance with random sample splitting: cut value on PfS scale equals 7

*Dependent variable: Creative performance*

---

	<i>Model 5</i>
PfS	.070 (.196)
Degree centrality	-.277** (.080)
Degree centrality x Job rank	.049** (.014)
Age	-.022 (.025)
Gender	-.530 (.683)
Tenure	-.070 (.078)
Constant	6.302

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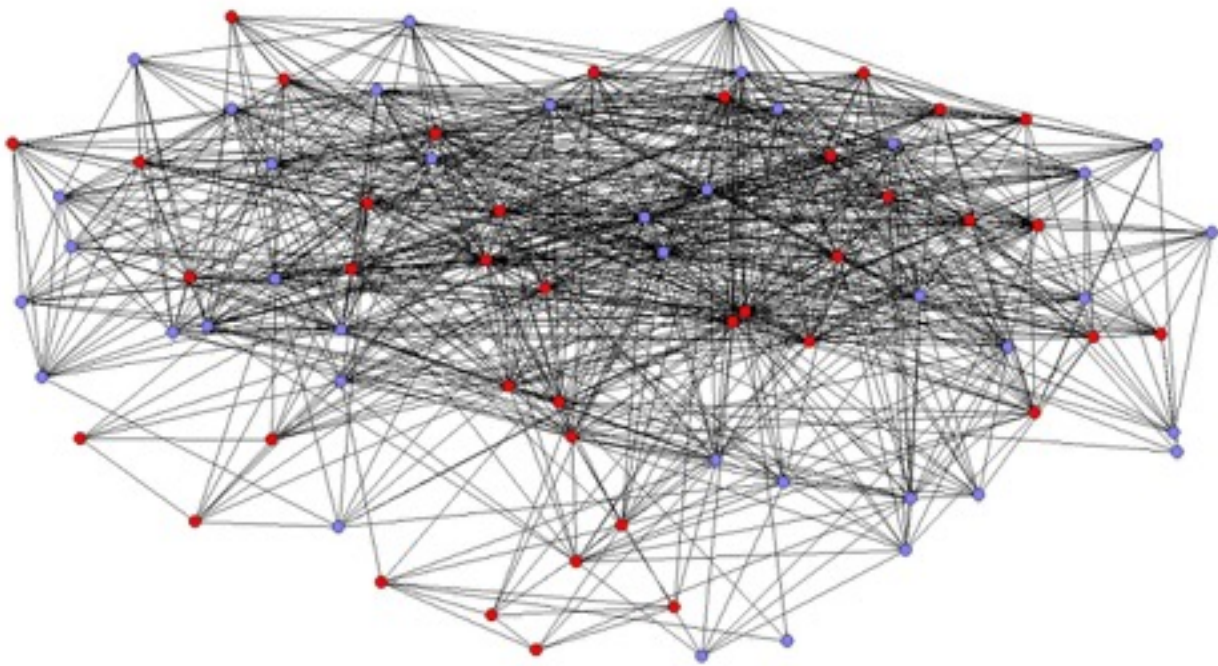
R-sq	.543
F	3.954**

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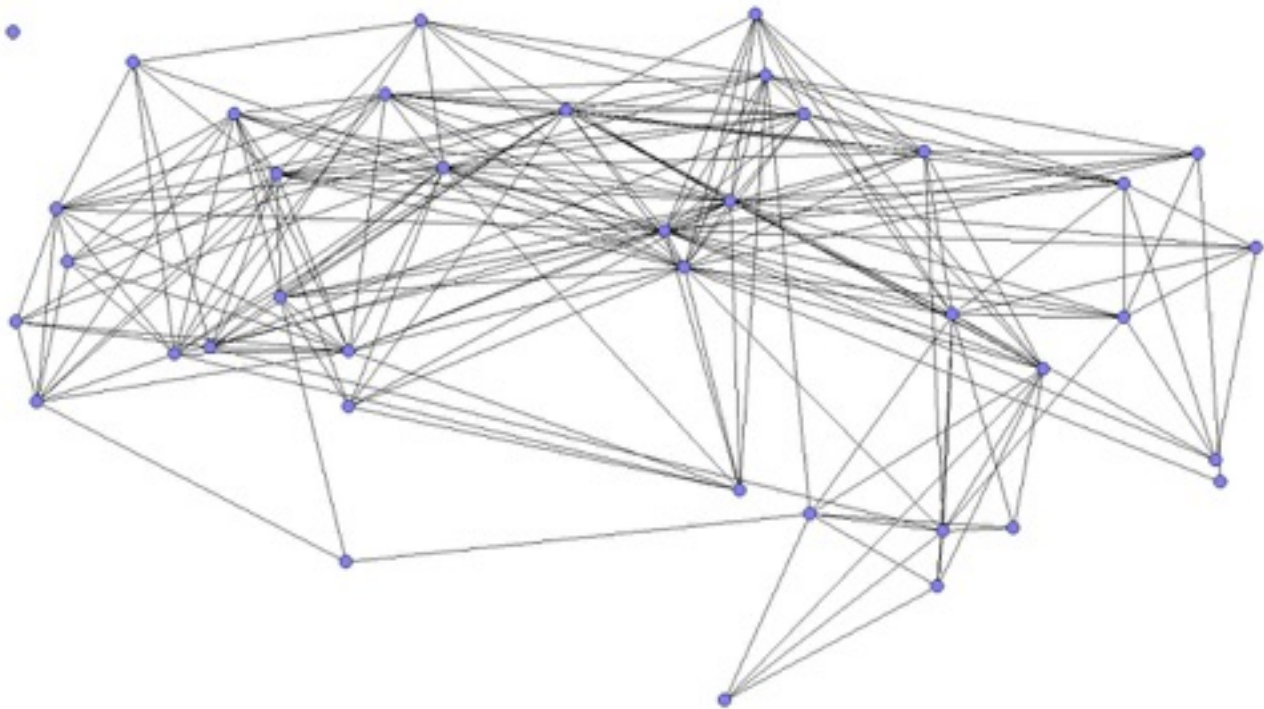
*N=53, notes: gender: «1» female, «0» male*

*significance: \* $p < 0.05$ , \*\* $p < 0.01$*

**Figure 1. Network of R&D department. Nodes in blue:solitary; nodes in red: non-solitary.**



**Figure 2. Network of solitary individuals of R&D department.**



## CHAPTER III

### Network Cognition And Creative Performance

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#### **Abstract**

This article aims to assess individual creativity in intra-organizational networks from a fresh angle. Building our arguments upon cognitive social structures literature, we argue that creative performance can be driven not only by means of holding advantageous positions in the network, but also by believing in holding these. Firstly, we use social capital theory (Coleman, 1988) to investigate how degree centrality and brokerage affect creativity. Secondly, we switch to cognitive social structures domain and explore what outcomes would perceptions of holding these positions generate. We test our theory on a sample of 93 respondents employed in R&D department of a large Russian-based company operating in gas machinery industry. The results of analysis provide support for most of our predictions and reveal that creativity, indeed, is a product of network position and network cognition.

Keywords: *cognitive social structures, creativity, social network analysis*

## Introduction

*«A man is the product of his thoughts. What he thinks, he becomes.»*

*-- Mahatma Gandhi*

The research on individual creativity in organizational networks and is burgeoning. Pioneer scholars applied classic network theories to creative contexts (e.g., Perry-Smith and Shalley, 2003; Kijkuit and van den Ende, 2007) and came with groundbreaking yet occasionally contradicting results that brought confusion to the field (e.g., Perry-Smith, 2006; Teigland and Wasko; Donati et al., 2016; Jokisaari and Vuori, 2014). Perhaps not surprisingly, suchlike inconsistencies required a fresher perspective and new angles. Ergo lately, social network literature started to consistently draw attention to factors that can complement network properties when explaining individual creativity, thus embracing the interdisciplinarity (Casciaro et al., 2015; Cangialosi et al., 2021) and post-structural approach to the phenomenon (Kilduff and Tsai, 2003). Some of the variables that have already been explicitly discussed include personality traits, cognitive styles, and creator's knowledge and skills (e.g., Groser et al., 2018; Rhee and Leonardo, 2018; Chua, 2018). Interestingly, it appears that even such comprehensively investigated network properties as brokerage or network density can manifest themselves in unexpected way, and change the magnitude or even direction of association with individual creativity (e.g., Kijkuit and van den Ende, 2010; Stea and Pedersen, 2017; Carnabuci and Dioszegi, 2015). Curious findings arising from this approach encourage scholars to dig deeper and establish novel links and associations that can shed more light on the nature of the phenomenon. After all, if thousands of years of creativity studies history (see Runco and Albert, 2010, for a review) have taught thinkers anything, it is that every particular case of creative endeavours of individuals is unique and requires exclusive examination.

Thus in intra-organizational context, individual creative performance is a product of interception of such dimensions as organizational culture, social context embodied by social networks, work environment and personality with fixed set of traits and qualities (George, 2007). And while the latter of these qualities has been recognized and celebrated in the field, less attention has been devoted to more elusive aspects of creativity: attitudes and thoughts. What do they have to do with social networks? Scholars have repeatedly stated that networks do not act, but people do (Burt et al., 2013). Therefore for an individual to put networks to use, they must first have a corresponding

perception of their position and overall situation, and *think* of it in some way. However, in creativity and network studies almost no attention was devoted to potential role of another actively evolving stream of research, cognitive social structures (CSS), a concept suggested by David Krackhardt (1987). Indeed, CSS adds up novel arguments to relational network effects, highlighting how mental reconstruction of existing network structures tends to vary from real state of art, and how such perceptions impact network behavior of people at work (Brands, 2013; Brands et al., 2015; Byron and Landis, 2021). This stream of research unequivocally allows us to assume that not only networking itself, but also the thought of networking can lead to desired creative outcomes. Thus CSS critically evaluates the classic approach to interpersonal networks and claims that (a) individual perception of social networks can dramatically diverge from reality, and that (b) certain network perception schemes can have a sufficient effect on one's performance (Casciaro et al., 2014; Krackhardt, 1990; Smith et al., 2020). We believe that CSS can become a missing piece of the puzzle that is needed to complete the image of individual creativity in intra-firm networks. The research question of this study is the following: *what independent effects do network position and cognition have on individual creative performance?* Answering this question is important because it will not only shed the needed light on the understanding of complex and multidimensional phenomenon, but it can also guide practitioners who are in pursuit of creativity enhancement.

The choice of the setting in this article is in line with the research tradition in the field, with early (Kijkuit and van den Ende, 2010) and recent studies (Soda et al., 2019; Tang et al., 2020) using R&D settings to tackle individual creative or innovative performance relying in networks. We continue the established tradition and put our arguments to an empirical test using the data from R&D department of a large company located in Western Russia. As it is customary in R&D departments, production of «novel and useful» outputs is one of primary functions, overlapping with famous definition of creativity by Teresa M. Amabile (1983). In addition to that, we see R&D setting as an appropriate one for a study of this kind since the practical value of work outputs can be evaluated objectively and quite quickly, thus easing cross-sectional data collection.

The article proceeds as follows. Firstly, we briefly overview the literature on social capital theory (Coleman, 1988) and see how network density and brokerage affect individual creative performance, given the context. Secondly, we refer to CSS stream of research (Krackhardt, 1987), discuss its interceptions and differences from structural network effects, and explore how beliefs of holding aforementioned network positions can influence one's creative performance. We conclude with spotting limitations of the study and suggesting directions for future research.

## **Social capital theory and individual creativity**

Social networks have gained prominence in social sciences as powerful metaphor to represent relations among agents at various levels, initially borrowing graph theory from mathematics and enriching its structural features with social, psychological and other content characteristics (Kilduff and Tsai, 2003). Social capital theory, one of the most celebrated streams of research in the field, tends to view a person as part of a broader social system and its norms, deeply affected by it and always interacting with it (Coleman, 1988). Instead of expecting people to be perfectly rational homo economicus, social capital theory invites researchers to subjectify and contextualize each particular case. According to the theory, creative performance is driven by cohesive social structures at conceptual (Coleman, 1988) and empirical levels (Donati et al., 2016). Scholars acknowledge that learning, tacit knowledge accumulation, and the overall ease of information flow across the network are enhanced in closed cohesive network structures (e.g., Fleming et al., 2007; Kijkuit and van den Ende, 2007; Uzzi and Spiro, 2005). One of the reasons behind it is that in dense networks, individuals are more likely to understand and support each other (Ahuja et al., 2012), usually prioritizing collective goals over personal ones (Coleman, 1988). In this vein, communication and promotion of creator's idea does not meet as much opposition and criticism as in sparser networks, and colleagues tend to engage into the process in a less competitive way, thus smoothing overall sensemaking process at different organizational levels (Kijkuit and van den Ende, 2010; Seibert et al., 2001; Burt, 2001).

### ***Network Density***

One of the common criticisms towards creativity in cohesive closed networks is the potential redundancy of information that flows through the ties (Burt, 2004; Zhou et al., 2009; Hirst et al., 2015). However, when it comes to information diversity in R&D networks, we believe there is an opportunity to reach it even in dense structures. Firstly, diversity can be originated directly by creators, who, as it happens in large organizations, usually have heterogeneous fields of expertise, education, or cultural background (Wang et al., 2014; Tang et al. 2017; Chua, 2018; Jang 2017). Indeed, research show that access to diverse knowledge in intra-firm networks is positively associated with innovativeness at individual level (Tortoriello et al., 2015). Similarly, Chen et al. (2008) claim that since people engaged into R&D teams are normally very diverse in terms of expertise and skills, it is tremendously important that they are engaged into active social interaction. In this vein, network density in R&D department will be naturally associated with efficient exchange of diverse perspectives and knowledge, ideas and opinions sharing. Ergo individuals

constituting the network can vary to an extent high enough to reduce risk of redundancy of information to the minimum.

Secondly, creators holding different positions in organizational hierarchy are very likely to differ substantially when it comes to objectives and challenges they face on a daily basis, leading to diversity in terms of perspectives (Kijkuit and van den Ende, 2007, 2010; Baer, 2010). Hence by working together, they can bring in enough fresh ideas and diversity to drive a creative project.

In addition to that, knowledge transfer goes rather seamless in dense networks, and actions are coordinated easily (Donati et al. 2016; Kijkuit and van den Ende, 2010; Fleming et al. 2007). This phenomenon heavily relies on subjective component of creative process in organizations, namely, on how individuals feel and how they perceive the situation at work. Dense network environment is emotionally comfortable for creators, thus they typically feel trust towards colleagues, can act openly and willingly share engage into reliable knowledge exchange (e.g., Donati et al. 2016; Kijkuit and van den Ende, 2010). Regular work-related information exchange helps everyone stay tuned on latest updates relating to any projects currently underway, thereby essentially increasing the speed and timeliness of resources coordination, alongside with tacit knowledge transfer (Jia et al. 2014; Seibert et al., 2001; Ahuja et al., 2012). Prior research stresses that in R&D contexts, mutually accumulated information is crucial for creativity and innovation, since it allows network members to build on each other's knowledge base, triggering novel combinations knowledge (Kijkuit and van den Ende, 2007; Putman, 1993; Chen et al 2008). Hence we suggest the following:

*Hypothesis 1: Embeddedness into a dense network positively affects creative performance.*

### **Brokerage**

Some of classic social networks studies justifiably claim that brokerage leads to enhanced creative performance (Burt, 2004; 1992; Tortoriello, 2014). Structurally, network brokers play role of bridges between otherwise disconnected clusters. In this sense, brokers escape a certain extent of homophily, caused by groups of people sharing similar behaviour patterns and opinions, and relying on the same information (Zhou et al., 2009; Grannovetter, 1973). Not surprisingly, such position exposes brokers to more diverse information and better insights, often leading to enhanced creative performance (e.g., Hirst et al., 2015).

However, contemporary studies recognize that brokerage is not necessarily beneficial in terms of creative outcomes, since the association between these variables often requires thorough subjectification. In other words, prior research explicitly demonstrates that brokers' creativity is heavily influenced both by micro-level factors, such as personality traits of network members, and meso- and macro-level factors, as embodied by the overall contextual setting (e.g., Perry-Smith and Mannucci, 2017; Soda et al., 2019; Carnabuci and Dioszegi, 2015). Indeed, it seems flippant to leave aside such tremendously significant elements as mentality of the nation, socio-economic situation, cultural values shared in the organization, and the very nature of work. To our knowledge, not many researchers in the field up to date have explored whether brokerage can in fact hinder individual creativity, but many prominent scholars discussed the diminishing returns of brokerage. For instance, Stea and Pedersen (2017) explained how brokerage can cause sufficient cognitive overload among R&D employees, and how the uncertainty and unpredictability of the task is accelerated by the heterogeneity of information originating from structural holes, often leading to confusion. Moreover, brokerage can expose creator to conflicting interests and behavioral norms originating from various social circles within the network, complicating the collaboration (Gomez-Solorzano et al., 2019).

Curiously, Rhee and Leonardi (2018) approach this same matter from micro-level perspective, explaining how diverse information coming from heterogeneous sources scatters cognitive efforts rather than allowing employees of R&D department focus down on the crucial domain-specific details. Perfectly in line with this logic, Carnabuci and Dioszegi (2015) show that those creators who have innovative cognitive style tend to struggle in brokering positions, since it hinders their ability to reach consensus with other network members and push nontrivial creative ideas forwards.

Brokerage has a dark side. As Soda and colleagues (2019) point out, brokerage «starts from the premise of an independent self, prioritizes individual goals over collective goals, focuses on the fulfilment of self-interest rather than the accommodation of social norms and obligations, and values task achievement more than harmonious relationships» (p. 1744). In this vein, brokers can often act in opportunistic and selfish manner, a behavioural pattern that can be beneficial in some organizations, and partially unethical in others. Indeed, prior research recognises the uncertainty and lack of trust arising from broker's reputation (Fleming et al. 2007). In organizations where employees encounter a strong sense of belonging, high commitment and feel mutual ownership of creative ideas and outcomes brokers may seem dangerous and undependable (Fleming et al. 2007; Xiao and Tsui, 2007; Soda et al., 2019).



Furthermore, the literature demonstrates that from a cultural perspective, brokerage can prove to be utterly ineffective in certain contexts. Thus Xiao and Tsui (2007) come up with surprising finding that in collectivistic culture, as in China, brokerage is in fact negatively related to career performance. Indeed, most of the published studies exploring the effects of brokerage focus on Western contexts (e.g., Venkataramani et al., 2014; Zou and Ingram, 2013) that are traditionally more individualistic (Xiao and Tsui, 2007). In organization theory, individualists are those who are oriented towards the self, whereas collectivists are oriented towards the collectivity (Parsons and Shils, 1951). In the field of management, Russian culture is often being compared to that one of China due to similarities in terms of country size and connection to the communist party (see Michailova and Hutchins, 2006). Russian culture is multi-layered, and vivid post-communism heritage affects micro-processes within organizations (Elenkov, 1998; Fey and Dension, 2003). And even though 30 years have passed since the collapse of the Soviet Union, to date, Russia remains a collectivist country (Nemeržitski, 2017; Michailova and Hutchins, 2006). As Elenkov (1998) points out when discussing the roots of collectivism in traditional Russian society, «individualistic traits were considered to be socially undesirable and destructive for group harmony. People who strived to be better than the rest were seen as taking away the rightful share of others.» Instead, national culture in Russia encourages people to be very group-oriented at work (Fey and Dension, 2003). Personal achievements are expected to help not only the very accomplisher, but also their colleagues, family, and generally impersonal groups of individuals (Triandis 1995; Tower et al. 1997; Elenkov, 1998; Realo and Allik, 1999). We believe that such prioritization of common goals over individual ones can make brokerage appear morally wrong both to the individual and alters. Interestingly, Casciaro and colleagues (2014) find that instrumental networking can in fact make people feel morally impure. Workplace creativity, too, is very responsive to national culture, and visible differences can be found between Western contexts and post-soviet arena (Jaskyte, 2008). Thus, employees' attitudes and values toward creativity are very likely to differ sufficiently (Jaskyte et al., 2020). In this vein, we are convinced that brokerage can seem morally wrong and become a hindrance to individual creativity at work.

To sum up, for the aforementioned reasons, we propose that in a setting of collectivistic nation, a sample of R&D engineers who work on very complex technological solutions that requires constant recombination of knowledge from different fields and disciplines, can in fact suffer from strictly negative consequences of network brokerage. By having said this, we advance the following hypothesis:

*Hypothesis 2: Brokerage negatively affects creative performance.*

### **CSS and individual creativity**

We have now seen how network structure can affect individual creative performance in intra-organizational networks. And while actual network graph portraits interactions map quite authentically, at the individual level, perceptions of the network tend to deviate (Brands, 2013). Ever since 1960s, scholars explored how individuals perceive and memorize social structures they are embedded into (De Soto, 1960; De Soto et al. 1968; Killworth and Bernard, 1976). The field has boomed after the publication of Krackhardt's (1987) seminal work, where the very concept of CSS was first introduced. Technically, CSS represent the three-dimensional system that includes the sender, receiver and perceiver of the communication that takes place. Let us explain this model on a simple example. Imagine, Jane (the perceiver) works in a medium-sized enterprise. Jane thinks that her colleague Ben (the sender) would normally reaches out to Alice (the receiver), his indirect supervisor, for work-related advice. Hence when Jane is thinking about the structure of social network of her colleagues, she would picture a link connecting Alice and Ben. In fact, we do not know whether communication between Ben and Alice takes place in reality, and thus we consider Jane's reflection on this matter her subjective perspective and a basis for CSS she generates. In contrast to that, if Jane personally interacts with Ben and Alice, we can consider it objective information that can be used for actual network configuration. CSS, therefore, represents patterns of social interactions as they are reconstructed by network agents.

----- *Insert Figure 1 here* -----

Interestingly, broad research evidence demonstrates that accurate mental reconstructions of networks are very rare (see Brands, 2013, for a review). In fact, memorizing social structures is energetically costly. Human brain algorithms uses shortcuts to recall complex network information (Smith et al., 2020), thus inevitably missing some of the crucial details. Usually, it will not be a priority (Byron and Landis, 2020), especially if reality differs from what people are comfortable to believe in. Instead, we think of network relations in accordance with established norms and widespread social expectations. As result, at times people subconsciously choose to remain delusional about the real state of art, preferring to believe that things are how they are supposed to be in one's world views (Byron and Landis, 2020; Burgoon and Hale 1988; Brands and Kilduff, 2015). Interior design of workplaces, too, creates boundaries for CSS accuracy: observation of

others is limited when coworkers are located in different rooms of production site, making it difficult to be aware of all interpersonal interactions taking place, and leaving the rest up to grapevine and personal expectations (Byron and Landis, 2020). It is not surprising at all that network misperceptions are so common. Some of the most thoroughly studied examples are overestimation of small-worldliness (Kilduff et al., 2008), gender expectations projection (Brands and Kilduff, 2015), exaggerated patterns of affiliation (Freeman and Webster, 1994), and other (see the review by Brands, 2013).

In line with this logic, even when isolated from relational network effects, CSS would have potential to affect our attitudes and behaviours in the network (Casciaro et al., 2015). As Byron and Landis (2020) argue, people consistently act in accordance with their beliefs and network perceptions. But if actions invariably lead to performance outcomes, does it matter if social structure understanding was accurate? As scholars point out, networks do not act by themselves (e.g., Soda et al., 2019). Instead, all actions are undertaken by people who not only objectively have a certain position in the network, but also have a certain perception of the overall situation at work and their role in it. Indeed, researchers seem deeply convinced that CSS impact individual job performance in many ways (Brands, 2013), but how would it affect individual creativity?

Surprisingly, not much has been said about the effect that CSS can have on individual creativity. We know, on the one hand, that CSS are partially a product of cognitive processes unfolding in one's brain (see Smith et al., 2020, for a review). On the other hand, we also are well aware of the findings originating from the prominent stream of cognitive psychology research that acknowledges the mental nature of phenomenon of creativity in people (Simonton, 2000). The research on creative cognition has been on the rise since 1990s. Classic studies in the field recognise creative cognition as very complex multi-layered phenomenon that draws on one's knowledge, personality, motivation, imagination; but that is also contextually situated (e.g., Ward et al., 1999; Runco and Chand, 1995). Despite its multidimensionality, creative cognition is natural to every human being and mostly relates to (1) how the problem at hand is perceived and structured, and (2) how the new information is obtained and processed (Guilford, 1967; Michael, 1999).

Recent studies in the field of social networks and individual creativity, too, have explored how cognition manifests itself in intra-organizational networks, and some thrilling results have been detected. For instance, unpublished manuscript of Biscaro and Montanari (2018) explores the association between CSS and creativity and comes up with curious results, showing that creative individuals tend to perceive their network either as very sparse or very dense. Li et al. (2018) come

up with a surprising finding that a cognition of helping a colleague to enhance their creativity positively affects giver's creativity, too. Carnabuci and Dioszegi (2015) draw readers' attention to how cognitive psychology predefines individual and organizational behaviour in social networks, and expose what cognitive styles would be beneficial in what network structures. Similarly, Perry-Smith (2014) explored how psychological balance caused by receiving information from strong vs. weak ties drives individual creativity. In this vein, it is indeed paradoxical that the interplay of CSS and individual creativity in intra-firm networks has not yet been thoroughly studied. In the following passage of the paper, we put up two hypotheses aiming to cast a bridge between cognition of being embedded into certain network structures and creativity.

### ***Cognition of Network Density***

A common misperception about social networks arises from the balance theory that suggests that in seek of psychological balance, individuals cognitively try to symmetrize the relationships in the group (De Soto, 1960; Heider, 1946; Crockett, 1982). It results in expectations of positive and negative affect transitivity in social networks (Kumbasar et al., 1994), and also in distorted images of overall network structure (e.g., Freeman and Webster, 1994). For example, Kumbasar et al. (1994) found that while individuals tend to perceive their direct network as dense and reciprocative, they also picture their indirect network as sparse and lacking reciprocative ties. Similarly, Krackhardt and Kilduff (1999) demonstrated that the cognized balance in a close network significantly exceeds that of an intermediate social distance. This argument suggests that in the organizational context, such systematic biases can easily result in overestimation of density of the network, because co-workers collaborate on daily basis to fulfil essential tasks.

But what consequences would perception of embeddedness into a densely connected network trigger for individual creative performance? As Perry-Smith (2014) writes, psychological balance in perception results in expectation of one's colleagues to have exactly the same domain-relevant information and knowledge pool. For creativity, that would translate as high degree of homogeneity that offers no fresh ideas, no diverse perspectives and thus little opportunity to come up with anything truly novel and useful. Such belief is dangerous, since it can dim creator's perceived potential of the network and lead to a conclusion that in this work environment, no groundbreaking ideas can originate.

Additionally, belief to be embedded into a dense homophilic network can insinuate that the creator has to conform to a customary way of doing things, cutting off curiosity, playfulness and

experimentation that are so important to individual creativity (see George, 2007, for a review). Indeed, a recent study by Lee and colleagues (2020) demonstrated that those who perceive their network as dense would tend to identify with it. In dense networks there is not so much opportunity to stand out or embrace creative experimentation, which results in higher extent of perceived structural equivalence (Lorrain and White, 1971; Krackhardt, 1987; Michaelson and Contractor, 1992). The prior literature shows that individuals are prone to adopting the behaviour of colleagues who seem to hold structurally similar positions in the organization. Behavioural pattern adopted by such colleagues appear to be contextually appropriate, altogether resulting in individuals opting for similar courses of action and corresponding decisions (Burt, 1987, 2004; Kilduff and Oh, 2006). The necessity to fit in can cause uncertainty about the reaction to creator's nontrivial actions, causing stress and confusion, and repulsing consequent creative efforts (George, 2007; Argyris, 1990). Moreover, not only such perception constrains and cages creativity, but it is even uncomfortable enough to push creators to quit their jobs for good (Krackhardt and Porter, 1986).

Of course such perceptions can sufficiently diverge from the actual state of art, and the network can be diverse enough to give birth to high quality creative ideas. But we believe that regardless, cognitive processes can be equally important. Research in the field of creativity and social network highlights the importance of individual cognition. Cognitions shape beliefs, beliefs shape opinions, opinions trigger actions. In this case, we claim that cognition of embeddedness into a dense network is an independent variable that has enough power to have visible effects on individual creative performance:

*Hypothesis 3: Cognition of embeddedness into dense network negatively affects creative performance.*

### ***Cognition of Brokerage***

Our next step is to explore what happens when an individual believes to be a broker in the network, and how it relates with their creative performance. We know from prior literature that brokers are typically exposed to non-redundant information and diverse perspectives (e.g., Burt, 2004; Zou and Ingram, 2013; Stea & Pedersen, 2017). But what happens when one *believes* to be a broker? To our knowledge, it can stimulate their creative performance in several possible ways.

Firstly, prior research shows that brokerage is perceived as signalling power, control, status and agency (Brands et al., 2015; Brands and Mehra, 2019; Burt, 2005). Basing their arguments on social neuroscience literature, Smith and colleagues (2020) point out that brokers are indeed seen as individuals of high social importance. Hence we expect the belief of being a broker to be very empowering for a creator. It boosts individuals' the perception of importance of their own opinion and power to broker the knowledge. They are more likely to be convinced of having a unique perspective to creative problems at hand, as one is convinced of seeing the situation from a broader perspective than those colleagues who do not seem to hold brokering positions. Such cognition must result in bolder creative actions and willingness to get actively involved into creative processes in the team. The logic behind this argument partially interplays with the definition of self-efficacy (Bandura, 1977) and creative confidence (Phelan and Young, 2003). Both of these concepts are recognized as powerful drivers of individual creativity both in creativity and social networks literature (Grosser et al., 2017; Anderson et al., 2014; Beeftink et al. 2012; Kelley and Kelley, 2013; Lee, 2011).

Secondly, belief to be a broker releases the pressure to conform to norms and rules. Instead, it pushes the individual to seek for alternative solutions and novel techniques, therefore embracing the dissimilarity that is known to facilitate creativity in professional networks (e.g., Biscaro and Montanari, 2018; Zhou et al., 2009; Daskalaki, 2010). Such behaviour facilitates the uniqueness of perspective and exposes the individual to non-trivial problem solving even more. By adopting experimentation approach one gradually becomes more open to new experiences (Baer, 2010), the trait that is very strongly associated with creativity in social networks (Baer, 2010; Zare and Flinchbaugh, 2018).

Curiously, Byron and Landis (2020) explain that when it comes to network perceptions, people are often so strongly motivated to maintain a positive self-view about their role in interpersonal relations, that they can even choose to have distorted yet self-assuring self-views. In this vein, if brokerage is seen as a position of social power and unique creative perspective, it must be associated with positive self-view, and creators may subconsciously choose to believe to be brokers, even if in reality it is not necessarily true. Therefore we expect brokerage and perceived brokerage to have independent effects on creative performance. Based on the aforementioned, we posit:

*Hypothesis 4: Belief of being a broker positively affects creative performance.*

## METHODS

### *Research setting*

We gathered the empirical data to test the theory from a large company located in Western Russia, called here GasMach. GasMach produces gas machinery and operates both in international and domestic arena, with 30% market share in Russia. The firm focuses on production of equipment necessary for extraction and transportation of gas, namely, meter stations and components, high and low pressure gas machinery, lock off valves, and the equipment necessary for maintenance of these products. As seen from this description, GasMach is vertically integrated and embraces a large proportion of the value chain. Activities are co-located in the same area, with separate sites across the city. After a number of preliminary interviews with GasMach management, we have decided to focus on R&D department that appears to be of central prominence in terms of creativity and innovation, as it prototypes tailor-made novel products according to clients' needs and special requirements, asking its employees to be engaged in creative tasks. The department is formally divided in two separate sub-departments under different management. Sub-departments include a number of teams engaged into work on various products from GasMach assortment. Methodological complexity and interdisciplinary nature of tasks facilitates collaboration between engineers from teams and sub-departments, making GasMach an ideal setting for social network research. We have opted for single firm data collection for the sake of avoiding firm-varying factors and potential heterogeneity of intra-organizational factors that can affect creative behavior of employees (e.g., Stea et al., 2017).

### *Procedure*

The data were collected in close collaboration with GasMach management. There was a mutual interest in the study. To managers, it was strategically important to understand the interaction patterns in the department and to spot out employees who are central in informal knowledge sharing network. Prior to collecting the data, we have attended several meetings with top managers in order to better understand the specificity of organizational culture, agree on the terms of collaboration and ensure privacy.

The first wave of quantitative data collection took place in May-August 2019 and consisted a surveys for employees and subordinate evaluation scale for managers. Since the company is located in Russia, the survey was translated into Russian with translation-back translation procedure

(Brislin et al., 1973). Respondents filled in questionnaires including three blocks: network roster (Soda and Zaheer, 2012), cognitive network section (Mehra et al., 2014; Brands et al., 2015), and a set of demographic questions. On average, it took respondents 15 minutes to fill in the survey. Managers of the department were asked to evaluate creative performance of their subordinates (Perry-Smith, 2006; Li et al., 2018). It took up to 2 hours for managers to complete the evaluation.

One year after first wave of data collection, in September 2020, GasMach management expressed availability for collaborating once again. It was an occasion to explicitly discuss the results of analysis and to ensure that no important information went missing. Our primary purpose was to gather qualitative data to better understand specificity of individual creative process in the organization. Recent studies in creativity and networks field acknowledge the importance of mixed methods when assessing creativity in networks (Li et al., 2018; Soda et al., 2019). Thus, to support quantitative data, we have run three on-site interviews with two managers of R&D department and with the commercial director of GasMach. Interviews were conducted in Russian, recorded on a voice memo, transcribed and translated into English. Average interview duration equalled 23 minutes.

Interestingly, communication with GasMach management revealed that the company has slightly shifted its production focus and expanded the product line with new pump technology. For these purposes, GasMach hired a team of engineers to join R&D department. The team moved from competitor site in the area to work on new product development. Further investigation revealed that within timeframe between two data collection waves several more people were hired. Prior research shows that newcomers network in a slightly different way, as they view the network from a fresh perspective and need a certain amount of time to adjust to the work environment (Jokisaari and Vuori, 2014). Although network dynamics can have tremendous effects on creative work (Perry-Smith and Mannucci, 2017), certain studies show that certain aspects can have an enduring effect on individual creativity (e.g., Kijkuit and van den Ende, 2010). In the current study, adding new respondents to the final sample was a good opportunity to test the reliability of the theoretical model and overall stability of proposed network mechanisms. In this vein, we opted for expansion of original dataset. In pursuit of studying new employees, we have replicated the survey of 2019 in a new network of 2020. We used identical questionnaires for both waves of data collection. For robustness check, we have downsampled and run statistical analysis for respondents of year 2019 alone, and found no considerable difference in the way data attests the model. Results of supplementary analysis are reported in the Appendix.



## ***Participants***

Respondents are engineers of different qualifications and areas of expertise, including but not limited to mechanical engineering and software engineering. Daily tasks of most of the engineers in the sample was to work on blueprints and 3D drawings for gas machinery prototyping. The final sample consists of 93 respondents, 78 of which took part in the survey in year 2019, and then 15 other respondents were new employees of GasMach who filled in their questionnaires in 2020. At the time of data collection in 2019, R&D department in GasMach had 83 employees, of which 78 agreed to take part in the survey. The gender breakdown was 32% female and 68% male. In 2020, 85 people were employed in R&D department, and 69 of them took part in the survey. The gender breakdown remained similar: 29% of respondents were female, and 71% were male. To ensure robust results, we have run independent samples t-test prior to launching the analysis. This procedure confirmed our expectations, as there were no significant difference between subsamples in terms of variables of interest.

## **Variables**

### ***Network measures: brokerage and density***

We focused on advice network that was described as communications in seek of work-related advices, access to resources, help, assistance and work-related instructions. To gather network data, we followed network roster approach (e.g., Wang et al., 2015; Donati et al., 2016). Each respondent was given a full list of employees in the department and was asked to indicate those to whom the respondent referred to for work related advice. Once collected, we have put employees' responses in a matrix, where a relation between a dyad was marked as «1» if it existed, and «0» otherwise. Scales used in the study can be found in the Appendix.

Brokerage was measured with betweenness centrality routine in Wolfram Mathematica. Betweenness centrality captures the number of times when a network actor acts as bridge on the shortest path when connecting a dyad, or as Borgatti (2005: 60) puts it: “the volume of traffic moving from each node to every other node that would pass through a given node”. This measure is widely used to assess brokerage in social networks (e.g., Li et al., 2018; Stea and Pedersen, 2017; Perry-Smith, 2006).

For network density assessment, we focused on general network pattern (e.g., Zhou et al., 2009). By these means, we have studied the effects of overall network culture in the organization, rather than

the one of ego's direct ties, that can potentially be biased by ego's hierarchical position, tasks, and personality. Network density thus was measured by cluster and reflected the number of connections among network actors divided by the total number of such potential connections.

Each measure was calculated independently for each year. Thus for those respondents who filled in the survey in 2019, network density and brokerage measures are derived from the network of 2019. For new employees of the department (15 respondents), we constructed a separate network as of 2020 (68 network agents), including all respondents who participated in a survey during a second wave of data collection. Following the same procedure, we computed network density and brokerage values. As result, the final sample includes 78 respondents with network measures are based on the network of summer 2019, and 15 respondents whose network measures were generated from the network of summer 2020.

### ***Cognitive network: brokerage and density***

For cognitive network measures, we used the visual method suggested in the work of Mehra and colleagues (2014). It allows to graphically represent certain dimensions of network as stylized images. This method is relatively new, but it has already manifested itself as efficient and promising in the literature. For example, Brands et al. (2015) used this method to investigate how gender affects charisma in intra-firm networks. Interestingly, recent literature reviews name this method a promising direction of data collection, as in the works of Jaspersen and Stein (2019) and Kwon et al. (2020).

The logic behind choosing this method was twofold. Firstly, it is efficient for networks of relatively large size, as in GasMach. Reconstruction of the whole network can be cognitively challenging, and would take much longer time to perform, constraining attentiveness and honesty of respondents. Secondly, some network properties, such as brokerage, are difficult to assess with network roster, as respondents may connect alters yet not recognize their own brokering role (Mehra et al., 2014). Thus for perceived brokerage, respondents could select how many of such positions they hold, ranging from «zero» to «many». In our sample, perceived network density ranged from 0% to 100%.

### ***Creative performance***

We have asked managers to evaluate their subordinates. Creative performance was assessed by means of Oldham and Cummings' Integrated Creativity scale (1996). The scale consisted of three questions regarding novelty and usefulness of creative outputs and is actively used in the field of

creativity studies as a measure of individual creative performance (e.g., Sue-Chan and Hempel, 2016, Shin et al., 2016; Baer and Oldham, 2006). Based on the year of survey completion, we used ratings of 2019 and 2020, accordingly.

### ***Control variables***

Demographic data from the questionnaire were used to add well-established control variables to statistical analysis, as embodied by tenure and age. In order to control for year of participation in the survey, we introduced a dummy variable that equalled 0 for 2019 and 1 for 2020, correspondingly. Research in the field acknowledges that under certain circumstances, closeness centrality can affect individual creativity in intra-organizational network (Zhang et al., 2017 Perry-Smith, 2006). Closeness centrality represents the cumulative length of shortest paths from the given network node to every other node in the network. We included this variable to the analysis to ensure that in our sample, it does not serve as alternative trigger for individual creativity. The measure was calculated in Wolfram Mathematica based on network data attained from 2019 an 2020 surveys.

----- *Insert Table 1 and Table 2 around here* -----

## **RESULTS**

*Table 1* displays descriptive statistics and bivariate correlations. Direct network position effects on creative performance are evident from the table. As expected, there was no significant correlation between network position and cognition. Thus, embeddedness into a dense network did not overlap with cognition of such, and similarly, holding a brokering position did not result in realization of such. Interestingly, respondents' tenure is found to be positively associated with perception of brokerage, but not that one of density. Meanwhile in reality, tenured employees tend to be engaged into dense networks where they do not seem to hold brokering positions.

*Table 2* presents the regression results. Model 1 shows results for control variables alone. Models 2 and 3 test two sets of hypotheses separately, while in Model 4, all variables are put together for another test. Hypothesis 1 predicted that network density will positively affect creative performance. As Models 2 and 4 show, there indeed is a significant interrelation between network density and creative performance (Model 2:  $\beta = 0,248$ ,  $p < 0,05$ ; Model 4:  $\beta = 0,255$ ,  $p < 0,01$ ). Hypothesis 2 stated that brokerage is negatively associated with creative performance. Model 2 and 4 demonstrate that this hypothesis holds (Model 2:  $\beta = -0,342$ ,  $p < 0,05$ ; Model 4:  $\beta = -0,305$ ,  $p < 0,05$ ).

Hypothesis 3 suggested that belief of being embedded into a dense network constrains creative performance. Models 3 and 4 tested this hypothesis. There was support for this hypothesis in the form of significant interrelation between perception of density and creative performance (Model 3:  $\beta = -0,213$ ,  $p < 0,05$ ; Model 4:  $\beta = -0,186$ ,  $p < 0,1$ ). Hypothesis 4 predicted that perception of holding a brokering position will be positively affiliated with creativity. According to Models 3 and 4, this hypothesis does not hold, due to low statistical significance of results (Model 3:  $\beta = 0,138$ ,  $p < 0,2$ ; Model 4:  $\beta = 0,092$ ,  $p < 0,4$ ). Together, network density and brokerage explain not less than 20% of variation in creative performance, as opposed to perceptions of density and brokerage, that explain slightly less than 10% of variation.

## DISCUSSION

It is no surprise that researchers tend to explain individual creative performance in intra-firm networks based on network brokerage and density. Prior literature demonstrates surprising results that show how brokerage and network density can drive individual creativity (Perry-Smith and Mannucci, 2017; Kijkuit and van den Ende, 2010; Burt, 2004). Our study suggests a novel way to assess the aforementioned relationship. Basing our arguments on social capital theory (Coleman, 1988), we suggest that in certain contexts, network density triggers individual creativity, and brokerage hinders it. Further, by acknowledging that cognitive processes constitute an essential component of individual creativity, we reflect on how perception of network structure can alter creative performance in intra-organizational networks. By doing so, we develop a model in which not only network position and structure, but also perceptions of network density and brokerage are directly related to individual creative performance.

The results of our study are encouraging and intriguing. Our findings are indeed in favour of social capital theory as powerful driver of individual creativity. We find strong support for our suggestion that dense network structures can boost creativity and innovation performance due to mutual understanding, simplified information transfer, and enhanced collective action coordination that are crucial for creative tasks in R&D (Coleman, 1988; Kijkuit and van den Ende 2007). Another finding is more unconventional. While many classic studies in the field celebrate brokerage and view it as a useful tool for creativity enhancement (e.g., Burt, 2004; Venkataramani et al., 2014), we demonstrate that in certain specific settings it can in fact be a hindrance to individual creativity. Thus if the national culture is strongly collectivistic (Xiao and Tsui, 2007; Elenkov, 1998), the job

task requires complex knowledge recombination (Stea and Pedersen, 2017), and deep cognitive concentration (Rhee and Leonardi, 2018), as it happens in our setting, brokerage can turn out gloomy and malicious.

A curious finding arises from CSS theory. We discover that belief of being embedded into a dense network is positively associated with creativity in intra-organizational network, regardless the actual network structure. Network density perception empowers an individual, makes them feel that their perspective can be unique and fresh. From psychological balance theory we know that people expect their closest colleagues to have the same knowledge and information as they do (Perry-Smith, 2014). But belief of being a member of a sparse advice network in creativity-encouraging, and it cancels out a possibility of being a victim of groupthink.

Surprisingly, outcomes of perception of holding a brokering position were not as apparent. While our expectation was that it would positively influence individual creativity, we did not come up with statistically significant results. This result replicates that one of Biscaro and Montanari's (2018) unpublished manuscript where authors suggested this association as hypothesis and likewise, did not find support for it. One of the possible reasons behind our result can be found in the work of Casciaro and colleagues (2014), where authors discuss how instrumental networking can make individual feel dirty, as if the actions they are taking up are not totally morally justifiable. Since brokers usually manipulate information in networks solely for their own profit rather than common good, and such actions might constrain alters and make broker feel guilty. Another potential reason, of course, can be found in cultural underpinnings that have been discussed above.

We also draw attention to how CSS biases can lead to positive outcomes, a point majorly overlooked in prior research (Brands, 2013). This study specifically highlights the dissimilarity of network position and network perception in terms of the influence they can have on individual creativity. Although scholars in CSS field have long explained how biased our network perceptions can be, not so many articles explore independent effects of network position and cognition. The current article explicitly demonstrates that embeddedness into a dense network and perception of such have opposite effects on individual creativity. The reason behind it is that these two factors affecting creativity are very dissimilar in essence and dependent on two separate mechanisms, one being objective and socially situated, and the other being of cognitive nature and not necessarily conscious.

It is also interesting to note that our model holds both for permanently employed respondents and newcomers. The absence of significant effects of year dummy in regression analysis allows to assume that network effects explored in this study are enduring and stable.

In sum, our findings contribute to the theory in several ways. Firstly, we refresh the theoretical approach to studying individual creative performance in intra-organizational networks. By introducing a novel angle to view the phenomenon, we expand the existing theory and bridge it with CSS stream of research. Management literature has investigated effects of network perceptions for over three decades, but to our knowledge, none of CSS components has ever been applied to understand the nature of individual creativity in organizations. By constructing our theory and demonstrating results, we successfully cast a bridge between two fields and justify why it was necessary to do so. We show how theories arising from interdisciplinary domains compliment one other to unveil a multilayered phenomenon of individual creativity.

We see this research as being practically applicable in companies that are interested in boosting the creativity and innovativeness of the staff. Since the perception of network structure can play such significant role in shaping work outcomes and performance, it can become a good tool for human resources. Individuals believe that high network density chokes their creativity, thus it is important to convince them that the network they are embedded into is sparse. Organizational culture and work environment can be organized in such a way that would make employees feel that they are dissimilar to others, and that the contribution they can make would not overlap with that one of others.

### ***Limitations***

This study is not free from limitations. First, strict setting contextualization in this study sets certain boundaries. Hence naturally, there may be some obstacles with extrapolating our findings to a substantially different industry in a Western country. The association between network position, its cognition and individual creativity can significantly diverge in such settings, and researchers may discover novel magnitude and even direction of association between variables. One of our aims, however, was to acknowledge the heterogeneity and celebrate the diversity of cultural underpinnings. Second, we used supervisor evaluation to assess individual creativity of respondents. Although such approach has become mainstream in the field (e.g., Sue-Chan and Hempel, 2016, Shin et al., 2016; Rhee and Leonardi, 2018), one cannot deny a chance of supervisors' subjective perceptions affecting the evaluation. More objective rankings, such as

patents or publications records, performance bonuses or overall project success could be used to prove the validity of dependent variable values (e.g., Kijkuit and van den Ende, 2010; Dolfsma and van den Eijk, 2016; Fleming et al., 2007).

### ***Suggestions for future research***

The complexity of relation between CSS and creativity deserves further investigation. Researchers in the field should devote attention to intertivist between personality traits, CSS and creativity. Despite existing evidence of individual cognition having impact on network perceptions (see Smith et al., 2020, for a review), to our knowledge, researchers to date have not attempted to study in depth the association between personality psychology and CSS in pursuit of uncorking the phenomenon of creativity. Such studies, however, could sufficiently enrich the literature and orient the future research toward mindful approach to creative performance. For example, in-depth analysis of correlation between Big Five personality traits, self-efficacy and conformity value and CSS patterns can reveal novel psychological explanans to compliment the established social network theory.

We find it curious how perception of network density and structural network density have opposite effects on creative performance. While these findings are strictly in line with social capital and CSS theories, accordingly, we cannot deny that it is rather counterintuitive. We believe that digging deeper into this phenomenon can lead to thrilling insights. Why is it that we are more creative when we see the world this way? It is customary to associate misperceptions with narrow perspective, but can it be true that misperceptions are actually serving us?

It could also be interesting to see to what extent the theoretical mechanism suggested in this study would replicate in a different industry setting. Prior research provides arguments in favor of domain specificity of creative work, and this dimension involves both personal traits that are affiliated with creativity (Feist, 2006) and tasks to be performed (Baer, 2010a). In this study, we focused on the creativity of engineers in R&D department, and engineers are known to have a number of distinctive features when it comes to creative performance (Cropley and Cropley, 2005). But would the magnitude of the correlation change in, say, a cultural and creative industries? Or would scientists encounter similar effects of network position and cognition? Answering these questions could not only compliment the theory, but also have a high practical value among creators and managers of creative projects. In support of suggested directions for future research, the field also needs an interdisciplinary and comprehensive literature review that would detail various aspects of

the phenomenon and spot deep associations between the aforementioned variables. We fundamentally believe that more scholars should feel inspiration to study the topic deeper and bring this field to fruition that it deserves.

## CONCLUSION

The findings of this study speak to evolving stream of research on individual creativity in intra-organizational social networks. Recent studies recognize the importance of cognitive processes (Rhee and Leonardi, 2018; Carnabuci and Dioszegi, 2015) on creativity in social networks. In line with prior research, we take a step forward and introduce CSS (Brands, 2013; Brands et al., 2015) to the domain. The proposed theory aims to complement the existing body of knowledge by adding an additional dimension of network brokerage and density. This study suggests that not only the very network position, but also the cognition of one's position in social networks can have a significant impact on individual creative performance. Acknowledgement of important role of cognitive mechanisms triggered by CSS can offer scholars a set of novel explanations of individual creativity in intra-organizational networks and spice up the existing theory.

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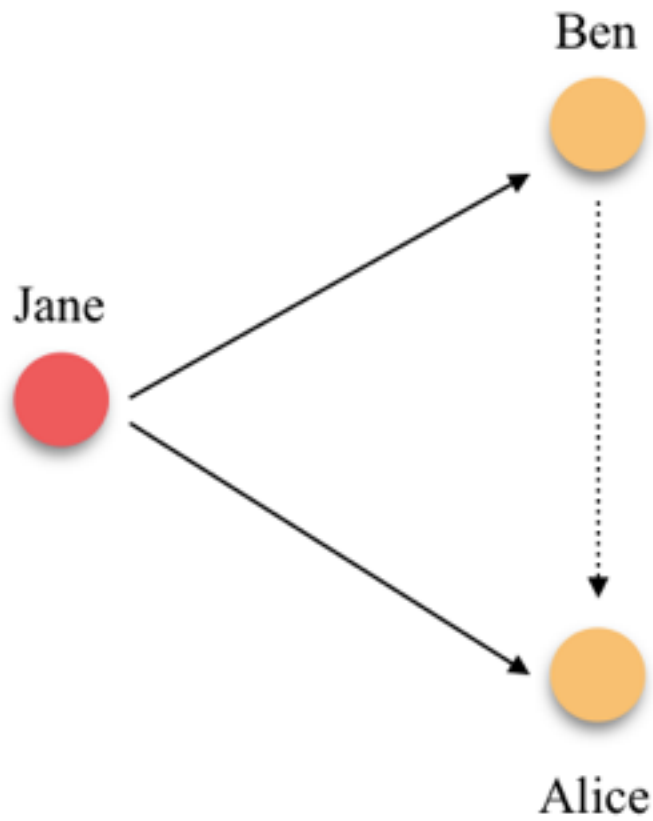
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*Figure 1. CSS illustration, Jane is ego node  
Solid arrows represent existing links, dotted arrow represents  
perceived relation in the network*





## Tables

Table 1. Descriptive statistics and bivariate correlations

	Mean	S.D.	Min.	Max.	1	2	3	4	5	6	7	8
<b>1 Creative performance</b>	4.244	1.368	1.00	7.00								
<b>2 Density</b>	0.469	0.174	0.36	1.00	0.347**							
<b>3 Perception of network density</b>	4,234	0.753	2.00	5.00	-0.112	0.030						
<b>4 Brokerage</b>	14.253	22.033	0.00	131.83	-0.330**	-0.102	0.042					
<b>5 Perception of brokerage</b>	2.574	1.168	1.00	5.00	0.169	0.081	0.065	-0.149				
<b>6 Closeness centrality</b>	0.572	0.080	0.41	0,78	-0.030	-0.092	-0.112	0.266**	-0.013			
<b>7 Age</b>	37.670	12.123	22.00	72.00	0.126	0.046	0.124	0.242*	0.082	0.311**		
<b>8 Tenure</b>	6.632	5.683	0.00	22.00	0.129	0.212*	0.093	0.125	0.233*	0.316**	0.602**	
<b>9 Year dummy</b>	0.181	0.387	0.00	1.00	0.152	0.043	-0.147	-0.119	0.006	-0.042	-0.145	-0.219*

*N=93, significance \* $p < 0,05$ , \*\* $p < 0,01$*

Table 2. Regression results

	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>	<b>Model 4</b>
Density		1.981** (0.796)		2.038** (0.787)
Brokerage		-0.023*** (0.007)		-0.021** (0.007)
Perception of density			-0.416** (0.205)	-0.363* (0.192)
Perception of brokerage			0.175 (0.133)	0.117 (0.124)
Closeness centrality	-0.923 (1.909)	1.007 (1.835)	-1.456 (1.928)	0.420 (1.852)
Age	0.000 (0.015)	0.011 (0.015)	0.004 (0.015)	0.015 (0.015)
Tenure	0.038 (0.032)	0.016 (0.030)	0.031 (0.032)	0.011 (0.31)
Year dummy	0.565 (0.376)	0.328 (0.359)	0.415 (0.383)	0.240 (0.358)
R-squared	0.042	0.205	0.097	0.244
Intercept	4.648***	2.707**	6.203***	4.142**
F-value	0.968	3.743	1.551	3.426

*N=93, Standard errors are in parentheses*

*significance \* $p < 0,1$ , \*\* $p < 0,05$ , \*\*\* $p < 0,01$*

## Appendix

### APPENDIX - CSS survey

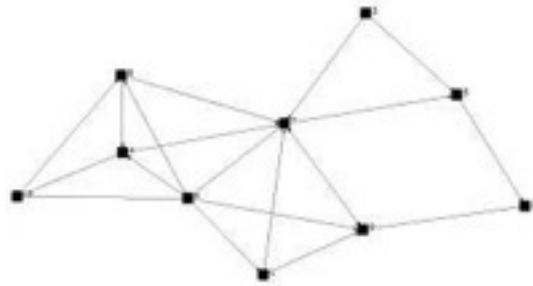
#### 1. Visual Scale to Capture Perception of Whole Network Density.

This question focuses on your perceptions of the degree of interconnectedness in your team. The more interconnected the network, the more dense the pattern of relations within the network is. Please select the picture that best represents the degree of interconnectedness in the informal advice network in your department.

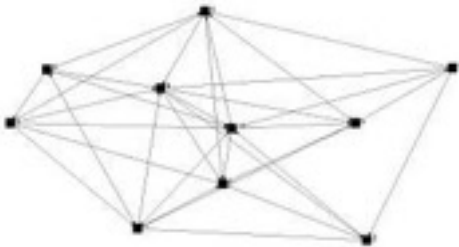
1. No one asks anyone for advice.



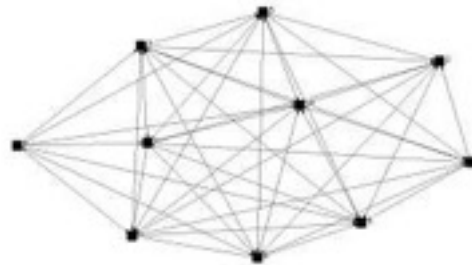
2. A few people in my department ask each other for advice.



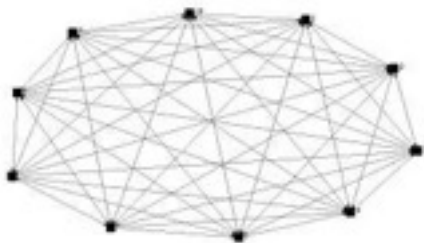
3. About half the people in my department ask each other for advice.



4. Most people in my department ask each other for advice.



5. Everybody in my team asks each other for advice.



## 2. Visual Scale to Capture Perception of Ego Network Bridging.

In the diagram below, there are two groups/cliques of people. The large circle that connects the two groups/cliques can be thought of as a bridge. Using the scale below, please rate the extent to which you think you occupy a bridging position in advice network of your colleagues [the organization], i.e., the extent to which, like the «you» circle, you are close colleagues with groups that otherwise do not ask each other for advices.

- 1: I do not occupy any bridging positions
- 2: I occupy few bridging positions
- 3: I occupy some bridging positions
- 4: I occupy considerable amount of bridging positions
- 5: I occupy many bridging positions

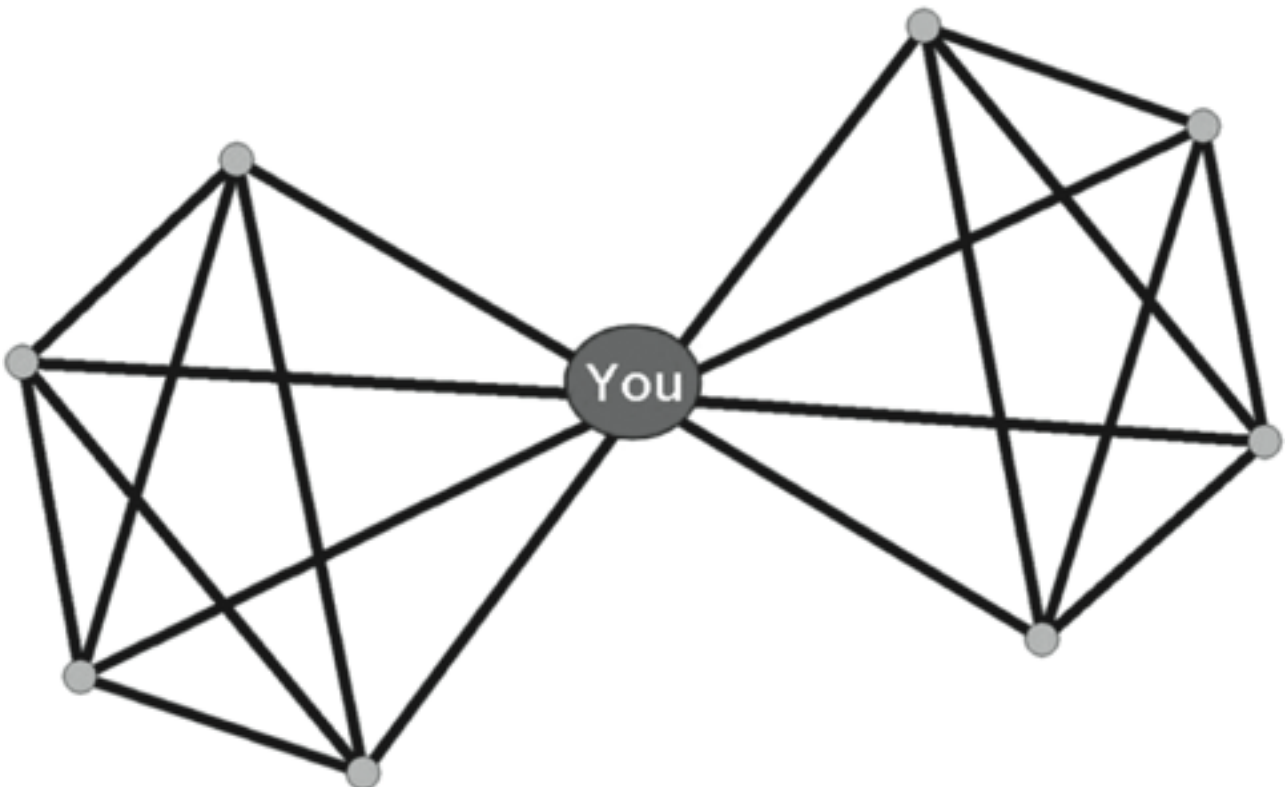


Table 3. Regression results for respondents of year 2019

	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>	<b>Model 4</b>
Density		1.982** (0.956)		2.095** (0.949)
Brokerage		-0.025*** (0.007)		-0.023*** (0.007)
Perception of density			-0.363 (0.219)	-0.387* (0.213)
Perception of brokerage			0.184 (0.146)	0.155 (0.139)
Closeness centrality	-1.468 (2.273)	1.520 (2.211)	-1.553 (2.282)	1.273 (2.227)
Age	0.000 (0.018)	0.012 (0.016)	0.005 (0.018)	0.016 (0.016)
Tenure	0.052 (0.037)	0.025 (0.035)	0.043 (0.038)	0.019 (0.036)
R-squared	0.035	0.219	0.093	0.267
Intercept	4.864***	2.335	5.847***	3.551**
F-value	0.904	4.049	1.478	3.142

*N=78, Standard errors are in parentheses*

*significance \* $p < 0,1$ , \*\* $p < 0,05$ , \*\*\* $p < 0,01$*

## APPENDIX - Subsample robustness check

## APPENDIX - Network graphs

Figure 2. Network graph of GasMach R&D department in 2019.  $N = 78$ .

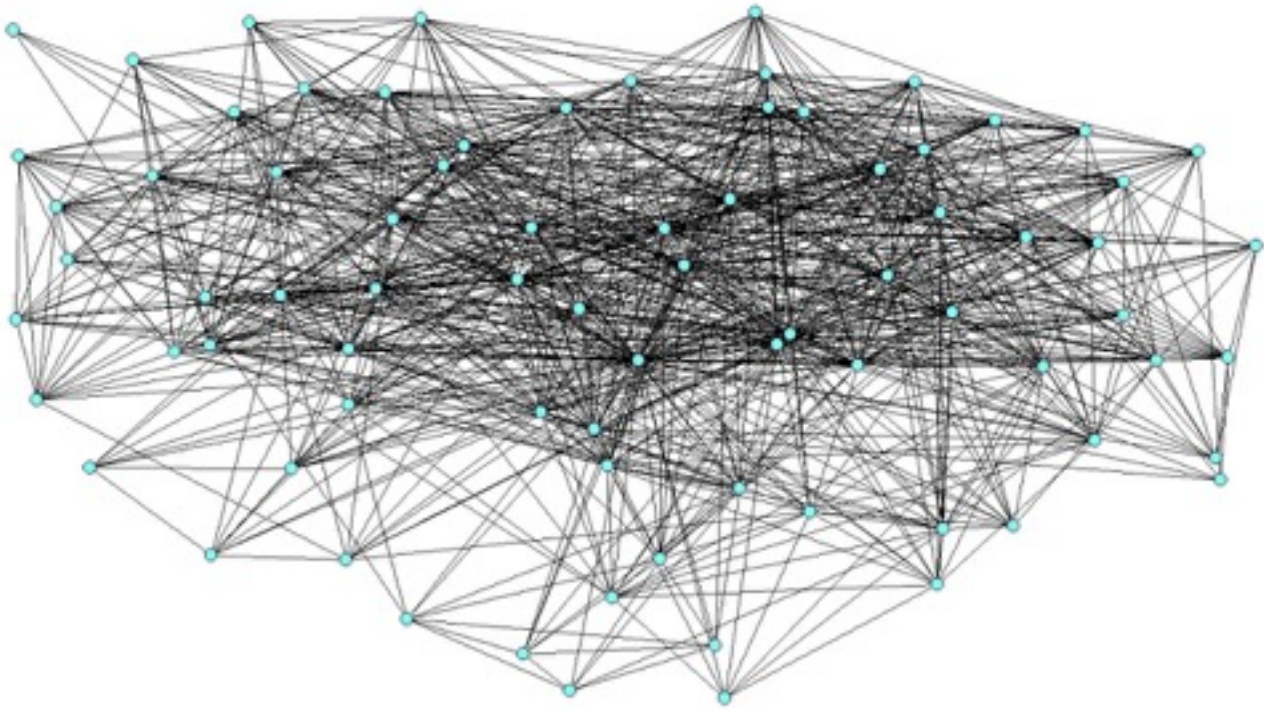
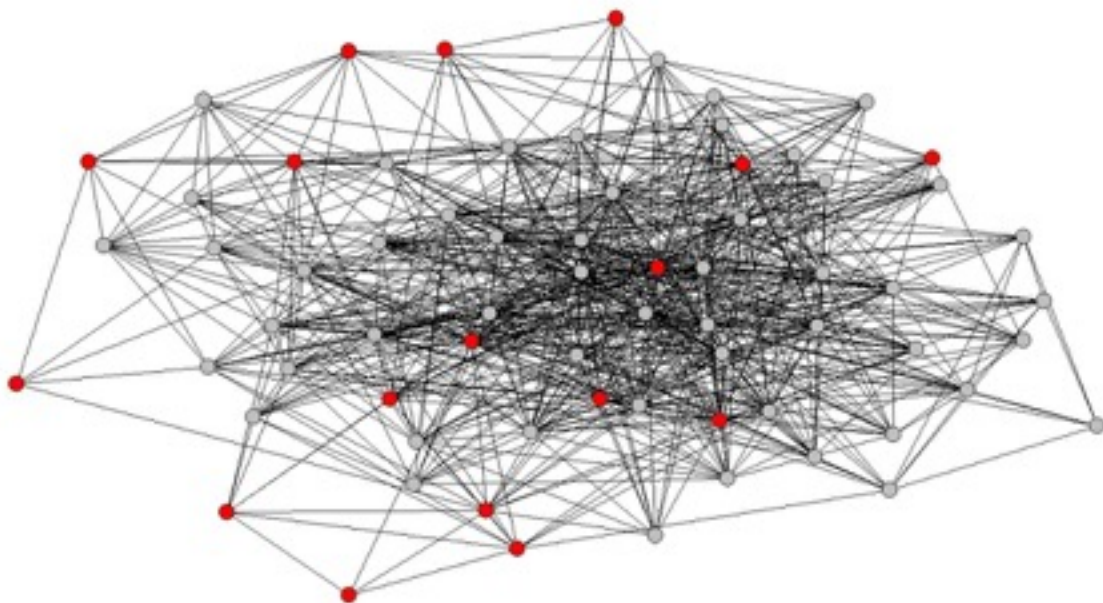


Figure 3. Network graph of GasMach R&D department in 2020. Grey: old employees; Red: new employees.  $N = 69$ .



## Conclusion

This work focuses around the domain of organizational behaviour and explores individual creativity in social networks. Each chapter of the dissertation makes a separate contribution in line with the general purpose of the doctoral dissertation. Thus, first chapter contains systematic review of all relevant studies published in the field of individual creativity in social networks. By entwining theories borrowed from various domains into a three-dimensional model, I come up with a comprehensive interpretation of the phenomenon. Key dimensions of the process revealed are creativity continuum, context and ego node's personality traits. Second chapter is based on the idea that creative individuals are not alike (Feist, 2006), and their creativity is born from different sources. Thus, we find that solitary individuals attain creativity by means of embracing time alone rather than by networking intensively. These findings set boundary conditions on the celebrated benefits of degree centrality and expose how seemingly negative personality trait can turn out positive in an unconventional manner. Third chapter connects individual creativity in intra-organizational networks to cognitive social structures literature (Krackhardt, 1987). I find that network position and network cognition have independent significant effects on individual creative performance, and that cognitive and network mechanisms are driven by a set of dissimilar non-overlapping factors. This chapter proves once again that individual cognition is strictly subjective and that it can have somewhat surprising consequences.

Undoubtedly, post-structural approach to creativity in social networks is a big step towards unveiling the true nature of the phenomenon. But by viewing it as a starting point, one can challenge the conventional understanding of what creativity truly is. The classic definition of creativity describes it as production of novel and useful outputs (Amabile, 1983). Although widely used in the literature, it does not reflect the complexity of the phenomenon, and the form that it takes in the modern world. Nowadays, creativity has become a necessity, a means of survival in the world that undergoes disruptive changes. It would be wrong to assume that it belongs solely in cultural and creative industries, or in the innovation sector. One of the lessons of the global pandemic is that adjusting to the new reality is not an easy task. In a long-run, it involves massive socio-economic reconstructions. But every longterm picture consists of days, moments, cases. How do we act in response to irregularities, if they happen on a daily basis? Creative actions are undertaken by individuals who are able to absorb multifaceted stimuli from the external world and

sift them through the prism of the self, effectively recombining the information given, navigating it towards the optimal solution. In a world tremendously complex, individual creativity takes infinite number of faces, it varies in scope, degree and magnitude. Unquestionably, it is firmly present in everybody's lives. Due to that reason, every creative endeavour is so unique and valuable, and every creator is dissimilar from the other. There is no possibility, nor there will ever be any, to narrow down this complexity to such low degree that it would become possible to suggest a one-for-all solution on how one can be creative. However, the foundation remains unshaken and solid, for we always build upon the social environment we are embedded into, external context of work and our own selves. In line with this argument, in my work I demonstrate that a large proportion of variation in individual creativity in organizations is hidden within individuals, deeply rooted into their personal qualities, unique ways of sensemaking and individual perception of reality. However, we function in the society that shapes us throughout our lives (Csikszentmihalyi, 1988), and deeply affects our micro-level actions and perceptions (George, 2007). Therefore creativity is a product of intersecting dimensions.

Although individual creativity is a key issue in organizational behaviour research, it has potential to build up to something much larger in scope. For example, organizational creativity depends on integrative capabilities of employed individuals, and the process of creating an innovation is a coherent set of choices and solutions undertaken by each participant in the collective. Current work is useful for scholars and practitioners who are interested in supporting multi-level creativity in organizations, since I approach the phenomenon from a broad set of angles and study each intra-organizational network as a whole.

Future researchers are exposed to a pool of opportunities. Each chapter addresses this issue from its own angle. Nevertheless some suggestions for the research agenda are rather universal in the field of creativity in networks. I have explicitly demonstrated that individual creativity in intra-organizational networks is a shapeshifter. Within the given pipeline of three dimensions and network embeddedness, opportunities for future research are nearly limitless. Heterogeneity of approaches, frames and even domains is to be embraced. By using this dissertation to identify the leading patterns customary to a certain industry, organizational culture or personality type, scholars can uncover many novel mechanisms of creative work.

To conclude, this dissertation thoroughly investigates and critically evaluates the topic of individual creativity in intra-firm networks. I challenge the conventional approach to the phenomenon. Averse



to oversimplified theorizing, this work dismantles main theories in the field and reconstructs them anew, adjusting them to the more complex reality by interweaving classic network theories with non-structural complimentary explanans. As result, creativity appears rejuvenated and alive, responsive to social environment, and reflecting times we are living.

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