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Exploiting individual creative inputs for team creativity: a role differentiation approach

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**Exploiting Individual Creative Inputs for Team Creativity:
A Role Differentiation Approach**

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Exploiting Individual Creative Inputs for Team Creativity: A Role Differentiation Approach

PhD thesis

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on the authority of the
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the decision by the College of Deans.

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To Jian Wu & Xiuzhen Wang, my beloved parents

献给我挚爱的父母，吴坚和王秀珍

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Chapter 1 General Introduction

Creativity is defined as the generation of both novel (original, new) and useful (feasible, appropriate) ideas or solutions to problems (e.g., Amabile, 1998; Sternberg & Lubart, 1999). Many creative tasks nowadays are undertaken by organizational teams, composed of members who have diverse ideas, expertise, and perspectives, which enables them to deal with complex and non-routine tasks that individuals cannot achieve alone (Basadur & Head, 2001). For example, research and development (R&D) teams are widely adopted in industries such as science, high-tech production, and consulting, where creativity plays an essential role in the success of new products or services. People also work in groups in emergency rooms or in military contexts to cope with high-demand problems in creative ways (Driskell, Salas, & Driskell, 2018). In research, team creativity is conceptualized as the generation of both novel and useful outcomes by a group of people working together, such as solutions, products, proposals, and services (Shin & Zhou, 2007). In the past decades, research interests in exploring teams' creative potential has continued to grow (Mathieu, Hollenbeck, van Knippenberg, & Ilgen, 2017). Yet, our understanding of how teams make use of members' inputs such as knowledge and skills to facilitate team creativity and problem solutions is far from complete (Shalley & Gilson, 2004; Shin & Zhou, 2007).

To advance our understanding of creative processes in teams, this thesis proposes that it is essential to realize that the creative process actually consists of multiple interdependent activities. Although creativity scholars have primarily highlighted the importance of generating ideas (e.g., Amabile, 1998), to produce high-quality outcomes in creative tasks (e.g., solutions, proposals, products) teams also need to perform other processes or activities, such as idea evaluation and selection, idea development, and idea implementation (Harvey, 2014; Perry-Smith & Mannucci, 2017). Indeed, engaging in creative problem solving also involves the processes of constructing problems and searching information before generating

solutions (Reiter-Palmon, Herman, & Yammarino, 2008; Zhang & Bartol, 2010a). Seen in this way, the question of exploiting creative inputs of members is, in essence, about coordinating and distributing their engagement (such as time and effort) in different creative processes to make effective use of their inputs (such as expertise and perspectives) to produce creative outcomes.

There has been a long tradition in creativity research on team diverse inputs such as members' different functional backgrounds, demographic differences, and cognitive and affective attributes (Joshi & Roh, 2009; Mello & Rentsch, 2015; Van Knippenberg & Mell, 2016). In understanding how teams exploit members' inputs to perform creative tasks, this thesis proposes that researchers should also consider members' diversity in participating in different processes or activities. The current literature on team creativity, however, has (implicitly) assumed that team members play the same role in performing creative tasks, ignoring the possibility that individuals specialize in their roles and differ in the creative processes or activities that they perform. Although some literature has proposed that individuals may specialize their participation in certain activities (e.g., Crawford & LePine, 2013; Humphrey & Aime, 2014; Mathieu et al., 2017), empirical research is scarce. In response, this thesis challenges the assumption that members engage in creative processes indiscriminately, and propose an alternative perspective, *role differentiation*, to study member differences in their roles (or participation) during different team creativity processes. In particular, the current thesis aims to explore what factors lead to role differentiation, and when role differentiation benefits team creativity.

ROLE DIFFERENTIATION: CONCEPTUALIZATION

Role differentiation is conceptualized as the extent to which team members specialize their engagement or participation during different taskwork (creativity) processes. Drawing from the information processing perspective, creative processes in this thesis are defined in

terms of the journey of an idea, from the early stage of being created to the final stage of being implemented into team outcomes. A high level of role differentiation implies that members differ not only in their participation across creative processes, but also in their participation within one process. It denotes that the allocation of members' participation is not uniform across all activities (i.e., across all creative processes), but that the relative contribution (participation) of individual members can change as the team performs different activities.

The role differentiation approach treats teams as information processing systems, and focuses on the taskwork components that are necessary to perform creative tasks (referred to as creative processes or activities), such as problem construction, idea generation, or idea development. It is important to note that those creative processes do not necessarily overlap or coincide with labor task divisions, which are often predefined by employees' job obligations. For example, one team can use all members to fix a technical problem for a client but at the same time have members differ in their roles during creative processes: One member may generate many ideas, whereas others concentrate on further developing these ideas. It is also likely that a team performs several projects simultaneously, but that one member always engages in certain creative activities (e.g., idea generation) in each project.

Past research has assumed that team processes such as information sharing and information elaboration are shared properties that are the same for all individual members (Kozlowski & Klein, 2000). However, it is unlikely that all members devote the same time and effort to all team processes. Some research has indeed implied that team members with a certain cognitive style (e.g., creative thinking, attentive to details, and conformist) prefer to participate more in an activity for which that style is required (Kirton, 1976; Miron-Spektor, Erez, & Naveh, 2011). When teams are composed of members with various cognitive styles, it is therefore likely that members specialize in different creative activities, such as idea

generation, idea evaluation and development, and idea implementation. Recent team composition research has also called for more attention to within-team heterogeneity in team process research, proposing that team members may differ in their participation in different processes (Crawford & LePine, 2013; Humphrey & Aime, 2014). For example, some recent literature has suggested to studying diversity in team interaction processes and team emergent states (emergent diversity; Van Knippenberg & Mell, 2016). Other researchers have explored how individual differences aggregate to the team level by considering members' differentiated contribution or different roles during task performing (e.g., Aime, Humphrey, DeRue, & Paul, 2014; Humphrey, Morgeson, & Mannor, 2009). Our approach of role differentiation, by contrast, captures the distribution of members' engagement in creative processes, which extends prior notions of specialized roles to the creativity literature.

ROLE DIFFERENTIATION: THE PRESENT APPROACH

In the current thesis, I propose that role differentiation potentially derives from two sources. First, *diversity of membership status* may influence role differentiation. For example, changes of membership may induce a categorization between newcomers and old-timers, who often contribute to team creativity in different ways (e.g., Choi & Thompson, 2005). Newcomers prefer to develop and elaborate existing ideas instead of proposing radically new ideas, expecting that this is a better strategy to be socially accepted by old-timers (Summers, Humphrey, & Ferris, 2012). The potential differences between newcomers and old-timers in generating ideas and getting them accepted by the team will be tested in Chapter 2. Second, differentiated roles may also derive from team members' diverse cognitive resources, such as diversity of cognitive styles, or *expertise and knowledge*. People have certain preferences to perform some activities, and are more motivated to perform activities that are in accordance with their specialty but less in the domain where they have less expertise (Faraj & Sproull,

2000; Franz & Larson Jr, 2002; Puccio, 1999). The influence of cognitive diversity will be examined in chapter 4.

In this thesis, I further argue that role differentiation serves as an effective approach for teams to deal with complex and non-routine creative tasks. Thorough processing of information is necessary for every creative process, requiring teams to perform each activity (e.g., information search, idea generation, idea development) to at least an adequate extent. However, two issues arise if teams have all members perform all creative activities to the same extent. First, the task environment that teams face is often ill-defined, resource-demanding, and challenging (Amabile, Conti, Coon, Lazenby, & Herron, 1996; Driskell et al., 2018). Such situations often leave teams under high pressure to coordinate diverse inputs, and may even make it ineffective to have all members participate in every process. Research has indeed suggested that teams rush to finish tasks instead of deliberately process information when under high-pressure (Sitkin, See, Miller, Lawless, & Carton, 2011). Second, different creative processes often require different expertise or even opposing cognitive styles (Harvey, 2013; Miron-Spektor et al., 2011), and individuals are unlikely to have all skills to perform all tasks well. Role differentiation may act as an effective approach that teams can adopt to deal with the creative task requirement and a challenging task environment. In this regard, this thesis proposes that role differentiation may benefit team creativity, especially in high pressure situations or when teams lack enough resources to uniformly perform all creative activities. All three chapters will examine the relationship between differentiated roles and team performance measured in different ways, and the moderating role of lack of resources will be examined in chapter 3.

This thesis also examines contextual factors that may affect the formation of role differentiation and the influence of role differentiation on team performance. First, when roles are differentiated, members are able to concentrate more on the process that they excel

at and spend less effort on others. Importantly, team members should know each other's expertise, so that they can perform tasks in their area of expertise, but are also willing to accept that someone takes the lead in other activities. Second, specialization might not guarantee that members' inputs are used systematically and effectively to create team outcomes, and research suggested that it can be quite difficult to integrate diverse work from different sources (Harvey, 2013). I propose that a willingness to cooperate is needed for teams to integrate all members' work to produce one final outcome. Third, because role specialization is mainly concerned with the amount of time and effort that members invest in certain activities, how they make decisions (e.g., the autonomy of decision making) may also influence the efficiency and effectiveness of role differentiation. In this thesis, I draw on the Motivated Information Processing in Groups Model (MIP-G; Bechtoldt, De Dreu, Nijstad, & Choi, 2010; De Dreu, Nijstad, & Van Knippenberg, 2008) and on the literature on team transactive memory system (TMS; Lewis & Herndon, 2011; Liang, Moreland, & Argote, 1995), to examine moderating factors (i.e., prosocial motivation, transactive memory system, and decision-making structure) that affect the emergence and influence of role differentiation.

CHAPTERS OVERVIEW

Chapter 2: Group Membership Change and Group Creativity: A Motivated Information Processing Perspective

Chapter 2 examines the relationship between membership change and the development of group creativity. This chapter studies diversity in terms of membership status, or team tenure (i.e., newcomers vs oldtimers), caused by team membership change. An underlying assumption is that newcomers may possess different perspectives and ideas from oldtimers, and that membership status therefore also entails a latent diversity of cognitive resources (knowledge and perspectives). This chapter examines membership change as a

factor that potentially triggers role differentiation between newcomers and old-timers in terms of idea generation and idea evaluation and acceptance.

Prior literature has suggested that membership change stimulates idea generation in groups, but (1) has not yet considered the important distinction between radical ideas that substantially differ from existing ones and incremental ideas that modify and adapt existing ideas and (2) has not considered whether ideas generated by newcomers benefit the creativity of final products. This chapter draws on insights from motivated information processing theory and propose that membership change stimulates epistemic motivation, which benefits the generation of both radical and incremental ideas. Furthermore, this chapter proposes that idea generation will subsequently contribute to group creativity when members are pro-socially motivated to work closely together, but that this may differ for incremental versus radical ideas. These hypotheses were tested in a laboratory study, in which I manipulated membership change (yes/no) and pro-social motivation through collective rewards (yes/no).

Chapter 3: Role Differentiation in Creative Processes: A Configural Approach to Team Creativity

This chapter in particular examines whether and when role differentiation benefits team creativity. This chapter develops the concept of creative role differentiation and propose that team members may differ in their inputs both within and across different creative activities (i.e., problem construction, information search and encoding, and idea generation). Drawing insights from the team cognition and team structure literature, it is argued that creative role differentiation benefits team creativity because it allows for the efficient use of members' expertise. In particular, I propose that these benefits are stronger when teams lack resources for creativity and when teams have high autonomy of decision-making (i.e., low centralization). Hypotheses were tested in a field study. I then conducted a follow-up qualitative study to obtain a deeper understanding of creative role differentiation in work

teams. The qualitative study also aims to examine an underlying assumption in this chapter, that role differentiation derives from members' expertise in different creative processes (i.e., diversity in terms of cognitive styles or knowledge).

Chapter 4: Exploiting Team Cognitive Diversity in Challenging Situations: The Role of Creative Role Differentiation and Transactive Memory System

This chapter explores team cognitive diversity (skill diversity in particular) as the antecedent of role differentiation during creative processes for teams that perform complex and non-routine tasks. In addition, this chapter extends the study context to a highly challenging task environment. Previous research has suggested that team cognitive diversity benefits team performance. However, how teams working in challenging situations utilize members' cognitive inputs (such as expertise and skills) has remained unexplored. This chapter examines team performance on complex and non-routine tasks in a sample of teams in a two-day, high time-pressure, high-profile artificial intelligence (AI) and blockchain hackathon event. From an information processing perspective, I conceptualize *role differentiation*, to describe the distribution of members' cognitive inputs in different task processes (i.e., problem construction, information search and encoding, idea generation, idea evaluation, idea development, and idea implementation). Drawing from the categorization elaboration model of team diversity and the literature on team shared cognition, this chapter addresses questions of 1) whether and when team cognitive diversity determines the degree of role specialization in these teams; and 2) whether and when role differentiation is associated with better team performance in a high time pressure context.

Chapter 5: General Discussion

This chapter summarizes the major findings of the three empirical chapters, and discusses theoretical implications for team diversity, team composition, team creativity, and team creative processes literature. In addition, this chapter provides managerial and practical

advice for organizations and team managers on how teams may exploit employees' creative inputs to produce creative outcome and increase team performance, especially in challenging situations. Altogether, this dissertation develops an alternative approach, role differentiation, to study the distribution of members' diverse inputs (in other words, the coordination of members' participation) in different creative processes, which seems to be an effective way to perform non-routine and complex creative tasks. Figure 1.1 depicts an overall conceptual model, and Table 1.1 provides the conceptual overview of each chapter of the current dissertation.

TABLE 1.1
Chapters Overview

Overview	Chapter 2	Chapter 3	Chapter 4
Input sources	Membership change	--	Team cognitive diversity
Role differentiation	Idea generation; idea acceptance	Problem construction; Information search and encoding; Idea generation	Problem construction; Information search and encoding; Idea generation; Idea evaluation; Idea development; Idea implementation
Team performance	Team creativity on a decoration-design task	Team creativity of team outputs	Team rankings in Hackathon challenges
Contextual factors	Pro-social motivation	Resources for creativity; Centralization of team decision making	Transactive memory system

FIGURE 1.1
Conceptual Model of Dissertation

Chapter 2 Membership Change, Idea Generation, and Group Creativity: A Motivated Information Processing Perspective¹

Membership change – having old members leave and/or new members join a group – is a prevalent phenomenon among all types of groups (Ziller, 1965). Although it can disrupt group routines (Moreland & Levine, 1982), membership change can potentially stimulate creative activities: newcomers are often viewed as “fresh blood” who bring in new perspectives and prevent groups from rigid thinking (Ziller, 1965; Ziller, Behringer, & Goodchilds, 1962). Indeed, membership change has been found to stimulate collective idea generation (e.g., Choi & Thompson, 2005; Gruenfeld, Martorana, & Fan, 2000). In particular, groups experiencing membership change tend to generate a larger number and more diverse ideas as compared to those with stable membership (Choi & Thompson, 2005; Nemeth & Ormiston, 2007).

However, group creativity, defined as the joint generation of novel and useful outcomes by a group of people (Hoever, Van Knippenberg, Van Ginkel, & Barkema, 2012), does not end with idea generation. Rather, creative ideas generated in a group have to enter the collective process of idea evaluation, selection, and integration in order to be developed into a final group product, such as a report, prototype, or marketing campaign (Girotra, Terwiesch, & Ulrich, 2010; Harvey & Kou, 2013; Kohn, Paulus, & Choi, 2011; Rietzschel, Nijstad, & Stroebe, 2006). Fruitful idea generation alone does not guarantee group creative success. For example, creative ideas that are too extreme may be abandoned in the implementation stage (Gruenfeld et al., 2000) and group members may fail to recognize or select the most creative ideas (e.g., Rietzschel et al., 2006). Thus, the question of whether the

¹ This chapter is based on Wu, S., Nijstad, B. A., & Yuan, Y. (2021). Membership change, idea generation, and group creativity: A motivated information processing perspective. *Group Processes & Intergroup Relations*, 1368430221999457.

positive effect of membership change on idea generation extends to (final) group creative outcomes is vital to the group creativity literature.

In this paper, we draw on Motivated Information Processing in Groups (MIP-G) theory (De Dreu, Nijstad, Bechtoldt, & Baas, 2011; De Dreu et al., 2008; Nijstad & De Dreu, 2012) to examine two questions: 1) under which conditions does membership change contribute to (final) group creative outputs, and 2) what is the role of idea generation in this process? MIP-G theory suggests that group creativity requires epistemic motivation that drives members to engage in in-depth information processing, but also prosocial motivation to stimulate members to work interdependently and in the interest of the group (Bechtoldt et al., 2010). We propose that membership change stimulates idea generation, because the presence of newcomers triggers collective reflection and epistemic effort to comprehend the task and generate new ideas (heightened levels of epistemic motivation, (Choi & Thompson, 2005). However, we further propose that integrating these ideas into a final group product depends on the extent to which members are motivated to collectively process and integrate them. Based on MIP-G theory, we predict that membership change will stimulate idea generation, but that this only translates into high levels of group creativity when group members have high pro-social motivation.

This perspective suggests that the effect of membership change on group creativity essentially boils down to the question of how creative ideas are used and integrated into a final group product. In this respect, it is important to note that not all ideas are created equal, but that they vary from minor adaptations (incremental ideas) to radical breakthroughs (radical ideas), depending on their relative originality as compared to existing ideas (Janssen, 2003; Silva & Oldham, 2012). Radical (versus incremental) ideas represent groundbreaking ways to solve problems, and are often viewed as more risky and costly. This distinction is vital, because people tend to comprehend, process, and utilize incremental and radical ideas

differently (Berg, 2016; Criscuolo, Dahlander, Grohsjean, & Salter, 2017; Janssen, 2003; Mueller, Melwani, & Goncalo, 2012). In general, the creativity literature suggests that the selection and implementation of radical ideas is more challenging (e.g., Girotra et al., 2010), and that processes may be different where incremental versus radical ideas are concerned. We therefore also take this distinction into account.

In sum, we propose a moderated mediation model (see Figure 2.1), in which membership change stimulates (incremental and radical) idea generation, which, in turn, translates to group creativity depending on the pro-social motivation of group members. As such, this research contributes to the membership change literature, suggesting conditions under which newcomers stimulate not only idea generation, but also the creativity of a final group product. It also contributes to the group creativity literature and motivated information processing theory, by more closely considering the distinction between incremental and radical ideas.

FIGURE 2.1

Conceptual Model

THEORY AND HYPOTHESES

Group Membership Change and Idea Generation

Following earlier work, group creativity in this paper is defined as the generation of novel and useful outcomes by group members who work together (Hoever et al., 2012). We distinguish group creativity from idea generation, because a (final) creative outcome, such as a report, solution, or campaign, is likely to contain several ideas. Furthermore, group creativity does not only involve idea generation, but also idea processing, selection, development, and application in a final group outcome (see also Girotra et al., 2010; Harvey & Kou, 2013; Kohn et al., 2011; Rietzschel et al., 2006).

Past research has proposed that membership change can stimulate idea generation, because membership change challenges members in two ways. On the one hand, newcomers bring new ideas and diverse perspectives to a group (Choi & Levine, 2004; Levine, Choi, & Moreland, 2003), which can stimulate groups to generate more ideas (Dugosh, Paulus, Roland, & Yang, 2000; Simonton, 2003). On the other hand, the presence of newcomers inspires old members to reflect on their previous ways of working, which stimulates their own epistemic process (Choi & Thompson, 2005; Ziller et al., 1962). As a consequence, groups that have experienced membership change have been found to generate more ideas

than stable groups (Choi & Thompson, 2005; Nemeth & Ormiston, 2007). This effect is not only due to newcomers bringing in new ideas, but also to oldtimers, who become more creative after membership change (Choi & Thompson, 2005).

Motivated Information Processing Theory

In this paper, we apply Motivated Information Processing in Groups (MIP-G) theory to understand and extend these relationships. MIP-G theory proposes that group creativity benefits from group members having high levels of epistemic motivation to excel at complex cognitive tasks, and high levels of pro-social motivation to work closely together in the interest of the group (De Dreu et al., 2008; Nijstad & De Dreu, 2012). Epistemic motivation refers to a willingness to expend effort to achieve thorough and rich understandings of the group and the group task. Epistemic motivation should benefit idea generation, because it leads group members to consider multiple perspectives and not be satisfied with only a few or obvious ideas. Indeed, evidence suggests that groups generated more ideas (e.g., Chirumbolo, Mannetti, Pierro, Areni, & Kruglanski, 2005) and also ideas that were more original (e.g., Bechtoldt et al., 2010) when group members held high rather low levels of epistemic motivation.

MIP-G further suggests that epistemic motivation alone is not enough to achieve high group creativity. Rather, also pro-social motivation is required, which refers to members prioritizing group outcomes over individual outcomes. Pro-social motivation ensures that members pay attention to each other's ideas, and will integrate available ideas from other members in a cooperative way to achieve group success. Previous research suggests that pro-social motivation is required for groups to fully reap the benefits of high epistemic motivation (Bechtoldt et al., 2010) and of independent thinking (Bechtoldt, Choi, & Nijstad, 2012). Applied to the context of membership change, in the following we suggest that 1) membership change is likely to raise group member's epistemic motivation, and that this will

stimulate the generation of both incremental and radical ideas, but 2) that this will only lead to creative (final) outcomes when pro-social motivation is high, and 3) that these processes may differ for incremental versus radical ideas.

Membership Change and Radical versus Incremental Ideas

Despite its relevance, research on membership change has not made the distinction between incremental and radical ideas. As noted, radical ideas differ substantially from existing ones and represent fundamental changes, whereas incremental ideas are adaptations and modifications of existing ideas and contain only minor changes (Dewar & Dutton, 1986; Madjar, Greenberg, & Chen, 2011). This distinction is important, firstly because any change brought about by newcomers in existing practices or ideas can both be incremental or radical: ideas that are introduced after the arrival of a newcomer may be fairly similar to previous ideas in that group (incremental), or can be completely different from previous ideas in that group (radical). Secondly, because research suggests that people treat incremental and radical ideas differently, it likely matters whether the arrival of a newcomer leads to the generation of incremental or more radical ideas (Girotra et al., 2010).

We propose that the arrival of a newcomer drives group members to reconsider their existing ways of working, and to more in-depth and less habitual processing of both existing and new information; in MIP-G terms, the presence of a newcomer will raise epistemic motivation of group members. There are two reasons for this. Firstly, the entry of a new member is a change to the group that will inevitably require adaptation by old members. New members will have new and unknown characteristics, and it is not a priori known how newcomers will behave in the context of the group. Group adaptation to new and partly unknown circumstances benefits from high epistemic motivation and reflection (Randall, Resick, & DeChurch, 2011), and the uncertainty and disruption of routines associated with a change in group membership is likely to trigger reflection among old members to deal with

changed circumstances (Moreland & Levine, 1982; Rink, Kane, Ellemers, & Van der Vegt, 2013).

Secondly, with the presence of newcomers, old members have to explain their approaches, tasks and working to newcomers. They may also have to (re)evaluate and compare different ideas and make changes to their approach. Some research has suggested that even if newcomers have no intention to produce changes to the group or their perspective is not so novel, their presence can still motivate group members to think of changes (Levine, Moreland, & Choi, 2001; Phillips, Liljenquist, & Neale, 2009). Due to perceived dissimilarity, group members should perceive the need for updating available information or routines in their group to complete tasks, thus they will communicate more to expose different viewpoints, and to get a comprehensive understanding to fulfill group tasks. This effect of membership change on group reflexivity reflects increased levels of epistemic motivation compared to groups with no membership change. In sum, after membership change, group members will have high epistemic motivation to carefully think about their current condition and assess the changes that newcomers may bring. Stable groups, in contrast, are more likely to continue their previous ways of working without much reflection.

In turn, such reflection is likely to stimulate idea generation. On the one hand, the arrival of newcomers invites group members to review current group objectives, work routines, and ideas, because it inevitably requires the introduction and explanation of the task environment, and of existing group processes and working styles, to newcomers (Choi & Thompson, 2005; Gruenfeld et al., 2000). This is likely to result in adjustments and revisions of existing practices and ideas (Summers et al., 2012), mainly in the form of incremental new ideas. On the other hand, newcomers can bring to the group knowledge and ideas that are different from existing ones (Choi & Thompson, 2005), which may directly contribute to group goals (Marks, Mathieu, & Zaccaro, 2001). Relying on such novel inputs may drive the

group to discard existing ideas and suggest new approaches to promote group creative outputs (Choi & Levine, 2004; Kane, Argote, & Levine, 2005; M. West, 1996; M. A. West, 2003), which can result in major changes (i.e., radical new ideas). We therefore propose:

Hypothesis 1a: Membership change increases the generation of incremental new ideas.

Hypothesis 1b: Membership change increases the generation of radical new ideas.

Translating Idea Generation into Group Creativity

Translating (radical or incremental) ideas into group creative outcomes does not occur automatically. New ideas need to be selected (or discarded), developed, and integrated in a final product. However, group members often are not willing to combine different ideas into a single outcome (Stasser & Titus, 1985), and may fail to recognize the connection between disparate ideas (M. D. Mumford & Gustafson, 1988). Synthesizing ideas can be particularly difficult for diverse groups (e.g., when newcomers and oldtimers hold different paradigms and mindsets in a group) as members lack a shared understanding of group goals. Group membership change, which creates perceived differences, unfamiliarity, or even lack of trust among members (Van Der Vegt, Bunderson, & Kuipers, 2010), therefore brings challenges in translating ideas into group creativity.

According to the MIP-G model, members should have high pro-social motivation – the desire to benefit groups instead of individuals – to produce creative products. First of all, people with high pro-social motivation are more willing to take different ideas and perspectives into account, and spend more effort on processing and utilizing different ideas (Bechtoldt et al., 2010). Such increased openness to ideas fosters individuals to explore opposing perspectives, which increases the potential that ideas of good quality are selected and adopted. Secondly, pro-social motivation leads members to prioritize group outcomes

above individual needs and to work closely together towards a group goal (e.g., producing a creative product; Bechtoldt et al., 2010; De Dreu, 2007). Therefore, members care about group products and interpersonal processes, and strengthen within-group cooperation. If such pro-social motivation is lacking, group members may not attend to or integrate other members' inputs in group processes and outcomes (De Dreu, Weingart, & Kwon, 2000). Also, as prior studies suggest, group members tend to evaluate information thoroughly and utilize superior ideas that are more relevant to them (Kane et al., 2005). Thus, pro-social motivation encourages group members to process and consider ideas stimulated by newcomers and implement these ideas in a synergetic way. It follows that membership change may benefit group creativity by stimulating idea generation, but that this only translates into high group creativity when pro-social motivation is high.

However, these processes may critically depend on the nature of generated ideas. Specifically, we argue that incremental ideas are more likely to be accepted and used in a final group product than radical ideas. Firstly, it is usually easier to comprehend and adopt incremental ideas, because they do not differ much from previous (known) ideas. By comparing minor adaptations with existing routines, group members can see, without great effort, to what extent the new ideas improve old ones and whether they are worth pursuing further. Therefore, incremental ideas should be easily accepted and utilized by groups (Kane, 2010), because it is relatively clear that they will contribute to the creativity of group outcomes. Second, converting ideas to group outputs requires members to recognize similarities among different ideas (Harvey, 2013). Compared to radical ones, incremental ideas are by nature more linkable with existing ideas, and are thus more likely to be utilized for group outputs. Thirdly, incremental new ideas build upon existing ideas, and such convergent processes (i.e., the further development of existing ideas) have been found to be important for group creativity (Harvey, 2013; Kohn et al., 2011). In sum, it is not very costly

or risky to implement incremental new ideas that are developed based on existing ideas (Madjar et al., 2011), yet this may lead to the further development of existing ideas and therefore enhance group creativity (Harvey, 2013).

We therefore propose:

Hypothesis 2: Membership change is positively associated with group creativity through the generation of incremental ideas, and this indirect effect is stronger when pro-social motivation is high rather than low.

As to the impact of membership change on group creativity via radical idea generation, the situation is more complex. We will therefore approach the role of radical idea generation in a more explorative way. On the one hand, it is possible that pro-social motivation drives group members to be more open to radical ideas as a result of increased involvement in group processes. This may increase the chance that radical ideas are processed and utilized. Yet, on the other hand, considering the substantial changes that radical ideas imply, they may not be easily integrated into a group product, even when pro-social motivation is high. Besides, as a result of inherent risks in radical ideas, it is often difficult to determine whether radical new ideas would yield better outcomes than existing ideas (see also Dewett, 2004; Sethia, 1989). As such, and because the inclusion of radical new ideas involves major adaptations of a group's plan, members may feel reluctant to adopt radical ideas even when pro-social motivation is high (see also Baer, 2012; Mueller et al., 2012). Given these contrasting perspectives, we do not formulate a hypothesis about the relation between radical idea generation and group creativity, but examine this in a more exploratory way.

METHODS

We tested these hypotheses in a laboratory setting to observe the causal effects of membership change and pro-social motivation on group idea generation and the creativity of

a final product. We thus manipulated membership change and pro-social motivation at the group level, coded (radical and incremental) idea generation using video recordings, and assessed group creativity by coding a final group product.

Sample and Research Design

We used a 2 (group membership change: yes vs. no) $\times$ 2 (pro-social motivation: high vs. low) between-group design for this study. 186 students (85 males, 101 females) at a Dutch University participated in this study in exchange for 8 euros or course credits. Participants were randomly assigned to 62 groups of three members. We had to drop three groups from the sample because they did not believe our manipulation of pro-social motivation (see manipulation check, below) and three further groups because videos were not recorded due to a technological failure, leaving a final sample of 56 groups. A sensitivity power analysis using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) revealed that our sample size of 56 groups ($\alpha = .05$, $1 - \beta = .80$) can detect small-to-medium effects of $f = 0.43$.

Each group was instructed to complete a poster design task that was adapted from previous studies on group creativity (Adarves-Yorno, Postmes, & Haslam, 2007; Harvey, 2013). We videotaped groups to measure idea generation during task performance, and trained raters that were blind to the purpose of this study assessed creativity of the end product (a poster). The task consisted of two stages. In the first stage, each group brainstormed for 10 minutes. Then in the second stage, group members worked on the poster design for another 20 minutes.

Procedure

To manipulate membership change, we arranged two groups to work on the task simultaneously. Upon arrival, six participants were randomly assigned to two different groups to work in two adjacent experimental rooms that were identical in their layouts. In each group, members were randomly seated at a rectangular table. Participants received a

colored tag (one yellow, one green, and one red) and were instructed to pin it on their clothes. This allowed group members to distinguish the other members. Next, the experimenter explained the poster design task. Three participants worked as a group to design a poster for a fictitious charity organization called *Animal Rights Protection* (ARP for short). Through printed materials, participants learned that ARP focused on a variety of animal rights issues such as wildlife hunting, habitat loss, and stray animal adoption. The goal was to design creative posters for ARP to attract donations or volunteers, and participants were instructed to be both original and practical in their design. Participants also learned that during the task one member might be switched with someone from the other group. They were informed that whether there would be a member switch and who would be switched would be announced after the brainstorming part (i.e., after the first stage).

Before working on this task, groups first performed a 5-minute ice-break activity in order to get acquainted with each other. Participants introduced themselves to their groupmates and wrote down as many similarities as possible among their home cities or countries on a piece of notepaper. They were also asked to think of a group name and a slogan together. After this, participants started the first stage, during which they brainstormed together to generate ideas for their posters for 10 minutes. Group members discussed how they would like to design the poster, and one piece of paper was provided to take notes and draft designs. After this brainstorming stage ended and before the start of the second stage, the experimenter interrupted the groups, and the manipulation of membership change and pro-social motivation took place. Next, groups received materials for crafting a poster, including one piece of A2 sized blank paper, six pieces of A4 sized colored paper, two scissors and two pots of glue, several colored markers, and one ruler. Then the experimenter set the stopwatch and groups started the second stage. Groups were allowed to continue brainstorming during the second stage, and were instructed to finish their poster designs

within 20 minutes. Upon completion of the task, participants filled out a short questionnaire independently without interaction with others. Then they were debriefed and thanked.

Manipulations

Group membership change. In the condition of membership change, both groups working in parallel were informed that members who held *green* tag would be exchanged immediately after the brainstorming part. Right after groups finished the brainstorming part (i.e., the first stage), the experimenter walked the newcomers with green tags to their new groups (in the adjacent room) and then instructed groups to complete the poster-making part (i.e., the second stage) together. In the control condition without membership change, two parallel groups in adjacent rooms remained unchanged throughout the task. However, in both the membership change and the no change conditions, the experimenter entered the room, ended the first part of the task, introduced the manipulation of prosocial motivation, and provided groups with the materials to make the poster.

Pro-social motivation. We manipulated pro-social motivation via collective rewards after the first stage of brainstorming and right after the membership change manipulation, but before the poster-making stage (see also Bechtoldt et al., 2010). This manipulation aligns with previous studies that suggested that granting collective rewards motivates group members to achieve collective instead of individual goals (Wageman & Baker, 1997). Collective rewards imply that individual members rely on each other to obtain rewards (Pearsall, Ellis, & Bell, 2010; Van der Vegt & Janssen, 2003), and thus drive group members to work together to achieve group objectives (Harrison, Price, Gavin, & Florey, 2002). In the condition of high pro-social motivation, the experimenter introduced an extra monetary bonus of 20 euros for each member (60 euros total) that would be awarded to groups that scored in the top 5 of most creative posters. Groups in the condition of low pro-social motivation did not receive any information about collective rewards.

Measures

Radical and incremental idea generation. The groups focused on various topics concerning animal rights protection, such as wildlife hunting, stray animals, cruel treatment of animals, and habitat destruction. Within each broad theme (e.g., habitat destruction), participants also provided various “stories” to convey in their poster, such as polar bears “crying” on the melting ice, or tigers losing their home. This variety was used to differentiate between radical and incremental ideas that were generated in the second part of the experiment (i.e., after the manipulation of membership change). Radical new ideas were operationalized as ideas that had not been proposed by members *of this group* during the preceding brainstorming part, and incremental new ideas were operationalized as ideas that evolved from ideas that had already been proposed in the brainstorming stage *of this group*. Thus, the distinction between radical and incremental ideas was based on relative rather than absolute novelty.

For example, in one group, one member suggested to draw a picture of a zoo, where a lion was looking sad while people were taking pictures and kids were throwing things. We coded this as a radical new idea, because similar ideas had not been proposed before that. Following this idea, another member suggested to draw a city next to the zoo, which indicated that people could walk back to their own home. Because this idea built on a previous idea, we coded it as an incremental idea. Another example is that one member in a group proposed to draw an animal that was already extinct, or was going to be extinct in a couple of years. This was a radical new idea, because similar ideas had not been proposed before that in this group. After that, another member proposed to draw stray animals who had lost their home. Because this idea was not formed based on a previous idea, it was also coded as a radical idea.

To obtain objective measures of group idea generation, we coded incremental and radical idea generation in the second part of the task (i.e., after the membership change manipulation) based on the video recordings. Two research assistants blind to the research purpose first transcribed the video recordings in such a way that it was possible to track “who said what”. Next, one research assistant marked all text excerpts that concerned either incremental adaptations or radical changes. To check coding reliability, the second assistant coded all transcripts following the same approach. Two raters displayed substantial agreement in their coding of the number of incremental adaptations ($ICC = .80$) and radical changes ($ICC = .61$), for generally accepted reliability criteria (Landis & Koch, 1977). Because these excerpts did not only contain radial or incremental ideas about the content of the posters, but also other suggestions, such as suggestions about idea implementation, task arrangement, and coordination (see also Jackson & Poole, 2003), one coder refined coding further, and coded only the incremental and radical *ideas* about poster design and content. A third research assistant, blind to the research purpose, coded a random selection of 13 groups’ transcriptions (21% of total groups) to establish reliability. The two raters displayed substantial agreement in their coding of the number of incremental idea ($ICC = .85$) and radical ideas ($ICC = .97$), following generally accepted criteria (Landis & Koch, 1977). We used the *number of incremental and radical ideas* to capture idea generation in the second stage of task (i.e., the poster-making part).

Idea acceptance. In addition to testing our primary hypotheses, we also conducted exploratory analyses on the role of pro-social motivation in groups’ acceptance of generated ideas. We proposed that pro-social motivation encourages group members to process and integrate new ideas and work for group goals rather than individual gains, and that such acceptance of ideas would benefit group creativity. To examine this, we coded the number of generated ideas that were finally incorporated into group products. We therefore counted the

total number of accepted ideas generated during the second stage of the task (i.e., the poster-making part), and labeled this as *accepted incremental ideas* and *accepted radical ideas*, respectively. We also established whether an accepted idea was suggested by an oldtimer or a newcomer.

Group creativity. Creativity refers to the generation of products that are *both* novel and useful (Amabile et al., 1996). In our study, creative posters should both be original and effectively attract the audience (i.e., useful), a requirement that was clearly communicated to participants at the beginning of the task. In previous studies, these two dimensions have often been examined separately in problem-solving tasks in which novel solutions should also be useful (e.g., Bedell-Avers, Hunter, & Mumford, 2008). Considering that the effect of membership change and pro-social motivation on creativity may due to either the novelty or the usefulness portion, or both, we conducted analysis on **group creativity**, as the mean score of novelty and usefulness, and also on **novelty** and **usefulness** as separate outcome variables.

Two different raters coded group creativity in terms of the usefulness and novelty of submitted posters. This ensured the independence of our coding of idea generation and group creativity, and avoided common source bias. Based on the consensual assessment technique (Amabile, 1982), we developed a 12-item scale on a 3-point basis. This scale was used to capture both the novelty and usefulness of designed products, and similar ratings have been used in previous creativity research (e.g., Harvey, 2013). Six items measured the usefulness of posters (e.g., “*The poster attracts the audience’s attention to animal rights protection issues effectively*”; $\alpha = .72$), and six items measured the novelty of posters (e.g., “*The physical appearance of the poster looks original*”; $\alpha = .79$). Two raters first independently assessed ten posters (approximately 17% of all posters) that were randomly drawn from all posters. Discrepancies were discussed and resolved to establish a common understanding of the rating scale. Subsequently, two raters scored all posters based on the revised rating scale

(see Appendix 2.A). The two rated reported highly consistent ratings (Shrout & Fleiss, 1979) on the usefulness of posters ($ICC = .89, p < .01$), as well as on the novelty of posters ($ICC = .81, p < .01$). Novelty and usefulness were found to be weakly correlated ($r = .15, p = .26$).

Control variable. The generation of ideas after membership change and the creativity of final products might be influenced by the ideas generated *before* newcomers joined the group (i.e., in the brainstorming stage). We therefore controlled the total number of incremental and radical ideas that groups generated in the first stage, and labeled as *idea generation in part I*.

RESULTS

Manipulation Checks

Three groups in the high pro-social motivation condition discussed the study purpose and expressed serious doubts about the collective reward (e.g., “we will never receive the 60 euros”). Because these participants explicitly stated that they were not convinced of the presence of rewards, we dropped those three groups from further analysis. Furthermore, we postulated that collective rewards (vs. no reward) would motivate group members to work collectively, would care more about fulfilling group goals, and would be more willing to attend to others’ ideas or viewpoints. As a result, group members should pay more attention to others and should be more willing to help integrate other’s ideas to achieve collective goals. Therefore, to check the manipulation of prosocial motivation, we examined differences between the two conditions in how much attention was paid to others’ contributions.

In the post-task questionnaire, all participants rated each other to indicate the extent to which each of the other two members “was paid attention to” on a 5-point item adapted from previous research (Cheng, Tracy, Foulsham, Kingstone, & Henrich, 2013). We aggregated the individual level data to the group level. A positive intraclass correlation ($ICC_1 = .64, ICC_2 = .84; F = 6.40, p = .01, N = 177$) indicated that the group was the appropriate level of

analysis. ANOVA (at the group level) on participants' rating of paying attention to others yielded a significant main effect for pro-social motivation condition ($F = 4.82, p = .03, N = 59$), confirming that groups in the reward condition reported a higher score on attending to others ($M = 4.25, SD = 0.41$) than did group in the no-reward condition ($M = 4.01, SD = 0.40$).

In terms of membership change manipulation, the recorded videos of the experiment showed that all groups in the membership change condition were aware of the presence of newcomers. In all cases, oldtimers introduced themselves to the newcomer proactively, which validated the manipulation of membership change. Furthermore, drawing from MIP-G theory, we argued that membership change increases group members' epistemic motivation to process information and generate ideas. Because group members with high epistemic motivation spend more effort to achieve a deep and thorough understanding of the task or problem (De Dreu et al., 2011; Nijstad & De Dreu, 2012), we used the amount of time that groups spent on task reflection as a behavioral measure of epistemic motivation. One research assistant measured the discussion time (in minutes) that groups used before they actually started to implement ideas into actions in the second task part. Results suggested that groups in the membership change condition devoted more time to reflection ($M = 6.22$) than those without membership change ($M = 3.14, F = 15.00, p < .001, N = 59$). This provided indirect evidence that groups in the membership change condition showed more task reflection and had higher epistemic motivation.

Descriptive Statistics

The means, standard deviations and correlations of all reported variables are displayed in Table 2.1². The means and standard deviations of measured variables in each condition, including group creativity, the generation and acceptance of incremental and radical ideas are summarized in Table 2.2.

² In addition to the reported measures, participants also reported task conflict, participative safety, and the building on and integration of ideas via post-task questionnaires. Given that those measures were not of focal interest, we omit them from further discussion.

TABLE 2.1
Means, Standard Deviations, and Correlations of Variables^a

	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9	10	11
1. Membership change	--	--											
2. Pro-social motivation	--	--	--										
3. Group creativity	1.93	0.36	.28*	.21									
4. Novelty	1.73	0.46	.28*	.13	--								
5. Usefulness	2.13	0.49	.15	.19	--	.15							
6. Idea generation incremental	6.25	3.70	.35**	.28*	.26 [†]	.19	.21						
7. Idea generation radical	2.25	2.70	.20	-.15	-.06	.15	-.24 [†]	.04					
8. Accepted incremental ideas	3.57	2.98	.19	.33*	.34*	.24 [†]	.29*	.75**	-.15				
9. Accepted radical ideas	1.36	1.73	-.13	-.20	-.13	-.10	-.09	-.10	.55**	-.23 [†]			
10. Newcomer incremental ideas accepted	1.59	1.95	--	.36 [†]	.48*	.17	.49**	.53**	-.21	.74**	-.30		
11. Newcomer radical ideas accepted	0.44	0.70	--	-.08	-.07	.10	.01	-.11	.43**	-.23	.77**	-.32	
12. Idea generation in part I	19.57	7.67	--	--	.06	-.11	.20	.04	-.21	-.02	-.18	-.17	.31

^a $N = 56$, due to technical issues, the videotapes were not successfully recorded for three groups for the second part and two groups for the first part of the task.

** $p < .01$, * $p < .05$, [†] $p < .10$.

TABLE 2.2
Means and Standard Deviations of Measured Variables in Different Conditions

Variables	No Membership Change		Membership Change	
	Low Pro-	High Pro-	Low Pro-	High Pro-
	Social	Social	Social	Social
	Motivation	Motivation	Motivation	Motivation
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
Group creativity	1.79 (0.45)	1.88 (0.31)	1.93 (0.30)	2.14 (0.28)
Novelty	1.64 (0.59)	1.57 (0.38)	1.72 (0.43)	2.02 (0.29)
Usefulness	1.94 (0.52)	2.18 (0.48)	2.14 (0.53)	2.26 (0.43)
Idea generation incremental	3.60 (1.80)	6.58 (3.94)	7.00 (2.80)	8.00 (4.56)
Idea generation radical	2.40 (2.92)	0.83 (1.40)	2.87 (2.59)	2.64 (3.20)
Accepted incremental ideas	1.86 (1.70)	4.33 (2.96)	3.43 (2.21)	4.85 (4.04)
Accepted radical ideas	2.00 (2.45)	1.08 (1.68)	1.36 (1.50)	0.92 (0.86)
Newcomer incremental ideas accepted	--	--	0.93 (0.92)	2.31 (2.50)
Newcomer radical ideas accepted	--	--	0.50 (0.76)	0.38 (0.65)

Test of Hypotheses

We first conducted regressions to test the effects of membership change on group idea generation in SPSS with 5000 bootstrapping iterations and computed 95% bias-corrected confidence intervals. Results suggested that membership change was positively related to the generation incremental ideas ($B = 0.70$, $SE = 0.26$, $p = .01$, $R^2 = .13$, $95\% CI = [0.19, 1.22]$), whereas membership change was not related to the generation of radical ideas ($B = 0.35$, $SE = 0.26$, $p = .18$, $R^2 = .07$, $95\% CI = [-0.17, 0.88]$). These results supported hypothesis 1a, that membership change would increase the generation of incremental ideas. However, hypothesis 1b was not supported. The presence of newcomers did not trigger the generation of radical ideas.

Second, hypothesis 2 predicted that the generation of incremental ideas would mediate the positive effect of group membership change on group creativity, but only when pro-social motivation was high. To test the hypothesis 2, we ran a moderated mediation analysis with 5000 bootstrapping iterations using the PROCESS macro in SPSS (model 14, Hayes, 2012), and computed 95% bias-corrected confidence intervals. Results are summarized in Table 2.3.

Results (see Table 2.3, model 1) revealed that the effect of incremental idea generation on creativity depended on pro-social motivation: the interaction effect of incremental idea generation and pro-social motivation on group creativity was significant ($B = 0.28$, $SE = 0.10$, $p = .01$, $R^2 = .24$, $95\% CI = [0.08, 0.48]$). Furthermore, pro-social motivation significantly moderated the indirect effect of membership change on group creativity via incremental idea generation, with a significant index of moderated mediation at 0.20 and a confidence interval that did not include zero ($SE = 0.11$, $95\% CI = [0.003, 0.44]$). Therefore, the moderated mediation hypothesis (Hypothesis 2) was supported. In particular, when pro-social motivation was low, the indirect effect of membership change on creativity

through incremental idea generation was negative but not significant ($B = -0.10$, $SE = 0.09$, $95\% CI = [-0.28, 0.07]$). By contrast, when pro-social motivation was high, the indirect effect was significant and positive: in this condition, membership change increased the generation of incremental ideas, which positively influenced group creativity ($B = 0.09$, $SE = 0.05$, $95\% CI = [0.01, 0.21]$; see Table 2.5, model 1).

In addition, we also examined the proposed effects on the novelty and usefulness of posters separately, to explore which of these two dimensions was more strongly affected by membership change and prosocial motivation. As results in Table 2.3 show (model 2), the interaction effect of incremental idea generation and pro-social motivation on novelty was significant ($B = 0.31$, $SE = 0.14$, $p = .03$, $R^2 = .18$, $95\% CI = [0.03, 0.58]$). Furthermore, pro-social motivation significantly moderated the indirect effect of membership change on novelty via incremental idea generation. The index of moderated mediation was significant as the $95\% CIs$ did not include zero ($B = 0.22$, $SE = 0.13$, $95\% CI = [0.002, 0.49]$). In particular, when groups had low pro-social motivation, the indirect effect of membership change on novelty through incremental idea generation was negative but not significant ($B = -0.13$, $SE = 0.10$, $95\% CI = [-0.34, 0.07]$). By comparison, when pro-social motivation was high, membership change was more likely to have a positive effect on novelty via incremental idea generation ($B = 0.09$, $SE = 0.06$). The $95\% CI$ for the indirect effect included zero $[-0.002, 0.23]$ (see Table 2.5, model 2), but the $90\% CI$ did not $[0.01, 0.21]$).

In terms of usefulness, results (see Table 2.3, model 3) suggested that the interaction effect of incremental idea generation and pro-social motivation was not significant ($B = 0.25$, $SE = 0.14$, $p = .08$, $R^2 = .15$, $95\% CI = [-0.03, 0.54]$). The $95\% CI$ for the index of moderated mediation included zero $[-0.06, 0.47]$ (see Table 2.5, model 3). Thus, no support was found for the moderating role of pro-social motivation on the indirect effect of membership change on usefulness through incremental idea generation.

We also performed moderated mediation analysis with radical idea generation as the mediator. However, the interaction effect between pro-social motivation and radical idea generation on group creativity was not significant ($B = -0.05$, $SE = 0.10$, $p = .63$, $R^2 = .08$, $95\% CI = [-0.24, 0.15]$; see Table 2.4, model 1). The indirect effect of membership change on group creativity through radical idea generation was not significant at either low ($B = -0.002$, $SE = 0.03$, $95\% CI = [-0.06, 0.06]$), or high pro-social motivation ($B = -0.02$, $SE = 0.03$, $95\% CI = [-0.07, 0.04]$). The confidence interval of the indirect effect included zero ($SE = 0.04$, $95\% CI = [-0.11, 0.06]$, see Table 2.5, model 4). In addition, the interaction effect of radical idea generation and pro-social motivation was not significant for novelty ($B = -0.06$, $SE = 0.13$, $p = .65$, $R^2 = .11$, $95\% CI = [-0.32, 0.20]$), or for usefulness ($B = -0.04$, $SE = 0.13$, $p = .77$, $R^2 = .13$, $95\% CI = [-0.30, 0.22]$), see Table 2.4, model 2 and 3. Neither did we found the indirect effect on novelty ($SE = 0.06$, $95\% CI = [-0.16, 0.08]$), nor usefulness ($SE = 0.05$, $95\% CI = [-0.12, 0.10]$), see Table 2.5, model 5 and 6.

In summary, we found evidence for the moderating role of pro-social motivation on the indirect effect of membership change on group creativity through incremental idea generation. The effect mainly worked for novelty rather than usefulness dimension of group creativity. In addition, membership change did not lead to the generation of more radical ideas, and radical idea generation did not contribute to group creativity, neither under low nor under high pro-social motivation.

TABLE 2.3
Bootstrapping Results for Moderated Mediation Models via Incremental Idea Generation

	Model 1				Model 2				Model 3			
	Outcome: Creativity				Outcome: Novelty				Outcome: Usefulness			
Variables	<i>B</i>	<i>SE^a</i>	LLCI	ULCI	<i>B</i>	<i>SE^a</i>	LLCI	ULCI	<i>B</i>	<i>SE^a</i>	LLCI	ULCI
Constant	1.72**	0.09	1.56	1.90	1.49**	0.12	1.25	1.72	1.97**	0.12	1.73	2.21
Membership change	0.23*	0.10	0.03	0.42	0.29*	0.13	0.02	0.56	0.16	0.14	-0.11	0.44
Idea generation incremental	-0.15 [†]	0.09	-0.32	0.03	-0.18	0.12	-0.42	0.05	-0.11	0.12	-0.36	0.13
Pro-social motivation (PSM)	0.13	0.09	-0.05	0.31	0.15	0.12	-0.1	0.40	0.12	0.13	-0.14	0.37
Idea generation incremental × PSM	0.28**	0.10	0.08	0.48	0.31*	0.14	0.03	0.58	0.25 [†]	0.14	-0.03	0.54
Idea generation in part I	0.02	0.04	-0.09	0.11	-0.05	0.06	-0.17	0.07	0.09	0.06	-0.03	0.22
<i>Model statistics R²</i>	<i>.24*</i>				<i>.18[†]</i>				<i>0.15</i>			

N = 56, ** *p* < .01, * *p* < .05, [†] *p* < .10.

Note. *CI* = 95% confidence intervals.

^a Estimates for standard error (*se*) were bootstrapped (5000 iterations).

TABLE 2.4
Bootstrapping Results for Moderated Mediation Models via Radical Idea Generation

	Model 1				Model 2				Model 3			
	Outcome: Creativity				Outcome: Novelty				Outcome: Usefulness			
Variables	<i>B</i>	<i>SE^a</i>	LLCI	ULCI	<i>B</i>	<i>SE^a</i>	LLCI	ULCI	<i>B</i>	<i>SE^a</i>	LLCI	ULCI
Constant	1.78**	0.08	1.62	1.94	1.56**	0.11	1.34	1.77	2.00**	0.11	1.79	2.22
Membership change	0.20*	0.10	0.00	0.39	0.21	0.13	-0.04	0.47	0.18	0.13	-0.08	0.43
Idea generation radical	-0.01	0.07	-0.14	0.13	0.08	0.08	-0.10	0.25	-0.09	0.09	-0.27	0.09
Pro-social motivation (PSM)	0.13	0.10	-0.07	0.32	0.15	0.13	-0.10	0.41	0.10	0.13	-0.16	0.35
Idea generation radical× PSM	-0.05	0.10	-0.24	0.15	-0.06	0.13	-0.32	0.20	-0.04	0.13	-0.30	0.22
Idea generation in part I	0.02	0.05	-0.07	0.12	-0.03	0.06	-0.16	0.10	0.08	0.06	-0.05	0.21
<i>Model statistics R²</i>	<i>.12</i>				<i>0.11</i>				<i>.13</i>			

N = 56, ** $p < .01$, * $p < .05$, † $p < .10$.

Note. *CI* = 95% confidence intervals.

^a Estimates for standard error (*se*) were bootstrapped (5000 iterations).

TABLE 2.5
Bootstrapping Results for Moderated Mediation Models

Moderator:	Conditional indirect effect			Index of moderated meditation model		
Pro-social motivation	<i>B</i>	<i>SE</i> ^a	95% <i>CI</i>	<i>B</i>	<i>SE</i> ^a	95% <i>CI</i>
Model 1: Creativity via incremental idea generation						
Low	−0.10	0.09	[−0.28, 0.07]	0.20	0.11	[0.00, 0.44]
High	0.09	0.05	[0.01, 0.21]			
Model 2: Novelty via incremental idea generation						
Low	−0.13	0.10	[−0.34, 0.07]	0.22	0.13	[0.00, 0.49]
High	0.09	0.06	[0.00, 0.23]			
Model 3: Usefulness via incremental idea generation						
Low	−0.08	0.12	[−0.30, 0.16]	0.18	0.14	[−0.06, 0.47]
High	0.10	0.06	[0.00, 0.24]			
Model 4: Creativity via radical idea generation						
Low	0.00	0.03	[−0.06, 0.06]	−0.02	0.04	[−0.11, 0.06]
High	−0.02	0.03	[−0.07, 0.04]			
Model 5: Novelty via radical idea generation						
Low	0.03	0.05	[−0.04, 0.18]	−0.02	0.06	[−0.16, 0.08]
High	0.01	0.04	[−0.03, 0.10]			
Model 6: Usefulness via radical idea generation						
Low	−0.03	0.05	[−0.16, 0.03]	−0.01	0.05	[−0.12, 0.10]
High	−0.04	0.05	[−0.15, 0.03]			

Note. *CI* = confidence intervals.

^a Estimates for standard error (*se*) were bootstrapped (5000 iterations).

Supplementary Analyses

Although radical and incremental idea generation were not correlated ($r = .04$, $p = .75$; see Table 2.1), it also conceptually makes sense to use the two indices in a single model (i.e., a ‘two-mediator’ model). We therefore ran analysis with two variables as parallel mediators in a single model, using the PROCESS macro in SPSS (model 14, Hayes, 2012), and computed 95% bias-corrected confidence intervals. We found a moderated mediation model only for incremental idea generation (index = 0.21, $SE = 0.12$, 95% $CI = [0.001, 0.45]$), but not for radical idea generation (index = -0.03 , $SE = 0.04$, 95% $CI = [-0.08, 0.02]$). The indirect effect of membership change, through incremental idea generation on group creativity was found only when groups had high pro-social motivation ($B = 0.09$, $SE = 0.06$, 95% $CI = [0.01, 0.22]$), but not when groups had low pro-social motivation ($B = -0.11$, $SE = 0.09$, 95% $CI = [-0.29, 0.08]$). Analysis of the two-mediator moderated mediation models on novelty and usefulness yield similar findings and simple slope patterns as we reported in the main text.

Acceptance of ideas. We argued that pro-social motivation benefits group creativity because it encourages groups to take different (particularly incremental) ideas into account and use these ideas for the group product. However, our primary analysis does not speak to the incorporation of incremental ideas in the final group products. We therefore examined the indirect effect of pro-social motivation on the creativity (novelty and usefulness) of group products through the acceptance of incremental (vs. radical) ideas. We ran a mediation analysis with 5000 bootstrapping iterations using the PROCESS macro in SPSS (model 4, Hayes, 2012), and computed 95% bias-corrected confidence intervals. Similar to previous

analysis, we controlled for the total number of ideas generated in the first task stage. The sample size for these analyses was 53 groups³.

First, a significant positive relationship was found between pro-social motivation and the acceptance of incremental ideas during the second stage of the task ($B = 0.67$, $SE = 0.27$, $p = .02$, 95% $CI = [0.13, 1.20]$). We also found a significant positive relationship between the acceptance of incremental ideas and group creativity ($B = 0.11$, $SE = 0.05$, $p = .03$, 95% $CI = [0.01, 0.22]$). The 95% confidence interval (CI) for the indirect effect did not contain zero ($B = 0.08$, $SE = 0.05$, 95% $CI = [0.001, 0.18]$). Results indicated that pro-social motivation increased the acceptance of incremental generated during the second stage, which in turn benefited group creativity.

We also performed mediation analysis on novelty and usefulness. Results suggested that the acceptance of incremental ideas was not related to the novelty of posters ($B = 0.09$, $SE = 0.07$, $p = .18$, 95% $CI = [-0.04, 0.23]$). The indirect effect between pro-social motivation and novelty through the acceptance of incremental ideas was .06 and was not significant ($SE = 0.06$, 95% $CI = [-0.02, 0.19]$). By contrast, the acceptance of incremental ideas was marginally and positively related to the usefulness of posters ($B = 0.13$, $SE = 0.07$, $p = .05$). The 95% CI for the indirect effect contained zero ($[-0.002, 0.27]$). However, the indirect effect was marginally significant ($p < .10$), 90% CI ($[0.01, 0.19]$). Although the evidence is not very strong, results imply that pro-social motivation was more likely to benefit usefulness rather than novelty by stimulating more acceptance of incremental ideas.

Second, we did not find a relationship between pro-social motivation and the acceptance of radical ideas ($B = -0.36$, $SE = 0.27$, $p = .19$, 95% $CI = [-0.91, 0.19]$). The acceptance of radical ideas was also not related to creativity ($B = -0.03$, $SE = 0.05$, $p = .59$,

³ Due to technique problems, research assistants could not code the acceptance of ideas during the second part for three groups.

95% $CI = [-0.13, 0.08]$), novelty ($B = -0.04$, $SE = 0.07$, $p = .55$, 95% $CI = [-0.18, 0.09]$), or usefulness ($B = -0.02$, $SE = 0.07$, $p = .81$, 95% $CI = [-0.15, 0.12]$). The 95% CI for all indirect effects included zero ($-0.06 < LLCI < -0.03$, $0.05 < ULCI < 0.09$). Results together demonstrated that pro-social motivation increased the acceptance of members' incremental ideas (but not radical ideas), which in turn benefited especially the usefulness aspect of group creativity.

Acceptance of newcomers' ideas. The previous results raise the question of whether newcomers' ideas in particular were accepted and integrated into a group's final product. We argued that for groups with high levels of pro-social motivation, members would be more willing to accept and combine newcomers' ideas. We therefore examined the mediating effect of the acceptance of newcomers' ideas in the relationship between pro-social motivation and group creativity (novelty and usefulness). For groups in the membership change condition ($N = 27$), we ran a mediation analysis with 5000 bootstrapping iterations using the PROCESS macro in SPSS (model 4, Hayes, 2012), and computed 95% bias-corrected confidence intervals. We again controlled for the total number of ideas generated in the first task stage.

First, these analyses suggested that pro-social motivation exerted a positive effect on the acceptance of newcomers' incremental ideas ($B = 0.83$, $SE = 0.37$, $p = .03$, 95% $CI = [0.07, 1.59]$), and that the acceptance of newcomers' incremental ideas was positively related to group creativity ($B = 0.15$, $SE = 0.06$, $p = .02$, 95% $CI = [0.03, 0.27]$). The confidence interval (CI) for the indirect effect did not include zero, 95% $CI = [0.001, 0.30]$, suggesting that the acceptance of newcomers' incremental ideas translated the positive effect of pro-social motivation on group creativity.

In addition to creativity, we performed analyses on novelty and usefulness. Results revealed that the acceptance of newcomers' incremental ideas was not related to novelty ($B =$

0.002, $SE = 0.08$, $p = .98$, 95% $CI = [-0.17, 0.17]$), but it was positively related to posters' usefulness ($B = 0.29$, $SE = 0.09$, $p = .003$, 95% $CI = [0.11, 0.48]$). The indirect effect of pro-social motivation on novelty was 0.002 ($SE = 0.07$, 95% $CI = [-0.12, 0.16]$). By comparison, the indirect effect of pro-social motivation on usefulness was 0.24 ($SE = 0.13$, 95% $CI = [0.02, 0.52]$), suggesting that accepting newcomers' incremental ideas translated the positive effect of pro-social motivation mainly into the usefulness of posters.

Second, we found no support for the mediating role of the acceptance of newcomers' radical ideas in the relationship between pro-social motivation and group creativity. Results revealed that pro-social motivation did not influence the acceptance of newcomers' radical ideas ($B = -0.32$, $SE = 0.39$, $p = .41$, 95% $CI = [-1.12, 0.48]$). The acceptance of newcomers' radical ideas did not influence creativity ($B = 0.02$, $SE = 0.06$, $p = .79$, 95% $CI = [-0.11, 0.15]$), novelty ($B = 0.06$, $SE = 0.08$, $p = .45$, 95% $CI = [-0.10, 0.22]$) or usefulness ($B = -0.02$, $SE = 0.10$, $p = .82$, 95% $CI = [-0.24, 0.19]$). The 95% CI for all indirect effects included zero ($-0.19 < LLCI < -0.12$, $0.02 < ULCI < 0.09$). Results together demonstrated that high pro-social motivation led to more acceptance of newcomer's incremental ideas (but not radical ideas), which in turn benefited mainly the usefulness aspect of group creativity.

DISCUSSION

Previous research suggested that new members can contribute to a group's idea repository, but it was less clear how membership change can shape the creativity of a final group product, such as a report, prototype, or campaign. Building on motivated information processing in groups (MIP-G) theory (De Dreu et al., 2008), the aim of the present research was to investigate the relationship between membership change, two types of idea generation (incremental vs. radical), and group creativity. It was predicted that membership change would be positively related to idea generation (both incremental and radical), but that idea generation would only benefit creativity when pro-social motivation of group members was

high. Using a task in which groups designed a poster in the laboratory, we found that membership change stimulated the generation of incremental ideas. Furthermore, incremental idea generation mediated the positive effect of membership change on group creativity (i.e., creativity of the final output – the poster), but only when groups were pro-socially motivated (i.e., could earn a reward when producing the most creative poster). These findings are consistent with MIP-G's suggestion that pro-social motivation is needed to turn ideas into high quality (creative) output.

Our study, however, did not find a relationship between membership change and the generation of radical ideas, and suggests that membership change exerts different effects on the two types of ideas. It seems that although the presence of newcomers may inspire groups to have new ideas, those ideas were more about minor adaptations to existing ideas. These results suggest that groups are less likely to give up existing thoughts, or that newcomers may feel reluctant to introduce ideas that were completely different to those of their new groups. We also did not find support for the influence of radical idea generation on group creativity. This is likely the case because these ideas are much harder to incorporate in a final product, at least within the limited time frame of the experiment. When (radical) ideas are ignored or discarded, they would exert little impact on the creativity of a final product, and this did not seem to depend on a group's level of pro-social motivation.

Our supplementary analysis revealed that pro-social motivation plays a role in encouraging groups to incorporate incremental ideas into the group product. We found that pro-social motivation increased the number of incremental ideas that were used in the posters, which in turn benefited creativity of the posters. The finding is consistent with MIP-G theory, suggesting that group members with high pro-social motivation are more willing to consider different ideas and combine ideas in a synergetic way. Importantly, such effect was also found for the incremental ideas generated by newcomers. Incorporating newcomers'

ideas contributed to group outcomes, suggesting a direct role for newcomers in enhancing group creativity.

In addition to group creativity, we also examined the novelty and usefulness of groups' products separately, and results suggested potentially different mechanisms for novelty and usefulness. We found that membership change was more likely to increase the *novelty* of team products under high pro-social motivation, and that this positive effect was translated via the *generation* of incremental ideas. The positive influence of pro-social motivation, on the other hand, mainly worked on the *usefulness* of group products, and this effect was translated via the *acceptance* of members' incremental ideas (among all groups) including those of newcomers (among membership change groups). Interestingly, to boost novelty, groups did not necessarily need to accept and incorporate as many ideas as possible into group products. In other words, it does not seem the case that the more ideas are accepted, the higher the novelty of posters. One possible reason is that groups incorporated a small number of ideas to enhance novelty. As more ideas generated, the chance that groups encountered a few good ideas was bigger. However, it did seem to matter for usefulness to incorporate more incremental ideas, including ideas suggested by newcomers. It is likely that details and minor adaptations regarding usefulness can be easily recognized and utilized. The more ideas were included, the more likely that groups covered every aspect to make the poster more useful. It should be noted, however, that this interpretation is speculative, and that in general effects on novelty and usefulness were in the same direction (and only differed in terms of relative strength of effects).

Theoretical Implications and Future Directions

These results have implications for various literatures. First, most previous research on membership change and group creativity has focused on idea generation (e.g., Choi & Thompson, 2005; Nemeth & Ormiston, 2007). This paper extends this work and examines

the complete link from group membership change to group creativity via idea generation.

Results suggest that new ideas inspired by newcomers do not always guarantee the achievement of creative outcomes. Rather, this relation depends on group member pro-social motivation and the type of ideas concerned (incremental versus radical).

Second, our study explores the relationship between group membership change and group creativity from a motivational perspective. The MIP-G model assumes that the combination of high epistemic motivation and high pro-social motivation leads to highest creativity as compared to other combinations (Nijstad & De Dreu, 2012). This study provides new evidence for this prediction and also indicates that the MIP-G model makes valid predictions in dynamic group contexts where group membership is changing. Our research suggests that group creativity requires the combination of diverse input (as stimulated by newcomers) and high cooperation to ensure that this input is actually transformed into group creativity (also see Bechtoldt et al., 2012). The importance of raising both epistemic and pro-social motivation is even more salient for the unstable groups with creative tasks. Specifically, our research emphasizes the role of pro-social motivation (in the form of collective rewards) as a contextual factor to process and integrate ideas to achieve high quality group outcomes. Therefore, the MIP-G model offers a solid theoretical foundation to explore the effects of newcomers on group creativity. Future research can further explore MIP-G and creativity in dynamic contexts.

Third, our paper has implications for research on group creativity and draws attention to the nature of creative ideas (i.e., incremental versus radical). Incremental and radical ideas bring different challenges for groups, and the nature of ideas is related to the way in which groups evaluate, select and integrate these ideas. Our research suggests that the nature of creative ideas should indeed be taken into consideration when the creativity of a final product is considered. We did not find the effect of membership change on the generation of radical

ideas, and radical idea generation was not related to group creativity, even when group members were pro-socially motivated. Clearly, future research should pay attention to the nature of creative ideas and further explore the relationship between radical and incremental idea generation and group creativity. For example, research can examine the conditions under which radical idea generation does contribute to group creativity. One possibility is that radical ideas are more likely included when a group is under pressure and has performed poorly in the past (cf. Choi & Levine, 2004), because poor past performance may signal that radical change is needed.

Fourth, the finding that especially incremental idea generation was positively related to group creativity (under high pro-social motivation) resonates with recent findings on the importance of idea development. For example, Harvey (2014) has proposed that groups do not necessarily need a large number of ideas to be creative, but rather need to synthesize their different perspectives. Similarly, Kohn et al. (2011) found that combining and integrating existing ideas could contribute to group creativity. Together with the current findings, this suggests that it is important that groups develop the ideas they have, and combine and integrate them. Rather than coming up with many radical different ideas, working on and refining existing ideas could be the best way to achieve creative outcomes in many situations.

Finally, the current paper highlighted that group members' motivation to work collectively on group products is essential to achieve group-level creativity. Collective rewards, which induce outcome interdependence among group members, reminds members of their common goals and unifies their efforts to work together (Courtright, Thurgood, Stewart, & Pierotti, 2015). Other types of interdependence might also influence the relationship between membership change and group creativity via pro-social motives, such as task or resource interdependence (Courtright et al., 2015; Kerrin & Oliver, 2002). Future research is encouraged to investigate this. Moreover, the need for cooperation and divergent

thinking within groups creates a potential tension between two activities. Group members may disagree whether they should devote more resources to combining ideas into outcomes or take time to generate more ideas. Our paper implicates that pro-social motivation may ease the tension to some extent by uniting individuals to work together. It would be fruitful for researchers to investigate how such tensions influence group-level processes and what factors allow groups to deal productively with these tensions.

Practical Implication

One clear implication for organizations is that group creativity can benefit from membership change. However, membership change is more likely to have these benefits when organizations adopt collective rewards or other types of group-based performance assessment, which require interdependent efforts of all members. Managers can use collective rewards as an intervention to improve the synergetic process of group creativity. Meanwhile, we may infer that incremental and radical ideas affect group creativity in different ways, and managers need to pay attention to the role of different types of ideas. Furthermore, our study may also imply work groups to pay more attention to the incremental ideas generated by newcomers, and may try to integrate more of their ideas into group products. For managers, one way to achieve this is to increase members' pro-social motivation, for example via collective rewards.

Limitations

As is generally the case with laboratory research, the generalizability of the present findings to the real world is constrained. For example, we operationalized membership change by letting one member leave the group and at the same time adding a new member to that group (i.e., member replacement). However, in a real work context, different types of membership change are possible (e.g., adding a member, downsizing). Moreover, our participants were students sharing fairly homogeneous backgrounds, whereas newcomers in

organizations can vary more. We also used a specific task, and our groups worked together for only a fairly short amount of time. However, even though our laboratory environment clearly is a simplification as compared to the real world, it does allow for causal conclusions and precise observations of group processes. Future work may examine the effects of membership change in ongoing groups in organizations.

Relatedly, we compared a condition with collective rewards (high pro-social motivation) with a condition without rewards (low pro-social motivation). It can be argued that effects were not due to the collective nature of the reward, but rather to the presence of a performance reward in the first place, and that individual rewards may have yielded the same effects. We chose not to use individual rewards in the present study (e.g., as a control condition), because when groups produce a single product (a poster in this case) it is not clear what exactly should be rewarded at the individual level. Moreover, if the mere presence of a performance reward has motivated our participants to be more creative, one would expect a main effect of performance rewards on creativity, rather than an interaction with idea generation or the pattern of moderated-mediation that we found. We therefore believe that it is, in fact, the collective nature of the reward that stimulated cooperation and allowed groups to better use the creative ideas that were generated. It would be interesting, though, to examine the effects of individual level rewards. For example, this may impact the degree to which different members' ideas are incorporated into a final product.

Another limitation is that we manipulated pro-social motivation via collective rewards, but we did not measure or manipulate pro-social motivation directly in our study. However, past research has often used group-based outcomes (vs. individual-based outcomes) to stimulate pro-social behaviors (e.g., Harrison et al., 2002). Besides, collective rewards have been widely considered as a strong factor to stimulate participants' pro-social motivation in many studies (Bechtoldt et al., 2010), and we found that collective rewards

increased participants' attention to and utilization of other members' input. Similarly, we assumed that membership change has positive effects because it stimulates reflection and epistemic motivation. Although further evidence supported this stimulating role of membership change on epistemic processes (i.e., more time and effort devoted to discussion and reflection), we did not directly measure epistemic motivation in this study. Future studies may want to capture pro-social and epistemic motivation directly or manipulate them in other ways.

CONCLUSIONS

We found that group members need to be motivated to work cooperatively together to benefit from membership change and achieve high group creativity. We further found that the nature of generated ideas matters in channeling the influence of membership change to group creativity: only incremental but not radical idea generation benefited the creativity of a final group product. As such, these findings suggest that cooperation is key to creative success of groups, especially in dynamic conditions of membership change.

APPENDIX 2.A

Assessment Scale of Poster Creativity

Please score from 1 (low) to 3 (high) the level to which ...

Novelty

1. The physical appearance of the poster is original.
2. The slogan in the poster is novel.
3. The story delineated in the poster is original.
4. The use of provided materials (e.g., paper, crayons, markers) is novel.
5. The ways of artistic expression of ideas (e.g., hyperbole) are original.
6. Overall the poster is novel.

Usefulness

1. The poster attracts the audience's attention to animal rights protection issues effectively.
2. The story that the poster delineates is clear and easy to understand.
3. The poster clearly states that it wants donations or volunteers from the audience.
4. The poster includes concrete but necessary information to make it available to donations or volunteers (e.g., contact information: official website, telephone number etc.).
5. The poster evokes the audience's feelings of sympathy/compassion to animals.
6. Overall, the poster can attract donations or volunteers.

Chapter 3 Role Differentiation in Creative Processes: A Configural Approach to Team Creativity

In recent years, team creativity researchers have become increasingly interested in the *process* through which teams produce creative outcomes e.g., Harvey (2014); (Kohn et al., 2011; Perry-Smith & Mannucci, 2017). Team creative process refers to actions that translate creative inputs, such as information and knowledge, into creative outcomes like products and solutions (Taggar, 2002). For example, some scholars emphasized problem construction, information search, and idea generation as important activities (e.g., Reiter-Palmon & Illies, 2004; Zhang & Bartol, 2010a), and others underlined the importance of the further evaluation, selection, elaboration, and implementation of ideas to achieve team creativity (e.g., Harvey, 2014; Harvey & Kou, 2013).

The growing knowledge of creative processes points to a crucial yet overlooked question: how can teams structure distinct creative processes to best leverage individual inputs? In particular, although individuals may differ in their participation in creative activities (e.g., Basadur & Head, 2001; Miron-Spektor et al., 2011), most studies (implicitly) assumed equal participation of team members in the different processes or activities (Van Knippenberg & Mell, 2016), and treated members' creative inputs as interchangeable. However, members that contribute disproportionately to problem construction may play a less important role in the idea generation, and those that are important for idea generation may not contribute equally to eventual idea implementation. How team members differ in their roles, not only within but also across creative activities, implies a configurative view of member involvement across different creative processes (see also Aime et al., 2014; Crawford & LePine, 2013; Humphrey & Aime, 2014; Van Knippenberg & Mell, 2016). Because teams may benefit from members *specializing* in certain (but not other) creative processes (e.g., Berg, 2016; Reiter-Palmon, Robinson-Morrall, Kaufman, & Santo, 2012), we

suggest that existing research on team creativity should be complemented with a theory that considers the *configuration* of team members' participation within and across various creative activities.

We develop the construct of *creative role differentiation* to capture team members' specialization in certain (but not in other) creative processes and activities, and link creative role differentiation to team creativity. Low creative role differentiation implies that members provide similar inputs within and across creative processes, whereas high creative role differentiation implies that members specialize in (i.e., participate more as compared to other members) a certain activity, and participation also differs across activities. For example, one member may be more involved in defining problems, yet another might exert more effort in exploration and searching relevant information to solve problems. Drawing from the literature on team cognition (Reiter-Palmon et al., 2008) and team structure (Crawford & LePine, 2013; Hollenbeck, Ellis, Humphrey, Garza, & Ilgen, 2011), we argue that there may be advantages to high creative role differentiation: it protects team members against cognitive overload or conflicts that may arise when every member performs all creative tasks, creates an efficient use of individual inputs, and improves intra-team communication.

Furthermore, we consider the question of *when* creative role differentiation will be more strongly related to team creativity. Firstly, considering that team members' time, attention, and abilities are limited, we propose that high creative role differentiation enhances team creativity in particular when teams lack resources for creativity (referring to any resource that is necessary for the execution of creative activities, such as time, money, or equipment), because this specialized structure optimizes the allocation of scarce resources within teams. Second, we propose that the effectiveness of creative role differentiation hinges on the freedom that team members have to allocate these scarce resources, rather than depending on top-down supervisory control. Relying on supervisors to make decisions is not

only inefficient, but also demotivates team members to proactively communicate and exchange information with each other. Therefore, we propose that reaping the benefits of creative role differentiation under conditions of scarce resources requires a decentralized decision-making structure in which teams can make effective and efficient decisions. Those hypotheses were tested in a quantitative survey study, followed by a qualitative study that further explored the emergence creative role differentiation in real work teams.

Our study contributes to the literature in two ways. First, our conceptualization of and empirical evidence about creative role differentiation provides a structural view of creative process engagement in teams, which has been shown as a critical mechanism to produce creative outcomes (Zhang & Bartol, 2010a, 2010b). Whereas existing research (implicitly) assumed that all members equally engage in creative activities, and that external factors stimulate all members' engagement indiscriminately, we develop a structural view to account for effective configurations of varying engagement of team members. This opens up a fresh view to consider how to effectively arrange members' distinct engagement in the team creative process, moving beyond the traditional approach of identifying the right *amount* of engagement in team creative activities (Gilson & Shalley, 2004) to examine the right *distribution* of creative activities across team members. Second, our paper contributes a contingency view to the literature on how to structure team creative processes. Existing studies have mainly examined how the combination of different processes in terms of *sequence* or *duration* affects team creativity (e.g., Goh, Goodman, & Weingart, 2013; Harvey & Kou, 2013; Kohn et al., 2011). However, we propose that the effects of how creative activities are configured in teams also depend on contextual factors, such as resources for creativity and centralization of team decision making. This extends our knowledge of the environmental factors that are needed for creative process structures to be effective, and may

inspire more research into how the effects of team structures depend on contextual contingencies.

THEORY AND HYPOTHESES

Creative Role Differentiation

Scholars have recognized that team creativity, defined as the generation of novel and useful outputs by team members who work together (Amabile et al., 1996; Shalley, Zhou, & Oldham, 2004), involves different processes that represent important stages or phases in the creation of a creative end product. For example, from the perspective of the “idea journey”, team creative processes involve idea generation, but also later idea development and elaboration, idea evaluation, and the implementation of ideas (e.g., Perry-Smith & Mannucci, 2017). Because creativity often involves the generation of solutions to problems, it can also be seen as a problem-solving activity, composed of problem construction, information search and encoding, and idea generation (Lubart, 2001; Reiter-Palmon & Illies, 2004; Zhang & Bartol, 2010a). These processes do not necessarily occur as a neat sequence, but may be seen as necessary and critical activities to eventually produce creative outputs (Kruglanski & Webster, 1991), and teams are likely to conduct different processes simultaneously or recursively. Harvey and Kou (2013), for instance, examined policy-making groups and identified different ways to structure creative processes, including an evaluation-centered mode in which idea generation and evaluation occurred simultaneously. The dynamics and complex features of team creative processes suggest that various processes need to be organized and structured, which leads to the question of how teams allocate individual inputs (e.g., time and effort) to those creative activities.

The concept of creative role differentiation is grounded in the notion that team members often differ in their creative inputs/effort, for example based on their expertise in creative activities (i.e., domain-specific specialty or skills; Berg, 2016; Dane, 2010; Kirton,

1976; Miron-Spektor et al., 2011; Reiter-Palmon et al., 2012). Unlike task division, which is largely determined by team leaders or through explicit work routines such as meetings, individual members' engagement in creative activities is often beyond job obligations (Chang & Lee, 2008). It does not necessarily overlap with the division of tasks, because team members may perform the same tasks but still specialize in different creative processes. Consequently, creative role differentiation may arise more or less spontaneously, as team members gain experience with each other and their tasks. Although much research has examined the division of labor at the organizational, industry, or societal level, the concept of creative role differentiation has not been examined in team creativity research. In the current paper, we consider the actual creative effort (or involvement or participation) of team members in different creative activities. Indeed, although creative processes could be structured without creative role differentiation (i.e., all members perform the same processes, or one or a few members perform all processes), a creative role differentiation structure in teams (T. V. Mumford, Campion, & Morgeson, 2006; T. V. Mumford, Van Iddekinge, Morgeson, & Campion, 2008), in which there is some degree of specialization and autonomy (Lawrence & Lorsch, 1969), is also possible.

Such a specific configuration of member inputs relates to, but differs from, a few other structural patterns in the literature. For example, the team relative contribution model distinguishes "core members," who play more important roles in team tasks, from "peripheral members" (Humphrey et al., 2009; Mathieu, Tannenbaum, Donsbach, & Alliger, 2014). This approach points out that task involvement is centralized to one or a few core members and therefore not all team members contribute to team performance equally. However, it does not discuss different levels of involvement across different (creative) processes, which is the main focus of our paper. Likewise, whereas the concept of process diversity involves the heterogeneity of participation in a single team (creative) process (Van Knippenberg & Mell,

2016), creative role differentiation implies a configuration in which team members specialize in creative processes. It does not only imply that members differ in their participation across creative processes, but also that participation differs within one process. Creative role differentiation is conceptually different from shared leadership (Pearce & Conger, 2002) and power heterarchy (i.e., shifts of relative power, Aime et al., 2014), because these approaches assume certain power dynamics. In contrast, creative role differentiation is not necessarily related to (shifting) leadership or power, but only implies that members differ in their relative *input*, such as time and effort, depending on the specific activity that is performed.

Figure 3.1 exemplifies the possible distribution of members' participation in a hypothetical team of three members (member X, Y, and Z) within and across three creative activities (problem construction, information search and encoding, and idea generation). Scores indicate the degree of each member's participation in each activity (3= "high"; 2= "moderate"; 1= "low"). Panel A presents an example of equal participation within and across all activities, consistent with the assumption of homogeneous member participation implicitly held in most previous research. Differentiated member participation regardless of activities (i.e., assuming no difference across activities), results in a core-periphery participation matrix, in which some members are more engaged than other members across all activities (Panel B). Finally, as Panel C illustrates, members can specialize in certain activities, but not in others, and participation of members also differs per activity. In other words, creative role specialization denotes that the allocation of inputs is not uniform across all activities (i.e., across all creative processes), but that the relative contribution of individual members can change as the team performs different activities.

FIGURE 3.1**Example of the Distribution of Member Participation in Creative Processes**

Participation Distribution	A: Equal Participation			B: Core-Peripheral Participation			C: Creative Role Differentiation		
<i>Members</i>	<i>X</i>	<i>Y</i>	<i>Z</i>	<i>X</i>	<i>Y</i>	<i>Z</i>	<i>X</i>	<i>Y</i>	<i>Z</i>
Problem construction	2	2	2	1	2	3	2	3	1
Information search and encoding	2	2	2	1	2	3	3	1	1
Idea generation	2	2	2	1	2	3	1	2	3

Creative Role Differentiation and Team Creativity

Although the effects of creative role differentiation on team creativity have not been tested, some empirical studies found that teams with a heterogeneous blend of cognitive styles (e.g., generator, optimizer, and implementer) outperformed homogeneous teams in creative problem-solving tasks (Basadur & Head, 2001) or were more innovative (Miron-Spektor et al., 2011). Although these studies did not capture the actual participation of different members in different creative activities, they provide initial evidence that specialization of members' creative inputs may contribute to creative performance. In general, team creativity benefits from an effective allocation of member effort to specific activities (Brophy, 1998). Drawing on insights from the creative cognition and team structure literature, we propose that creative role differentiation may benefit team creativity for two major reasons.

First, creative activities often require diverse or even opposing cognitive styles, and specialization prevents team members from cognitive overload or biases that may undermine creativity. Activities such as idea creation and elaboration require divergent thinking,

whereas activities such as integrating ideas and information benefit more from convergent thinking (Harvey, 2013). Research on individual cognitive styles (Kirton, 1976; Miron-Spektor et al., 2011) suggests that those two styles do not easily co-exist: people who are good at divergent thinking may not excel at convergent thinking and vice versa. For example, idea creators usually have difficulty focusing on implementation details (Caniëls, De Stobbeleir, & De Clippeleer, 2014; Gupta, Smith, & Shalley, 2006), and research on team-level exploration-exploitation has proposed that having members specialize in either exploration or exploitation may reduce cognitive demands and help teams to achieve superior creative performance (Andriopoulos & Lewis, 2009; Gibson & Birkinshaw, 2004). People who attempt to perform all creative activities may therefore encounter difficulties in shifting between cognitive styles, whereas creative role differentiation allows team members to concentrate on specific tasks. In turn, this reduces potential cognitive overload and biases during creative activities. In contrast, teams with low levels of creative role differentiation either require members to master all skills, or experience low efficiency (Grant, 1996; Hollenbeck et al., 2011).

Second, creative role differentiation may improve coordination and communication among members. Within each process, creative role differentiation creates a core-periphery structure in which the relative contribution of members differs (Humphrey et al., 2009). Such a structure facilitates the coordination of creative acts and reduces ambiguity (Hollenbeck et al., 2002), which helps channel information in teams. Additionally, having different specialists signals that a wide range of expertise is available, with different perspectives and knowledge, which fosters an open discussion and may eventually enhance team creativity (Hambrick, Cho, & Chen, 1996). Indeed, Aime et al. (2014) found that shifts between specialized roles can enhance team creative performance by increasing information exchange and by motivating individuals to promote diverse ideas. The realization that members differ

in their specialization can enhance members' understanding that the team benefits from exchanging information (Van Ginkel & Van Knippenberg, 2009), and individuals that appear to be core members are also more confident to share information with other team members (Franz & Larson Jr, 2002; Stasser, Stewart, & Wittenbaum, 1995). Taken together, we propose a positive influence of creative role differentiation on team creativity.

Hypothesis 1. Creative role differentiation in the team creative process is positively related to team creativity.

The Moderating Role of Resources for Creativity

We propose that creative role differentiation is more beneficial for team creativity in situations of resource scarcity. In this paper, resources for creativity are conceptualized as the generic materials that teams possess that are necessary to enable creativity, including time, physical, intellectual, and financial resources (Madjar et al., 2011). We view resources for creativity as a broad construct that encompasses a variety of more specific resources. This broad definition underlines the *adequacy* of various resources for creativity as a whole (Madjar et al., 2011; Zhou, Shin, & Cannella Jr, 2008), and therefore is neither limited to a specific type of resource, nor a certain combination of specific resources. In other words, we focus on whether teams have sufficient resources to support creative action, and compare situations of relative resource adequacy with those of relative resource scarcity.

Team creative activities are highly resource-dependent (Amabile et al., 1996; Gupta et al., 2006), relying on a supportive work context to provide resources, such as time and monetary rewards. However, organizational teams often compete for resources, and lack of resources can limit team efforts to explore information and experiment with new ideas (Ancona & Caldwell, 1992; Voss, Sirdeshmukh, & Voss, 2008). Because creative role differentiation allows for the efficient use of members' creative inputs, and because it may reduce ambiguity and provide guidance to minimize redundancies, we propose that creative

role differentiation will compensate for the negative effect of lack of resources on team creativity.

When resources are ample, team members will be able to perform all necessary creative activities, and the need for team members to specialize in particular creative processes is less salient. However, when teams lack sufficient resources, creative role differentiation offers an efficient way to allocate these scarce resources. Compared to a structure with low differentiation, where resources need to be distributed to all members who need resources to perform multiple creative tasks, teams with high levels of creative role differentiation can allocate resources mostly to “core” members who have the expertise to effectively utilize these resources (see also Delery & Shaw, 2001). With specialized engagement in specific creative activities, individuals do not invest considerable resources in activities outside their specialization, which reduces redundancies in actions (Hollenbeck et al., 2011). Because creative role differentiation suggests a principle to divide resources among team members, it also reduces potential process conflicts about resource distribution (Magee & Galinsky, 2008).

Because creative role differentiation ensures efficient use of resources, it will further mitigate the negative effect of resource scarcity on the *balance* among creative activities. The performance on one creative activity (e.g., idea generation) can depend on the performance on earlier activities (e.g., problem construction), and sufficient attention to all activities is therefore critical to generate superior creative outcomes (Reiter-Palmon et al., 2008). Evidence showed that, however, resource scarcity can lead team members to focus on finishing tasks quickly instead of devoting adequate effort to all relevant activities (Sitkin et al., 2011). For instance, teams often spend less effort on generating ideas or identifying problems, and more on implementing ideas, under high time pressure (Reiter-Palmon et al., 2008; B. M. Staw, Sandelands, & Dutton, 1981). Furthermore, teams rely more on heuristics

under resource constraints or tend to reach agreement quickly (Kruglanski & Freund, 1983). Insufficient inputs to some creative activities may reduce the creativity of team outputs. Creative role differentiation enables individuals to focus on a particular activity, and may assure that all relevant activities are performed at a reasonable standard, even when resources are scarce (see also Ericsson & Lehmann, 1996; Gupta et al., 2006). We thus propose that creative role differentiation is particularly beneficial in situations when teams lack sufficient resources for creativity.

Hypothesis 2. The positive relationship between creative role differentiation and team creativity is stronger when resources for creativity are scarce (compared to ample).

Decentralized Decision Making as a Boundary Condition

Creative role specialization is mainly concerned with the amount of time and effort that members invest in certain activities, but does not necessarily imply high power within that role. Indeed, creative inputs may not always be controlled by team members, for example because the team leader has the authority of distributing tasks to members, or because members make decisions collectively (Emich, 2014). In this regard, we examine the effects of centralization of decision making, which is defined as the extent to which employees can make decisions without consulting their supervisors (Hage & Aiken, 1967). When centralization is high, work decisions must be referred to the supervisor before employees can take actions; when centralization is low, decision making is delegated downward and employees are allowed to make their own decisions with low reliance on the supervisor (Hage & Aiken, 1967). Because research on team creativity has highlighted that it is critical to adopt an appropriate teamwork structure to leverage task-relevant knowledge and skills of members when resources are constrained (Hoegl, Gibbert, & Mazursky, 2008; Paulus, 2000; Thompson, 2003), we examine centralization of decision making as a potential boundary condition for the effects of creative role differentiation on team creativity.

For two reasons, we propose that to reap the benefits of creative role differentiation under resource scarcity, a decentralized decision-making structure is required. First, role differentiation will be more effective when members feel empowered to enact their roles (see also Hempel, Zhang, & Han, 2012). Team centralization defines the way that decisions and information flow within a team. In a centralized structure, decisions are made by those higher in the hierarchy, and this will reduce feelings of control over one's actions (Kirkman & Rosen, 1999; Pugh, Hickson, Hinings, & Turner, 1968), and will make creative role differentiation less effective. In contrast, creative role differentiation in a decentralized decision-making structure implies that team members are allowed to make their own decisions, without asking for approval from superiors. Feelings of self-determination and control over tasks motivate members to exert effort on what they excel at, based on the belief that their behavior will make a difference to team results (Zhang & Bartol, 2010b). At the same time, such a structure also motivates and improves information flow and the utilization of information within teams (Miller & Monge, 1986). In other words, differentiation of roles does not entail shifts of power until team members have the autonomy to make their own decisions, and such shifts of power are needed for creative role differentiation to be effective.

Second, a centralized decision-making structure creates inefficiencies in coordination (Van der Vegt, Van de Vliert, & Huang, 2005; Yuan & Zhou, 2015), which reduce the benefits of creative role differentiation for the efficient use of members' creative inputs. When taskwork is specialized, a decentralized teamwork structure provides members with the flexibility to monitor and coordinate their activities (Crawford & LePine, 2013). To be efficient, team members should have unconstrained communication to assign resources to members who have the required expertise (Hollenbeck et al., 2011). This is particularly important when teams lack resources for creativity, which requires an accurate allocation of resources to the right people. As Grant (1996) noted, having specialists facilitates the

efficiency of utilizing knowledge, but requires a decentralized structure, as special knowledge cannot easily be integrated and transferred to decision makers in hierarchical structures.

Applying this notion to work teams, in a centralized structure, decisions are made by leaders, who have to collect and assess information to make decisions of good quality. This costs time and effort, and reduces the flexibility to react to task changes and dynamic situations.

Furthermore, it also requires that leaders have broad expertise and can assign tasks and distribute information to the right people. This may easily overburden a leader, and lead to a less effective and efficient allocation of resources, which is particularly problematic when resources are scarce. One meta-analysis has indeed shown that when resources are deficient, project teams benefit from a low power distance culture, which is often associated with flat hierarchies and decentralized structure (Yuan & Zhou, 2015), because it allows for flexibility and because the creative efforts of team members can be better leveraged (Weiss, Hoegl, & Gibbert, 2017). In sum, decentralization enables one person to act in a leading role in the activity, and prevents inefficiencies of centralized coordination. We therefore propose:

Hypothesis 3. Resources for creativity and centralization jointly moderate the relationship between creative role differentiation and team creativity, such that this relationship is positive for teams with low centralization and less resources for creativity.

STUDY OVERVIEW

Two studies were conducted to test our hypotheses and explore the emergence of creative role differentiation in teams. In Study 1, we collected data among organizational teams via a quantitative survey to develop a measure of creative role differentiation and test hypotheses. In Study 2 we collected qualitative data as a follow-up study to explore how creative role differentiation emerges and how creative activities are coordinated in real-life scenarios.

STUDY 1: METHODS

To test these hypotheses, we administrated web-based surveys among 25 organizations in the Netherlands. The data was collected during winter 2018 and spring 2019, as part of a larger research project on creativity and innovation in Dutch organizations. Like most organizations, these selected companies are often faced with challenging and changing markets and customer needs. Given that creative problem solving is important in various organizational roles (Amabile et al., 1996), we did not restrict our sample to any specific industry or to any specific functional role (e.g., R&D, marketing) within the organization. The sampled organizations were small and medium-sized companies (or departments of larger organizations) with between 45 and 1000 employees, coming from a variety of sectors, including consultancy and research, construction, health and well-being, information and communication, agriculture, forestry and fishery, education, real estate, and transportation.

To mitigate concerns of common source variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003), we collected matched data from both employees (team members) and supervisors (team leaders). Specifically, we measured creative role differentiation and resources for creativity among team members, whilst measuring centralization and team creativity among team leaders. Prior to the survey, companies provided us with contact information of all employees at different hierarchical levels, including information on the team (or department) composition (i.e., who is in a team together and who is the team leader). We distributed a personalized survey link to each participant. Respondents learned that the survey aimed to explore creativity and innovation in their organizations and teams. Leaders and team members were invited at the same time and received different versions of the survey. We sent out reminders to participants one and two weeks after the initial invitation and closed the survey in a given company after three weeks. The initial sample consisted of 104 teams for which both employee and team leader data were available.

We measured creative role differentiation by asking team members to report on their creative activities in the team. To gauge accurate views of creative role differentiation at the team level, and to establish whether different members take the lead in different activities, we selected those teams with at least 3 responses. Also, a sufficient response rate per team is required to establish configuration patterns (Allen, Stanley, Williams, & Ross, 2007; Maloney, Johnson, & Zellmer-Bruhn, 2010). Because there is no established norm for minimum response rates in team research, we followed previous research on team diversity (e.g., Eigel & Kuhnert, 1996) to use a cutoff point of 50%. This reduced our sample from 104 teams to 73 teams. Team size ranged from 3 to 28, with a mean of 9.82 ($SD = 6.49$). Of the 526 participating employees, 22.7% were women. The average age was 42.43 years ($SD = 11.95$), and 60.1% had a bachelor degree or above. Of 68 team leaders who reported their demographic information (out of 73), 16.7% were women; their average age was 46.56 years ($SD = 11.32$), and 82.4% possessed a bachelor degree or above. The average organizational tenure was 17.95 years ($SD. = 33.15$) for employees and 17.32 years ($SD. = 13.08$) for team leaders.

Measures

Unless otherwise noted, we used the five-point scale from 1 = “completely disagree” to 5 = “completely agree”.

Creative role differentiation. Various work situations and creativity requirement can necessitate different creative activities in different organizations. Despite the diverse types of organizations/teams in our sample, we assume that all teams have to confront the challenges of creating novel problem solutions, at least to some degree (Reiter-Palmon & Illies, 2004). Therefore, we built on the creative problem-solving approach and measured team creative processes in light of earlier insights about creative process engagement at work: problem

construction, information search and encoding, and idea generation (Reiter-Palmon & Illies, 2004; Zhang & Bartol, 2010a).

Three items were used for problem construction (e.g., “I spend a lot of time assessing the nature of a problem before acting”, Cronbach’s $\alpha = .60$), five items for information search and encoding (e.g., “I consult a wide variety of information”, Cronbach’s $\alpha = .64$) and four items for idea generation (e.g., “I often try to think about new ways to achieve goals and objectives”, Cronbach’s $\alpha = .80$). Next, we identified members with the highest scores in each process. This yields a matrix of scores similar to those in Figure 3.1. A high level of creative role differentiation means that each creative process was led by distinct and non-overlapping members. For example, in a team with members A, B, and C, the highest creative role differentiation occurs when each member devotes most effort to a different role (e.g., A has the highest score on problem construction, B on information search, and C on idea generation). If, for example, A has the highest score on two roles, B on the third, and C on none of them, creative role differentiation is lower. Therefore, creative role differentiation can be calculated as the *variability* of leading members, which is also consistent with our conceptualization that creative role differentiation implies a shift of core members depending on creative processes.

Based on this matrix, we calculated creative role differentiation using the Blau index of heterogeneity (Blau, 1977), which is widely used as a variability/diversity measure of categorical data (e.g., Harvey & Kou, 2013). In particular, we assessed for each of the three roles which member had the highest score, and thus took the lead in that activity, and subsequently identified the set of all leading members in three processes (e.g., A, B, A). We then calculated the *Blau* index using this formula:

$$V = 1 - \sum_i p_i^2,$$

where p_i stands for the proportion of a member in each of the i categories (in the example (A, B, A), $p_A = 2/3$, $p_B = 1/3$, and V equals .44). V equals zero if one member leads all three activities (i.e., (A, A, A)), whereas the maximal value of V is obtained when all members take the lead in a different activity (i.e., (A, B, C); V equals .67 in this case).

An alternative measure of creative role differentiation would be to simply count the number of different leading members across activities. However, our diversity index reflects how different entities are distributed (the extent to which leading members are evenly spread), and therefore is more suitable. For example, two sets of leading members (A, A, B, B) and (A, A, A, B) have the same count (two), but different Blau index values, which are 0.50 and 0.38, respectively. Moreover, we also encountered situations where two members scored the same on a particular activity. For example, (A, A&B, C) and (A, B, C) have the same count of three, but are different in terms of distribution. We weighted half point to each individual in the situation when two scored the same. Hence, the set of (A, A&B, C) can be transferred to (1.5A, 0.5B, C) and creative role differentiation can be computed following the Blau index approach.

Resources for creativity. Employees reported resources for creativity in their team on three self-developed items (adapted from Madjar et al., 2011): Within our team 1) “we have the resources that are needed to try out new things”; 2) “we have the resources to develop novel products, processes, procedures”; and 3) “we have the resources we need to be innovative”. Cronbach’s α was .89, and interrater reliability and within group agreement was sufficient for aggregation to the team level ($ICC = .27$, $p < .001$; $r_{wg} \text{ mean} = .72$).

Centralization. Supervisors rated the extent that employees can make decisions without consulting their supervisors on five items derived from Hage and Aiken (1967). Cronbach’s α coefficient was .86. A sample item was “A person who wants to make his own decisions would be quickly discouraged”.

Team creativity. Team creativity was rated by team leaders with the scale from Farh, Lee, and Farh (2010). Items were 1) “My team’s output is creative”; 2) “My team’s output is original and practical”; and 3) “My team’s output demonstrates that the team is capable of using existing information and resources creatively”. Cronbach’s α coefficient was .81.

Control variables. We measured *team size* (number of team members) as a covariate to control its potential influence on team processes and team creativity, which was determined by the team leader’s listing of all people he or she considered members. To examine the predictive power of creative role differentiation, we also controlled for the mean level of creative process engagement on each activity, which has been found to predict team creativity in previous research (Zhang & Bartol, 2010a). We computed, per team, the average level of creative process engagement in terms of *problem construction*, *information searching and encoding*, and *idea generation* and used (labeled) these three as control variables ($ICC = .20, .18, .19$, respectively, $p < .01$). In addition, to rule out the confounding effect of the core-peripheral pattern (i.e., a few members scoring much higher than others on activities) in the relationships examined, we included the *variance* of members’ general engagement (determined as the mean of each individual’s engagement in three activities) within each team as a covariate. Finally, given that the job requirement for employees to perform work creatively may differ, we measured and controlled for *creative requirement* in hypothesis testing. Employees indicated the creative requirement about their specific job on a five-point scale of three items (“Suggesting and introducing new ideas into the organization is part of my job.”; “Creativity is important to do my job well.”; and “My job requires me to try out new approaches to problems.”), adapted from Yuan and Woodman (2010). Cronbach’s α was .73, and interrater reliability and within group agreement was sufficient for aggregation to the team level ($ICC = .26, p < .001; r_{wg\ mean} = .79$).

STUDY 1: RESULTS

Table 3.1 summarizes means, standard deviations, and correlations among measured variables. We performed hierarchical regression analysis to test hypotheses. Because sampled teams are nested in 25 organizations, we specified robust standard errors at the organizational level to account for possible heteroscedasticity in team creativity across organizations. We centered all (continuous) independent variables to reduce possible multicollinearity and facilitate interpretation. In step one, we entered control variables only. Step two added main effects to test the first hypothesis. Step three added two-way interactions testing hypothesis 2. In step four we added the three-way interaction, which provides tests of our final hypothesis. Table 3.2 summarizes those results.

TABLE 3.1
Means, Standard Deviations, and Correlations among All Variables

Variables	Mean	SD	1	2	3	4	5	6	7	8	9
1. Team size	9.82	6.49									
2. Problem construction	3.90	0.27	-.00								
3. Information search and encoding	3.90	0.24	.00	-.02							
4. Idea generation	3.54	0.33	.07	.42**	.48**						
5. Creative requirement	3.88	0.39	.01	.34**	.41**	.46**					
6. Variance in creativity engagement	0.14	0.11	.14	.27*	.13	.12	-.05				
7. Team creativity	3.69	0.63	.04	.04	.12	.16	.28*	-.03			
8. Creative role differentiation	0.48	0.21	.38**	.00	.03	-.02	.15	-.24*	.28*		
9. Resources for creativity	3.11	0.50	-.06	-.01	-.16	.08	.13	-.13	.04	.04	
10. Centralization	2.03	0.71	-.15	-.20†	.15	-.03	-.07	-.13	-.17	-.10	-.27*

Note: $n = 70$ (listwise deletion), three leaders did not report team centralization.

** $p < .01$, * $p < .05$, † $p < .10$.

In support of Hypothesis 1, results show that creative role differentiation was positively related to team creativity ($B = 0.87$, $F(9, 60) = 1.51$; $p = .03$; see Table 3.2, Model 2): a higher level of role differentiation is related to higher team creativity. Hypothesis 2 proposed that the relation between creative role differentiation and team creativity is moderated by resources for creativity, in such a way that creative role differentiation is more positively related to team creativity when teams lack resources for creativity, compared to when teams have many resources. Counter to expectations, however, results (see Table 3.2, Model 3) indicated that the interaction term was not significant ($B = -0.38$, $F(12, 57) = 1.15$; $p > .05$). Hypothesis 2 was therefore not supported. Hypothesis 3 stated that resources for creativity and centralization jointly moderate the relationship between creative role differentiation and team creativity. As hypothesized, the three-way interaction term was positive and significant ($B = 2.68$, $F(13, 56) = 1.40$; $p = .046$; see Table 3.2, Model 4).

We proposed that the three-way interaction would take on a specific form, in such a way that creative role differentiation is more positively related to team creativity when teams have less resources and less centralization of decision making. To probe the interaction, we estimated simple slopes at low and high levels (1 *SD* below and above the mean value) of resources for creativity and centralization, respectively. Results show that the relation between creative role differentiation and team creativity was positive and significant only when both resources for creativity and centralization were low ($B = 1.97$, $SE = 0.89$; $p = .03$). Hypothesis 3 therefore was supported. By comparison, creative role differentiation was not related to team creativity in teams with low centralization and high resources ($B = -0.92$, $SE = 1.08$; $p > .05$). Also, when centralization was high, creative role differentiation was not related to team creativity at low level of resources for creativity ($B = 0.44$, $SE = 0.68$; $p > .05$), nor at high level of resources ($B = 1.40$, $SE = 0.82$; $p > .05$). Figure 3.2 plots the simple slopes.

TABLE 3.2
Regression Coefficient for Models on Team Creativity ^a

	Model 1	Model 2	Model 3	Model 4
<i>Control variables</i>				
Team size	0.00	−0.01	−0.01	−0.01
Problem construction	−0.12	−0.34	−0.35	−0.24
Information searching and encoding	−0.01	0.10	0.07	−0.06
Idea generation	0.22	0.21	0.20	0.20
Creative requirement	0.40 [†]	0.34 [†]	0.33 [†]	0.31
Variance in creative process engagement	−0.07	0.39	0.46	0.41
<i>Main effects</i>				
Creative role differentiation		0.87* (0.76*)	0.79 [†] (0.66)	0.73 [†] (0.58 [†])
Resources for creativity		−0.06 (−0.01)	−0.03 (0.04)	−0.04 (0.03)
Centralization		−0.16 (−0.13)	−0.18 (−0.16)	−0.22 [†] (−0.21 [†])
<i>Two-way interactions</i>				
Creative role differentiation × Resources for creativity			−0.38 (−0.52)	−0.95 (−1.11)
Creative role differentiation × Centralization			0.00 (0.20)	0.28 (0.48)
Creative resources for creativity × Centralization			−0.14 (−0.21)	−0.27 (−0.34 [†])
<i>Three-way interaction</i>				
Creative role differentiation × Resources for creativity × Centralization				2.68* (2.89*)
<i>R</i>²	0.09	0.16 (0.10)	0.19 (0.12)	0.25 0.18
<i>F</i>	1.04	1.51 (2.48)	1.15 (1.46)	1.40 2.00 [†]

^a Regression coefficient for models without covariates in parentheses.

Note: $n = 70$ (listwise deletion), three leaders did not report team centralization.

** $p < .01$, * $p < .05$, [†] $p < .10$.

FIGURE 3.2

Interaction of Creative Role Differentiation, Resources for Creativity (RFC), and Centralization on Team Creativity

Explorative Analysis of Team Size

The sampled teams in our study have a wide range of team sizes (range from 3 to 28 members). We controlled for team size due to its potential influence on the focal variables. Notably, however, team size was significantly correlated with creative role differentiation ($r = .38, p < .01$; see Table 3.1), suggesting that creative processes were more likely to be performed by different members in larger teams. Indeed, in larger teams it may be more likely that members differ in expertise or preference, and that creative role differentiation emerges. We therefore performed two additional analyses.

First, we examined whether effects were robust when extreme-size teams were not considered. Following Tukey's method which uses the interquartile (IQR) range approach,

we identified seven teams as outliers with their team sizes larger than 21. We removed those teams and tested the proposed hypotheses following the same procedures as in the previous analysis. Results showed that creative role differentiation was positively related to team creativity ($B = 1.03$, $F(9, 53) = 1.53$; $p = .03$, $R^2 = 0.21$, $\Delta R^2 = 0.10$). The interaction between creative role differentiation and resources for creativity was not significant ($B = -0.45$, $F(12, 50) = 1.14$; $p > .05$, $R^2 = 0.22$, $\Delta R^2 = 0.01$). However, resources and centralization jointly moderated the relation between creative role differentiation and team creativity to a marginally significant level ($B = 2.49$, $p = .07$, $R^2 = 0.26$, $\Delta R^2 = 0.04$). Simple slope analysis revealed that the relation between creative role differentiation and team creativity was significant only when resources were scarce and when centralization was low ($B = 2.21$, $F(13, 49) = 1.32$; $p = .03$), but was insignificant when resources and centralizations were at other levels ($-0.63 < B < 1.47$, all $p > .10$). These results of main effects and simple slope tests are similar to those from the main analysis (Table 3.2).

Second, team size might also influence the extent to which teams benefit from creative role differentiation (when resources are insufficient). To explore whether the proposed relation between creative role differentiation and resources differs across team sizes, we additionally tested the interactive effect of creative role differentiation by resources by team size on team creativity via hierarchical regression analysis. We conducted this regression analysis following similar procedures as described in the main analysis. Results revealed that role differentiation exerted a significant main effect on team creativity ($B = 0.91$, $F(12, 60) = 1.01$; $p = .01$), but the three-way interaction term was nonsignificant ($B = -0.24$, $p > .05$, $R^2 = .17$). These findings showed no support for the interplay between creative role differentiation and team size.

STUDY 2: METHODS

Study 1 provided support for the hypothesis that creative role differentiation is positively related to team creativity, and that this relationship was moderated by resource scarcity and team centralization. In spite of these findings, Study 1 left unclear how creative role differentiation emerges, is coordinated, and maintained during creative activities. To gain more insight into this phenomenon and reveal the inner workings of the black box of role differentiation in creative work, we conducted a follow-up qualitative study on why role differentiation occurred in teams, and how team members coordinated their participation in creative activities. Answers to those questions would not only enrich our understanding of creative role differentiation, but could also provide additional evidence or shed more light on the role of resource scarcity and centralization of decision making.

To this end, we conducted a qualitative study with open-ended questions among a subset of participating companies. The qualitative study was done about two years after Study 1 was administrated (December 2020). We approached 24 teams from 8 of the sampled organizations from the industrial sectors of consultancy and research, construction, information and communication, agriculture, forestry, fishery, and real state. These teams were selected for their variation on the main measures from the survey study (i.e., creative role differentiation, centralization, resources for creativity, team creativity).⁴ We received complete responses from 10 team leaders and 7 team members from 17 teams. The average

⁴ This sampling strategy is to increase the chance of finding variety of teams' role differentiation. However, given the time lag between Study 1 and Study 2, and the fact the COVID-19 pandemic has also had a large impact on working life, stability in the values on these central variables cannot be assumed.

team tenure was 7.12 years ($SD. = 4.98$), and two were female. Participants received the link to the qualitative study via email and filled out the study online.

The procedure was as follows. Respondents first read the definition and description of three creative activities: problem construction, information search and encoding, and idea generation, consistent with our survey measure of role differentiation. We then introduced three patterns of team members' participation in creative activities based on the three patterns shown in Figure 3.1: the specialized (people have differentiated roles across those three activities), core-peripheral (one core member tends to perform all three activities), and equal pattern (every team member invests an equal amount of effort and time in all three creative activities). Respondents indicated which role differentiation pattern (specialized, core-peripheral, or equal) more closely described their teams, and were asked to describe the pattern in detail and with concrete examples. Following that, we presented three questions central to our research interest: 1) Why do you think such a pattern occurred in your team; 2) How do you think such a pattern contributed to your team creative performance; and 3) How did people in your team coordinate those creative activities. In the final step, participants answered a few questions regarding their demographic information. We encouraged respondents to write down concrete details as much as possible, and provided monetary compensation of 10 Euro per complete response.

STUDY 2: RESULTS

Researchers first checked whether the patterns that respondents indicated matched their follow-up descriptions, and whether they described activities that are related to creative processes. Out of the 17 responses, three were removed from our analysis, because they failed to describe creative activities. The others provided valid responses, and of the remaining fifteen respondents, nine indicated that their teams had a specialized pattern of member participation.

With respect to the inner working of creative role differentiation, three main observations stand out: (1) creative role differentiation often is related to team functional diversity; (2) creative role differentiation is also shaped by teams' (formal) procedures to perform tasks; and (3) teams differ in their centralization of decision-making when assigning different roles to team members. In addition, we observed that creative role differentiation was proposed to benefit team creativity in terms of efficiently using resources, capitalizing on diverse perspectives, and allowing members to learn from their experience. Quotations of evidence are summarized in Table 3.3.

TABLE 3.3

Summary of Qualitative Data for Creative Role differentiation (Study 2)

Topics	Quotations of evidence	
<p>A</p> <p>Role differentiation based on individual differences</p>	<p>“Setting up systems is a specialty that I do not have myself, but my colleague does. I myself have a broader view of the organization, which my colleague does not have.” (respondent #2; project application coordinator)</p>	
	<p>“The pattern within our current team is composed on the basis of expertise and talent.” (respondent #9; marketing and communication coordinator)</p>	
	<p>“The team consists of people with different expertise but also different personalities who each look at things in their own way and cause interaction with each other.” (respondent #10; regional manager)</p>	
<p>B</p> <p>Role differentiation derived from (formalized) task routines</p>	Fixed formalization	Flexible formalization
	<p>“I am more of the creative leader [to] generate ideas. My creative ideas are then tested for feasibility. Then the others also bring in ideas or [cleverness]. Their proposals are discussed and refined. Then the juniors get to work on it. [We coordinate through] weekly reconciliation, in type of projects” (respondent #18; developer, project manager)</p>	<p>“Often this differentiation arises naturally from the ‘problem’ or from the quality of the person(s).” (respondent #6, project logistic manager)</p>
	<p>“...The sales engineer...translates wishes and needs into engineering. This is preceded by the consultation within our team regarding the commercial feasibility of an idea.” (respondent #8; sales manager)</p>	<p>“Teams that I manage usually have direct contact with our customers. A solution is then devised. Usually by the person who received the question.” (respondent #3, customer consultant)</p> <p>When submitting a problem, a problem owner is often appointed... under the motto, ‘nice case will you pick it up?’ [Then] 1 or 2 colleagues are often added... for solving and providing feedback. (respondent #16, team member)</p>
<p>C</p>	High centralization	Low centralization
	<p>“Often these people are asked by the manager to find out [to perform] certain things. In general,</p>	<p>“[Our team coordinates by] mirror[ing] ideas from each person to other colleagues.”</p>

Decision making on the coordination of activities	<p>the manager divides the creative processes among those who have previously been involved in the design of the product concerned.” (respondent #4; engineering team leader)</p> <p>(respondent #12; planning manager) “If the ‘problem’ is structured into a clear problem annex objective, the team then filters out the do’s and who is going to deal with what.” (respondent #6, project logistic manager)</p>
D Implications for team creativity	<p>Diverse perspectives “By discussing a complex problem in the group, you get different perspectives and we usually arrive at a good solution.” (respondent #4; engineering team leader) “In this way the team reinforces the primary idea towards a broader innovation or creative solution.” (respondent #18; developer, project manager)</p>
	<p>Efficiency in resource using and communication “I think this is with the intention of efficiency. This is to avoid a large group discussion where there is a lot of ‘wandering’.” (respondent #16; regional team member) “By nature, I am a person who does a lot of work by wanting to do it quickly. That does not benefit creativity. I find it helpful for creativity not to make decisions right away. “This (role differentiation) means there is more time to think and a team member regularly comes up with better solutions to a problem. (respondent #3; customer consultant)</p>
	<p>Creative experience learning In addition to the individual goal, it also ensures that the common output of the team is achieved. In addition, there is growth and development of colleagues in the positions.” (respondent #12; planning manager) The aim is to give each other the space to get creative. (respondent #18; developer, project manager)</p>

Inner working of creative role differentiation

First, we observed that the differentiation of creative roles is closely related to team diversity in knowledge, skills, and expertise. When describing the (specialized) pattern, most respondents acknowledged that differences in members' expertise or skills serve as an important ground for teams to differentiate roles. Thus, a specialized role may be assigned in accordance with someone's expertise in certain techniques, the experience that has accumulated from previous work, or the personality/trait that brings advantages in some activities. For example, a marketing coordinator reported that the (specialized) pattern "within our current team is composed on the basis of expertise and talent". A regional manager described that the team consists of people with diverse expertise and personalities, who take different perspectives to look at things (see Table 3.3, topic A, respondent #9 and #10). This relates to our argumentation that creative role differentiation may arise from individuals' difference in skills, knowledge, or cognitive styles.

Second, we observed that creative role differentiation can emerge out of teams' (formal) procedures for performing a task. We noted earlier that creative role differentiation does not necessarily overlap with the division of tasks, but in some teams, the distribution of tasks contributes to creative role differentiation. For example, a sales manager from a commercial and marketing team described a typical specialized pattern where creative roles are differentiated on the basis of members' job obligations. Idea generation, elaboration, evaluation and implementation are performed by separate set of individuals: Branch representative propose new ideas, whereas other team members assess and elaborate the feasibility of ideas. Plans then go to the marketing specialists who make decisions on idea implementation. In this case, the division of individuals' functional roles also suggests the differentiation of creative roles. In addition, we observed that this pattern usually represents stable routines, and that an individual will often engage in the same creative activities. As the

example in Table 3.3 (topic B, respondent #18) revealed, sometimes leaders or senior members dominate idea generation, whereas junior members tend to contribute to the elaboration and implementation of ideas.

By contrast, some responses indicated that teams differentiate creative roles via more flexible routines, depending on the tasks or issues that the teams encounter. One manager explained that creativity is often required to solve problems from customers, and that this determines the actions of team members in the creative process. Roles are appointed based on the fit between members' expertise or experience and the nature of the problem. For example, one respondent offered, "When submitting a problem, a problem owner is often appointed. This is often the contributor, under the motto, 'nice case, will you pick it up?'". At the initiative of the problem owner, other colleagues are then made responsible for providing suggestions and feedback (see Table 3.3, topic B, respondent #16). This suggests a flexible formation of role differentiation in generating, elaborating and executing solutions. Creative role differentiation in those cases does not emerge from fixed task divisions, but is flexible and adaptive to solve certain problems.

Third, we observed that teams' decision making about role specialization (who is doing what) can be more or less centralized, which resonates with our findings from Study 1. Some teams apply a more centralized decision-making structure, where leaders or senior employees often determine the distribution of creative activities, whereas others seek consultation from them. For example, one engineer described that problems are constructed and explored by the manager together with employees who have experience in designing products, and that solutions are then passed on to other members for further elaboration (see Table 3.3, topic C, respondent #4). These solutions are then further developed by people with the role of "inventor". Role differentiation in other teams is coordinated in a more decentralized manner, based on members' shared understanding or collective discussion. For

example, a production/logistic team chooses to “filter out the do’s and who is going to deal with what” during group discussion (see Table 3.3, topic C, respondent #6). Decisions can be made without the presence of leaders via meetings jointly conducted by members, such as “weekly reconciliation”, “group weekly meeting”, or by means of “a content calendar”. One respondent offered, “by means of a project schedule, I [...] discuss the problems and progress with my colleagues every week”. Those observations suggested that teams relied on more or less centralized structures to manage and make decisions during creative role differentiation.

Implications for team creativity

In addition to the development of creative role differentiation, we also observed three implications for team creative performance: efficiency, diverse perspectives, and creative experience (i.e., learning). As suggested in some responses, a specialized structure was believed to bring efficiency in communication and avoids long group discussion (see Table 3.3, topic D, respondent #16). Other respondents acknowledged that creativity requires time resources, and that role differentiation would mitigate the rush to make decisions by saving time, energy, and costs for teams (see Table 3.3, topic D, respondent #3). Their perspectives on creative role differentiation align with our theorizing about the efficiency of role differentiation in terms of resources use.

Also, the specialized pattern improves the effective use of members’ expertise. Ideas are elaborated and improved as members perform different creative processes, which increases the generation of more diverse ideas and solutions, as well as the creativity of the final output. A senior project manager described how roles are differentiated in the team when designing an interactive website, “my creative ideas are then tested for feasibility. Then the others also bring in ideas or cleverness. In this way the team reinforces the primary idea towards a broader innovation or creative solution” (see Table 3, topic B and D, respondent #18).

Some respondents found that role differentiation helps employees in “gaining creativity experience in their positions” (see Table 3.3, topic D, respondent #18).

Respondents whose teams adopt equal patterns (low levels of role differentiation) also emphasized the benefit of gaining experience in creativity. However, this referred to more general experience across different creative tasks, instead of developing skills in depth within a certain process. For example, one team leader explained that “Participation provides insight and involvement. Team members can play a greater role in new creative activities because they have gained experience” (see Table 3.3, topic D, respondent #12).

GENERAL DISCUSSION

In the team composition and team creativity literature, researchers have considered differences in individual members’ contributions in various ways. For instance, researchers have examined team creativity as a function of the creativity of the most capable person (Taggar, 2002), the relative contribution of core and peripheral members (Humphrey et al., 2009; Summers et al., 2012), the variance across individual inputs (Schilpzand, Herold, & Shalley, 2011), and the blend of members with different cognitive styles (Baer, Oldham, Jacobsohn, & Hollingshead, 2008; Basadur & Head, 2001). Based on the notion that creativity involves distinct but interrelated activities, we introduced a different way to look at relative member contributions, and proposed that members can specialize in specific creative activities. We further proposed that such creative role specialization will benefit team creativity especially when resources are scarce and decision-making structures are decentralized.

In the first, quantitative study, we found that creative role differentiation benefits team creativity. Furthermore, we found that role differentiation was beneficial especially when resources for creativity were scarce, but this interaction only occurred when teams had decentralized decision-making structures. Reaping the benefits of creative role differentiation

under resource scarcity thus requires that teams have a decentralized decision-making structure. These effects did not depend on the inclusion or exclusion of large teams in our data. Although team sizes differed markedly in our sample (between 3 and 28 members), our results were robust for the exclusion of large teams.

The follow-up qualitative study further supported our conceptualization of creative role differentiation in teams. We observed that teams differentiated creative roles to utilize members' diverse skills and expertise, but that such differentiation can also derive from team task-performing procedures, either formalized by team routines, or flexibly determined depending on the specific task or circumstances. In addition, and consistent with our propositions, teams may adopt decentralized or centralized ways of decision making on how to coordinate creative activities. Furthermore, our qualitative observations were generally consistent with our core perspective, that creative role differentiation benefits creativity in terms of diverse perspectives and efficiency in communication and use of resources.

Beyond the above, there were a few observations from Study 2 that offer complementary new insights. First, we conceptualized role differentiation on the basis of team member (i.e., subordinate) participation, but the qualitative study revealed that team leaders in some cases play an important role in creative activities (e.g., generating ideas and solutions for members to implement). Second, based on the creative problem-solving approach, in our quantitative study we focused on creative role differentiation with regard to "early-stage" creative activities, such as problem construction, information search, and idea generation. In the qualitative follow-up, many teams emphasized the assessment of ideas (feasibility) and elaboration as important creative activities, as well as role specialization in those "later-stage" creative activities. Thus, creative processes can be composed of different activities, depending on tasks or job requirement of teams, and are not limited to what we explored in Study 1. Third, a new observation in Study 2 was that several respondents

emphasized learning and gaining experience with a particular activity. Indeed, depending on the level of role differentiation, participation in creative activities may lead either to learning a broad set of creative skills, or learning some skills in greater depth.

Theoretical Implications

Our paper sheds new light on team functioning and creativity in several ways. First, our paper provides an integrative view of multiple creative processes in team creativity. The idea that different creative activities co-exist and are interdependent in the team creative process is not new (Harvey, 2013), but research on team creative processes has often examined relevant activities in a scattered and disconnected manner (Gilson & Shalley, 2004). A more integrative view is important, because factors that foster one creative activity may hinder other activities. For example, idea generation often requires divergent thinking, which may impair team cohesion and consensus, whereas converging ideas are more likely to stimulate cohesion (Harvey, 2013). Creative role differentiation may be one way to reconcile the competing demands of different creative processes, and this construct may therefore help create a more integrative understanding of how teams can effectively move through the different stages of the creative process.

Second, our theory of creative role differentiation contributes to team composition research more generally. Recent research has highlighted that “a higher-level phenomenon is a complex combination of diverse lower-level contributions” and that lower-level entities ought to be weighted differently (Kozlowski & Klein, 2000). Our paper introduces this insight into the team creativity literature, and particularly addresses the question of how individuals’ creative efforts can be aggregated and affect team creativity. Our approach based on creative role differentiation goes beyond the consideration of core versus peripheral members, and beyond the notion of diversity in a single (creative) process (cf. Humphrey et

al., 2009; Van Knippenberg & Mell, 2016), because it simultaneously considers differences across members and differences across specific activities.

Third, our paper advances our understanding of team creativity by revealing that the benefits of specialized participation are contingent on resource scarcity and the centralization of decision making. Despite that many researchers have emphasized the importance of resources for conducting creative activities (e.g., Weiss et al., 2017), few studies have actually examined the question of how to improve the efficient utilization of creative resources. Our paper provides an “efficiency” argument to understand how resources and members’ creative inputs can be efficiently utilized through creative role differentiation, which offers a new perspective on team creativity.

Fourth, our paper also contributes to team creativity research by introducing team decision making structure as a boundary condition. Theories have noted that the authority to make decisions influences information exchange and communication within teams (Aiken & Hage, 1966). However, less is known regarding the contextual effect of team centralization on team creativity. Our paper empirically tested and found that decentralized decision-making acts as a boundary condition to reap the benefit of creative role differentiation under resource scarcity. This may inspire future research to further consider the relationship between team centralization and team creativity.

Practical Implications

This paper has practical implications for team management in organizations. We found that team creativity benefits from creative role differentiation particularly when teams have fewer resources for creativity and a decentralized decision-making structure. The dynamic and competitive work environment often challenges teams to be creative with limited resources. Managers can assist teams to develop differentiated roles when it is difficult to provide enough resources for creativity tasks. More specifically, this paper

measured three important creative processes: problem construction, information search and encoding, and idea generation. Managers may consider encouraging team members to undertake roles that they excel at. Furthermore, some autonomy in decision making was a necessary condition to reap the benefits of creative role differentiation when resources were scarce. Managers are thus advised to take both resource scarcity and decision-making structures into account in their efforts to create creative teams.

Limitations and Future Research Directions

The present study is subject to a number of limitations and suggests several future research directions. First, we used a cross-sectional research design in Study 1, which does not allow us to draw causal conclusions. Future research should adopt a longitudinal or experimental design to detect the causal effects of creative role differentiation, resources for creativity, and centralization on team creativity.

Second, we defined creative role differentiation based on members' engagement (i.e., effort) in creative activities. Core members were individuals who devoted the most effort, but this does not necessarily align with the distribution of power or perceived influence of members. For example, it is possible that one member is influential in a certain activity, even though this member does not spend the most effort on that activity. For future research it may be interesting to disentangle creative role differentiation based on effort versus on influence, and see whether these have similar effects.

Third, we examined problem construction, information searching, and solution generation as three important creative activities in Study 1. Because teams constantly encounter problems that require creative solutions, this measure applies to a wide type of organizations (Reiter-Palmon & Illies, 2004). However, various work situations can necessitate different creative activities. The idea of creative role differentiation can also manifest in other ways, such as differentiation based on convergent vs divergent activities

(Harvey, 2013), or on different sequences of creative activities (Goh et al., 2013). Like respondents stated in Study 2, role differentiation can also emerge in other activities, such as idea evaluation and idea elaboration, and the implementation of ideas. Study 2 therefore implies that our approach can be more widely applied to different creative processes. Future research may extend this theory of creative role differentiation to other circumstances highlighting different creative processes.

Lastly, we focused on general resources for creativity, but did not specify the types of resources. Individuals who specialize in different creative activities may have different sensitivities to different resource constraints (Scopelliti, Cillo, Busacca, & Mazursky, 2014). For example, a team member who generates ideas is perhaps less influenced by financial constraints than one who implements ideas, whereas time resources may be of the essence for both. Thus, a resource regarded as inadequate by a team member performing one role is likely to be seen as ample by someone performing another role. Focusing on one specific type of resource scarcity might therefore be problematic, because it may reduce the agreement among team members' perception of adequacy, and may obscure differences among different roles. Although our approach to focus on general (unspecified) resources partly solves this problem, future work may also examine the idea that different roles require different types of resources, and that teams are more creative when the right type of resource is distributed to the right person.

CONCLUSIONS

Taking a novel approach to team creative processes, this paper examined whether creative role differentiation (i.e., different members performing different creative activities) would stimulate team creativity. Based on a combination of quantitative and qualitative survey research, the results clearly suggest that creative role differentiation can be beneficial for team creativity, under the right conditions. In particular, creative role differentiation

stimulates creativity when resources are scarce but teams have sufficient discretion to make their own decisions on the allocation of these scarce resources. As such, the present research provides a novel avenue to study specialized creative inputs of team members and underlines the importance of considering the configuration of member inputs in the team creative processes in the team creativity research.

Chapter 4: Exploiting Team Cognitive Diversity in Challenging Situations: The Role of Creative Role Differentiation and Transactive Memory System

Occasionally, teams face the challenge of performing complex tasks or handling complex and non-routine problems under (severe) time constraints (Sheremata, 2000). This is the case in emergency situations, such as the emergency situation of Apollo 13 in 1970, in which the ground crew had limited time to fix various problems that had been caused by an exploding oxygen tank in the spacecraft (Amabile, Hadley, & Kramer, 2002). Emergency situations and other acute problems are demanding, because they can involve high stakes and high pressure, but at the same time require non-routine, creative problem solving (Reiter-Palmon et al., 2008). Moreover, apart from emergencies, teams often work under tight deadlines and time pressure, which may affect their ability to handle non-routine problems (Amabile et al., 1996; Driskell et al., 2018). Because non-routine problem solving can be both important and difficult under high pressure, we aim to shed more light on the processes that allow teams to perform well under challenging conditions. Specifically, we examine team performance in a sample of teams in a two-day, high time-pressure, high-profile artificial intelligence (AI) and blockchain hackathon event.

Performing complex and non-routine tasks often requires diverse cognitive resources; and teams with diverse expertise, knowledge, and perspectives may therefore outperform homogeneous teams (Cox & Blake, 1991; Joshi & Jackson, 2003; Milliken & Martins, 1996; Peters & Karren, 2009). From an information processing perspective, such cognitive diversity benefits team performance such as problem-solving and team creativity, by promoting the exchange and elaboration of task-relevant perspectives (Mello & Rentsch, 2015; Van Dijk, Van Engen, & Van Knippenberg, 2012; Van Knippenberg, De Dreu, & Homan, 2004). However, exploiting the benefits of cognitive diversity is challenging in high-pressure situations. Teams facing time pressure tend to engage less in creative thinking and

information elaboration, but focus more on finishing tasks quickly and often rely on familiar task approaches (Andrews & Smith, 1996; Baer & Oldham, 2006; Sitkin et al., 2011). Widely varying perspectives also make it difficult and time-consuming to reach a shared understanding or agreement of tasks (Mello & Rentsch, 2015; Milliken & Martins, 1996; C. Staw & Nemeth, 1989). Thus, whereas performing non-routine tasks requires the use of diverse resources, benefiting from diverse resources is difficult when working in a high time pressure environment.

To understand *how* and *when* diverse teams may still perform well and solve non-routine problems under severe time constraints, it is important to acknowledge that performing complex and non-routine tasks is not a singular activity. Teams that perform these tasks have to engage in different processes (or activities), such as problem construction, idea generation, and idea elaboration (e.g., DeChurch & Mesmer-Magnus, 2010; Perry-Smith & Mannucci, 2017; Reiter-Palmon & Illies, 2004). Most diversity scholars have (implicitly) assumed that all team members participate to the same extent in different processes, but recent literature suggests that individual members may differ in their relative contribution to different activities (Aime et al., 2014; Crawford & LePine, 2013; Humphrey & Aime, 2014; Van Knippenberg & Mell, 2016). For example, studies of cognitive styles suggested that members may perform those activities that they are good at (Miron-Spektor et al., 2011), and may have specific preferences for different aspects of tasks (Puccio, 1999). We suggest that diverse teams under time pressure may benefit from *specialization* in information processing, moving beyond the traditional notion of collective information processing.

In particular, we develop the concept of *role differentiation* and define it as members' specialization of their engagement both within and across different taskwork processes. This new concept captures the *distribution* of members' participation, rather than focusing solely on the general level (e.g., the average extent) of taskwork processes (e.g., collective

information elaboration). Integrating insights from the Categorization-Elaboration Model of team diversity (Van Knippenberg et al., 2004; van Knippenberg & van Ginkel, 2010) and the team shared cognition literature (DeChurch & Mesmer-Magnus, 2010; Liang et al., 1995), we propose that cognitive diversity in teams that work under high pressure is likely to lead to role differentiation in an attempt of the team to effectively manage time and expertise. In addition, role differentiation may have advantages over uniform increases in levels of different processes (Crawford & LePine, 2013), because it allows for more efficient use of members' inputs when working under time pressure. We therefore predict that role differentiation will be positively related to team performance in a high-pressure context.

The advantage of role differentiation, in essence, is that members specialize in what they are good at. The implication is that role differentiation can only be effective when team members have insight into one another's skills and expertise. This links with research on transactive memory systems (TMS, Wegner, 1986), which suggests that teams can better communicate and divide their labor in team processes when there is a shared understanding of "who knows (and is good at) what". On the one hand, such metaknowledge in the form of a highly developed TMS stimulates the development of role differentiation, because it is more readily recognized who should perform what activity. On the other hand, it will also make role differentiation more effective, because tasks are more likely performed by those team members who are good at it. We therefore propose that the degree to which teams have a well-developed TMS will moderate both the relation between team diversity and role differentiation, and the relation between role differentiation and performance (see Figure 4.1 for the conceptual model). These hypotheses are tested in a two-day high profile and high-pressure artificial intelligence and blockchain hackathon event.

FIGURE 4.1

Conceptual Model

THEORY AND HYPOTHESES

Leveraging Cognitive Diversity under Time Constraints

Cognitive diversity is defined as differences in thinking styles, beliefs, knowledge, and perspectives among team members (Mello & Rentsch, 2015; Shin, Kim, Lee, & Bian, 2012). Specifically, the present paper is concerned with the variation in different types of skills and expertise that team members possess (Dahlin, Weingart, & Hinds, 2005; Martins, Schilpzand, Kirkman, Ivanaj, & Ivanaj, 2013; Sauer, Felsing, Franke, & Rüttinger, 2006). Those cognitive resources may involve various expertise fields or task domains, and are particularly relevant for non-routine performance in complex and highly demanding task environments (Milliken & Martins, 1996).

To solve non-routine and complex problems, and to generate and implement innovative solutions, various scholars have argued that teams need to engage in different activities. From an information processing perspective, scholars have examined different processes or activities regarding how teams utilize members' cognitive resources (e.g., DeChurch & Mesmer-Magnus, 2010). For example, some scholars have examined problem-solving processes such as problem construction, information search and encoding, and the generation of solutions (e.g., Reiter-Palmon & Illies, 2004), whereas others have examined the “idea journey” consisting of idea generation, idea evaluation and elaboration, and idea

implementation (e.g., Perry-Smith & Mannucci, 2017). Those taskwork processes, referred to as members' interdependent acts that "convert inputs to outcomes through cognitive, verbal, and behavioral activities" (Marks et al., 2001, p. 357), are necessary to achieve high team performance.

The information processing perspective of team functioning views cognitive diversity as a source of different knowledge, insights, and expertise that leads to the generation of creative ideas or solutions to problems, and to high-quality decision making (Mello & Rentsch, 2015). The Categorization-Elaboration Model (CEM) of team diversity in particular suggests that an important process underlying this benefit is information elaboration: the exchange, discussion, and integration of knowledge and perspectives (Van Knippenberg et al., 2004; van Knippenberg & van Ginkel, 2010). Literature on team shared cognition also suggests that performing non-routine and complex tasks requires collective mental processes that involve not only divergent thinking, but also the convergence of different members' effort (Hinsz, Tindale, & Vollrath, 1997). Teams with high cognitive diversity attend to a wider range of knowledge and analyze information in greater depth than more homogeneous teams, which increases the quality of information use (Dahlin et al., 2005). Subsequently, this will lead to higher team performance, especially when working on complex and non-routine tasks.

Team diversity research has mostly focused on team-level processes in which all members indiscriminately engage and play the same role, such as (collective) information sharing and information elaboration (Crawford & LePine, 2013; Kozlowski & Klein, 2000; Van Knippenberg & Mell, 2016). However, organizational teams often work under time constraints that are laden with tight schedules and deadlines, or have to deal with emergency situations. Teams that face a complex task environment under high time pressure may find it difficult to leverage cognitive diversity. Time pressure demands members to take immediate

action, and teams tend to engage in less in-depth and more heuristic information processing: members are less interested in divergent thinking (e.g., idea generation), and less thoroughly or systematically engage in information elaboration (Kruglanski & Webster, 1991). Instead, they rely on existing routines and old ways of thinking, and seek to complete tasks quickly (Andrews & Smith, 1996; Baer & Oldham, 2006; Kelly & McGrath, 1985; Sitkin et al., 2011). Furthermore, experts may not view problems from the perspectives of others (Dane, 2010), and diverse expertise in teams makes it harder to reach a shared understanding of tasks due to social categorization processes that are aggravated when teams have limited time (Van Knippenberg et al., 2004). Because under challenging conditions teams have limited time to engage in thorough communication and information processing with every single member, the indiscriminate elaboration of information among all members would likely be inefficient and ineffective.

Cognitive Diversity and Role Differentiation under Time Constraints

We propose that, rather than increasing their overall level of information elaboration, diverse teams in high time-pressure situations may engage in *role differentiation*. As discussed above, individuals may not only differ in their cognitive resources as inputs for activities, but may also differ in their participation in different processes or activities. We conceptualize this approach as role differentiation (or role specialization) and define it as the extent to which team members specialize in different taskwork activities. Role differentiation, as a structural strategy to leverage cognitive resources under high time pressure, reflects the extent to which members hold differentiated, specialized engagement structures during taskwork activities. Low role differentiation implies that members provide similar inputs within and across activities, whereas high role differentiation implies that members specialize in (i.e., participate more as compared to other members) a certain activity, and participation also differs across activities. For example, one member may be involved more in defining

problems, yet another might exert more effort in exploration and searching for relevant information to solve problems. Role differentiation thus does not only refer to the diversity of members' participation within one activity, but to the differentiated structure both within and across different activities.

The notion that individuals may differ in their participation in different taskwork processes has received more attention in recent years. Team composition research has underscored individual differences in engagement in different processes and activities (Aime et al., 2014; Crawford & LePine, 2013; Humphrey & Aime, 2014; Humphrey et al., 2009; Mathieu et al., 2014). Some empirical studies also suggested that team members may differ in their preferences for certain activities (Kirton, 1976; Miron-Spektor et al., 2011; Puccio, 1999). Furthermore, high-pressure task environments (e.g., time constraints) also demand flexibility in the team's role structure, such that team members may specialize in some processes but not in others (Driskell et al., 2018). Such specialization is suggested to potentially benefit team performance such as creativity and innovation (Berg, 2016; Miron-Spektor et al., 2011). This implies that team members may specialize in different taskwork activities, especially in high time-pressure conditions, rather than increasing the overall level of information processing in the team (Crawford & LePine, 2013).

When teams are under time pressure, role differentiation is likely to derive from team members' diverse expertise (i.e., domain-specific specialty or skills; (Dane, 2010); (see also Basadur & Head, 2001; Berg, 2016; Kirton, 1976; Miron-Spektor et al., 2011). Under high time pressure, individuals have limited attention, time and energy to engage in all taskwork processes. Members' self-identified expertise may serve as a heuristic cue to differentiate into specialized roles, which allows them to engage in more detailed, thoughtful processing within that role. Indeed, diversity related to cognitive expertise and work experience provides "specific cues that allow for a more accurate and relevant basis of specialization" (Brandon &

Hollingshead, 2004, p. 925; Bunderson, 2003; Heavey & Simsek, 2017, p. 925). In a high-pressure context, relying on those cues can be particularly appealing, because it saves team members' time from discovering other's expertise and arranging taskwork processes (Morrison & Vancouver, 2000; Vancouver & Morrison, 1995). Thus, people who possess relevant knowledge tend to perform a particular activity more and share their opinions and information more often, whereas cognitively-peripheral members exert less influence and show less involvement (Jones & Kelly, 2013; Sargis & Larson Jr, 2002). Members who possess expertise are also more motivated to process information thoroughly rather than relying on familiar heuristics, and are more likely to exchange ideas and provide suggestions (Franz & Larson Jr, 2002; Stasser et al., 1995). Therefore, when members' knowledge is directly related to the cognitive skills needed for taskwork activities, diversity will induce high levels of role differentiation (especially in a time-restricted context).

Hypothesis 1: In high-pressure work teams, team cognitive diversity is positively related to role differentiation.

Role Differentiation and Team Performance

Research implied that specialized engagement increases the quality of taskwork activities, which potentially improves team performance (Sargis & Larson Jr, 2002; van Knippenberg & van Ginkel, 2010). We propose that in a high time pressure context, role differentiation is beneficial for team performance for two major reasons. First, teams no longer need to manage taskwork processes as collective activities that require all members' (equal) participation. This means that individuals can concentrate on activities that they excel at, and that their domain expertise is utilized more thoroughly (Crawford & LePine, 2013). Moreover, because role differentiation allows individuals to focus on a particular activity, all relevant activities are performed at a reasonable standard (Ericsson & Lehmann, 1996). Teams therefore are less likely to rush to finish tasks and deliver low-quality products under

high time pressure (Sitkin et al., 2011). Sufficient attention to all processes/activities is critical to generate superior team outcomes (Basadur & Head, 2001; Reiter-Palmon et al., 2008). If roles are not differentiated, some processes/activities may not receive enough attention, and a balanced focus on activities therefore improves the chance to generate high-quality team outcomes. Although some authors have proposed to randomly assign members to tasks to break stereotypes and increase adaptability (e.g., Harrison & Humphrey, 2010), this is difficult to achieve in a high time pressure environment, because team members are unlikely to acquire the required skills or expertise within limited time. Role differentiation in such situations may be a better way to structure different taskwork processes and enable individuals to leverage their expertise within each process.

Second, role differentiation promotes an efficient allocation of members' cognitive inputs, which will reduce redundancies and process loss in the coordination of actions (Hollenbeck et al., 2011; Humphrey et al., 2009). Expertise has to be coordinated. Team performance not only benefits from diverse expertise as input, but also from effective coordination, which implies the management of expertise to make expertise accessible to the team (Faraj & Sproull, 2000). Coordination includes the arrangement of which members should perform which activities. Compared to the low differentiated structure where all members need to take time to perform multiple activities, teams with high differentiation can allocate activities mostly to "core" members who have the required expertise. Therefore, team members do not have to invest much time outside their specialization, which reduces redundancies in actions (Hollenbeck et al., 2011).

In sum, effective taskwork processes require time and attention from team members (Crawford & LePine, 2013), which is challenging in high time pressure situations. Role differentiation facilitates team members' engagement in different activities, which enables the efficient coordination and execution of work (Tröster, Mehra, & van Knippenberg, 2014).

Hypothesis 2: In high-pressure work teams, role differentiation is positively related to team performance.

The Moderating role of Transactive Memory System

Teams under high time pressure tend to engage in heuristic processing, because they feel a strong pressure to come up with a solution quickly. Cognitive diversity allows for role differentiation based on self-defined expertise, which enables teams to process different viewpoints in-depth and properly utilize members' input. For this effect to occur, the premise is that team members are aware of others' expertise. However, members' awareness of others' expertise might not always be well-developed, and role differentiation is therefore not necessarily derived from an accurate recognition of members' expertise. In a high time-pressure context, knowledge about others' expertise helps teams to determine and differentiate roles that are consistent with members' expertise, and may also contribute to high team performance. Therefore, we propose that transactive memory systems have an important role in the emergence of role differentiation and in benefiting from it.

Transactive memory systems (TMS) refer to the interpersonal awareness of others' knowledge in teams (Lewis, 2003; Liang et al., 1995). When teams have a strong TMS, team members have a clear and accurate understanding of how knowledge and expertise is distributed in the team (DeChurch & Mesmer-Magnus, 2010; Lewis, 2003). Teams that have a good understanding of the knowledge and skills available to each individual member are more likely to differentiate roles matched to members' relative expertise. Only by developing a strong TMS can team members balance each other's expertise with their own when deciding which roles to enact. As such, in teams with an accurate TMS, team members are less likely to engage in tasks they believe they are best at as compared to *other tasks*, but more likely to engage in tasks they believe they are best at as compared to *other teammates*. Therefore, teams with a more accurate TMS are more likely to differentiate all roles that are

necessary to complete a task, and are less likely to develop role redundancies. For example, if a team of engineers all believe their highest ability is in website development, without realizing no one on the team is doing financial or market analysis, team role differentiation will be lower. For this reason, studies have found that a TMS together with high levels of diversity enables the differentiation and integration of innovative behaviors (Heavey & Simsek, 2017). In a high time-pressure context, such shared understanding helps teams to differentiate roles to the right person in a short time, instead of randomly or ineffectively assigning roles to team members.

Hypothesis 3: In high-pressure work teams, team cognitive diversity is more strongly and positively related to role differentiation when the team transactive memory system is stronger.

We proposed that role differentiation benefits team performance because it enables in-depth processing of inputs within each role or process and effective coordination of task contributions. This is based on the assumption that teams are able to allocate taskwork to the right person and that they know each members' expertise. Studies have indeed shown that team performance is higher when teams specialize and allocate work to the most proficient member (Littlepage, Hollingshead, Drake, & Littlepage, 2008). Furthermore, to generate high-quality team outcomes, teams also have to communicate and exchange information across different roles (or processes). Diverse teams often have different viewpoints, and time pressure may increase coordination and communication problems, and makes it difficult to reach agreement and integrate inputs from different members. This is particularly challenging when making quick decisions is vital to performance (Bechky & Okhuysen, 2011; Hoisl, Gruber, & Conti, 2017).

To reap the benefits of role differentiation, we propose that a well-developed TMS is needed. Indeed, knowledge of who knows what has been found to positively affect

coordination (Converse, Cannon-Bowers, & Salas, 1993), as well as information elaboration (Van Ginkel & Van Knippenberg, 2009). Past research has also found that differentiation may cause conflicts, may reduce communication, or may lead to biased processing of information among members who are not familiar with others' expertise (Van Knippenberg et al., 2004; van Knippenberg & van Ginkel, 2010). The awareness of others' expertise, in this regard, may motivate teams to coordinate members' unique inputs across "role leaders" from different specialty areas (Brandon & Hollingshead, 2004; Heavey & Simsek, 2017; Stasser et al., 1995). In particular, given high time pressure, recognition of the distribution of expertise saves time and reduces coordination efforts. During periods of high time pressure, members are more likely to accept that others handle specific tasks when they are aware of others' expertise (Smith-Jentsch, Kraiger, Cannon-Bowers, & Salas, 2009). Taken together, we propose that an accurate transactive memory system helps reap the benefits of role differentiation in high time pressure contexts.

Hypothesis 4: In high-pressure work teams, role differentiation is more strongly and positively related to team performance when the team transactive memory system is stronger.

METHODS

Data Collection Overview

We examined our hypotheses in the context of a high-profile event held in April, 2019, named Odyssey Blockchain Hackathon (see <https://www.odyssey.org/>). Odyssey is a blockchain and AI hackathon in which teams (often from companies, or government institutions, corporate and non-profit organizations) create digital solutions for social issues and challenges using blockchain, AI or other advanced technology. A total of 100 teams from various countries such as the Netherlands, Israel, France and England attended this event. During the Hackathon, the 100 teams could sign up for and work on 20 different challenges, and within each challenge five teams participated. The challenges were contributed by

external parties from governments (e.g., European Union, the Dutch Ministry of the Interior, Dutch Ministry of Justice and Security) and for-profit organizations (e.g., KLM, Vattenfall, Deloitte, TVM insurances). Challenges were built under different themes, ranging from wildlife restoration to data privacy and fossil-free future to cargo insurance and inclusive banking, all requiring AI and blockchain skills to build solutions. These external parties (“challenge owners”) were present during the event to provide more clarity about the nature of the challenge and to give teams feedback on their proposed solutions. Before the actual Hackathon event, teams could prepare for the event by attending preparation meetings, in which challenge owners provided more information to participating teams. During the actual event, teams could also consult with specialists such as lawyers, communication specialists, and technical specialists.

The hackathon began on Thursday, April 11th, 2019 11:00 AM and ended on Monday, April 15th 1.10 PM. On Thursday, April 11th, teams registered for the event and participated in two rounds of masterclasses by leading experts on technology, law and entrepreneurship located at different technology companies throughout the city of Groningen. On Friday, April 12th, the coding part of the hackathon started and teams began working non-stop on their challenges from 12:00AM onwards. Coding ended after two days on Sunday, April 13th 12:00AM, after which teams presented their coding solutions to a panel of judges comprising challenge owners and experts. Team rankings were subsequently announced during an “award show”, which was followed by a closing reception.

We used a multi-source, multi-method data collection strategy. A team of 10 researchers distributed and collected paper-and-pencil surveys before and after the hackathon. A day before the coding started (on Thursday, April 11th), research assistants handed the first paper-and-pencil survey to participants at the registration desk. People brought their responses on Friday morning to the hackathon site, which were then collected by a researcher

before the coding part of the event started (i.e., on Friday, April 12th between 10:00AM-12:00AM). We used this pre-hackathon survey to measure team transactive memory systems and other information. We supplemented the pre-hackathon survey with data from the registration form in which team captains had provided information on their team members' expertise and knowledge. The second paper survey was handed to individuals right after the moment that teams finished working on Sunday. This post-hackathon survey asked questions about team activities during the Hackathon, in which we measured role differentiation. Research assistants collected completed surveys on the spot (i.e., on Sunday, April 14th, between 12:00AM and 15:00PM), before teams were informed of their final team rankings. Both the pre- and post-survey took about 10 minutes to finish. Finally, we relied on judges' rankings of teams within the different challenges for operationalizing our dependent variable (i.e., team performance).

Participants and Sample

In the end, our researchers collected data of 96 teams with 572 participants who worked on 18 challenges: 16 challenges contained five teams for each, one challenge contained six teams, and one challenge contained 10 teams in total. To gauge accurate views of role differentiation and other measures at the team level, we followed team diversity research (e.g., Eigel & Kuhnert, 1996) and selected teams using a cutoff point of 50% response rate per team (Allen et al., 2007; Maloney et al., 2010). We further excluded two outlier teams: All teams reported to have a medium-to-high level of cognitive diversity (ranging from .61 to .93), except for two teams with the diversity index of 0, which suggested that members in those teams possessed the same cognitive skills (see below for the measure of cognitive diversity). Although it was theoretically meaningful to have non-diverse teams, those two teams may function very differently from other teams, and may skew the data or the interpretation of our results. Based on this, we excluded these two teams from the

following analysis⁵. The final sample size therefore was 62 teams with 399 participants.

Among participants, 26 were female (9.7%), 230 were male (85.8%), 12 individuals reported as “other” (4.5%), and 144 did not report gender information. The average age was 32.10 years old ($SD = 9.36$) and the average tenure in the current organizations (department) was 0.66 years ($SD = 1.24$).

Measures

Team cognitive diversity. We measured cognitive diversity indicated by the diversity of members’ skills, which was computed from the registration forms. The contact person in each team (the “team captain”) provided information about the technical skills of all team members by listing for each team member whether he or she had expertise in the domains: (1) front-end development, (2) back-end development, (3) cloud computing, (4) Android mobile development, (5) IOS mobile development, (6) Software architecture, (7) Software security, (8) UI/UX design, (9) Game design, (10) Data analysis, (11) SQL databases, (12) Hyperledger (Blockchain), (13) Ethereum, (14) Bitcoin, (15) BigchainDB, and (16) Other. On this basis, we calculated each team’s skill diversity, using Bunderson (2003) version of Blau (1977) heterogeneity index:

$$1 - \sum_{i=1}^k p_i^2$$

where p_i is the percentage of a team members’ total technical skills in the i th domain and k represents the total number of domains ($k = 16$ in the present case). This resulted in an overall score for a team’s skill diversity on a scale ranging from 0 (i.e., team members’ skills were concentrated in a single domain) to a theoretical maximum of .94 (i.e., team members’ skills evenly distributed across all eleven domains).

⁵ Results of data analysis remained unchanged when including those two teams.

Transactive memory system. Participants indicated the extent to which team members were aware of others' expertise on a 5-point scale with three items (from 1 = "completely disagree" to 5 = "completely agree"), derived from Faraj and Sproull (2000). Items were 1) The team has a good "map" of each other's talents and skills; 2) Team members know what task-related skills and knowledge they each possess; and 3) Team members know who on the team has specialized skills and knowledge that is relevant to their work. The mean scores of three items were calculated (Cronbach's $\alpha = .87$). We then aggregated individual-level data to the team level by averaging team members' scores ($ICC_1 = .14$, $r_{wg} = .83$).

Role differentiation. Teams in the Hackathon event performed complex and non-routine tasks that required creative problem-solving. To capture a full range of roles and activities, we integrated insights from team problem-solving literature and team creativity literature (e.g., Perry-Smith & Mannucci, 2017; Reiter-Palmon et al., 2008; Zhang & Bartol, 2010a), and assessed the involvement of each team member in six distinct activities: problem construction, information searching & encoding, idea generation, idea selection, idea development, and idea implementation.

To measure role differentiation, it was necessary to consider the roles related to all six activities and consider all team members simultaneously. Also, we wanted to maintain participant responses on the continuous scales of their measurement, instead of crudely categorizing members based on their relative rankings of specific tasks. This allowed for the possibility that members could report occupying multiple roles and that multiple members could report occupying the same role. It also allowed for perceived differences in member preferences for specific roles to be maintained, thus providing a more stringent test of our hypotheses. Based on these three restraints, we took two steps to measure role differentiation.

First, participants indicated how much time and effort they devoted compared to others (i.e., role ratings) during the Hackathon to the following activities (from 1 = “much less than others” to 5 = “much more than others”): 1) understanding the problem/challenge; 2) Collecting information; 3) Generating ideas/potential solutions; 4) Judging and selecting ideas for inclusion in the design/prototype; 5) Further developing, refining, and combining ideas; 6) Implementing ideas in practice. Based on their responses, we conceptualized teams as matrices composed of members and their “role ratings”, who may occupy a set of specific roles, at any level, while still belonging to the overall collective. Specifically, we geometrically interpreted teams in i by j matrices where i is the number of team members and $j = 6$ corresponding to the six roles considered. The matrix structure ensured that role ratings are ordered consistently among members, so that we could compare differentiation both among roles within an individual member and among roles (activities) across members simultaneously. In this way, we naturally allowed for the possibility of the configural emergence of roles as team members may be allowed to differ among any of the six roles within a given team, and roles may differ among any team members (see Appendix 4.A for two examples of team role differentiation matrices).

Then, we considered six roles existing in an x -dimensional space where x was the number of team members, and calculated the closeness of these role vectors (i.e., role differentiation) following formula:

$$P(T) = \sum_{m=1}^{j-1} \sum_{n=i+1}^j \frac{1}{\|t_m - t_n\|}, \quad t_m = \begin{pmatrix} t_{m,1} \\ \vdots \\ t_{m,i} \end{pmatrix}, \quad T = (t_1 \quad \dots \quad t_j)$$

$$\|t_m - t_n\| = \sqrt{(t_{m,1} - t_{n,1})^2 + \dots + (t_{m,i} - t_{n-i})^2}$$

This geometrical equation is 1 over (/) all the pairwise combinations of between members' role vectors (six roles ratings) using Euclidian distance calculation. Past research has adapted the calculation of Euclidian distance commonly used to assess dissimilarity of

different sets in a number of fields (e.g., Jaccard distance to calculate team variety; see Niwattanakul, Singthongchai, Naenudorn, & Wanapu, 2013). In our paper, we adapted this calculation to assess the closeness of the distribution of members' participation within and across six activities. Here, T represents the team and t_m represents the vector containing the m^{th} member's role ratings, $t_{m,k}$ represents the m^{th} role's rating for the k^{th} team member⁶. As such, roles on a given team that were reported as closer together produced a higher value and indicated less role differentiation across the team. Alternatively, roles that appeared farther apart, or were more differentiated within a given team, produced lower values. In this way, the highest values would be produced by teams whose members' role preferences covary in the same direction, e.g., all members saw problem construction as their primary role (albeit at different levels), idea generation as their secondary role, idea selection as their tertiary role, and so on. The lowest values would be produced by teams containing members who each perceived a unique primary role, i.e., each member sees themselves as primarily responsible for one of the six task roles, as well as perceiving unique secondary roles, unique tertiary roles, and so on. For interpretation purpose, we recoded the role differentiation score by timing $P(T)$ with -1 , thus larger scores indicated higher level of role differentiation.

Team performance. After the teams finished working on their challenge solutions, juries consisting of three people (one of whom was the challenge owner) evaluated the team coding solutions on four dimensions: (1) quality of prototype, (2) impact, (3) ecosystem contribution, and (4) 100-day acceleration (implementation) plan using a 6-point rating scale (ranging from 0 to 5 points). The “quality of prototype” dimension captured the viability, technical sophistication, and compatibility of the coding solution. The “impact” dimension captured the potential usability of teams' coding solutions for individual users and society in

⁶ In our data set, no teammates within a team had identical ratings across six roles, i.e., $t_m = t_n$, thus the denominator $\|t_m - t_n\|$ would not be undefined.

general, as well as the innovativeness of solutions. The “ecosystem contribution” captured the degree to which teams had assisted other teams during the hackathon, made their code publicly available (open source), and the extent to which the code solutions could be used by third parties and fuel future innovation. Finally, the “acceleration plan” dimension captured the quality of teams’ implementation plans and the commitment of relevant stakeholders for the solutions. There was a separate jury for each of the 18 challenges. Teams presented their solutions to the jury and provided the juries with the actual code of their solutions. After individually rating the teams using the aforementioned evaluation scheme, judges discussed their evaluations and made a final, joint ranking of the teams within their challenge. This ranking constituted our dependent variable (i.e., team performance⁷).

Control measures. We measured team size (number of team members) as a covariate to control its potential influence on role differentiation and team performance. To examine the predictive power of different creative processes on role differentiation and team performance (Miron-Spektor et al., 2011; Zhang & Bartol, 2010a), we also controlled for the mean level of creative process engagement on each activity. We computed, per team, the average level of creative process engagement in terms of each of the six activities.

RESULTS

Table 4.1 summarizes means, standard deviations, and correlations among measured variables. We performed hierarchical regression analysis to test the effect of cognitive diversity and transactive memory system on role differentiation. Because teams participated in 18 different challenges, we specified robust standard errors at the challenge level to account for possible heteroscedasticity in role differentiation and team performance across

⁷ The actual ratings of four dimensions were not available for most of the teams. We therefore used rankings that incorporated a consideration of all dimensions to indicate team performance, which reflected judges’ overall evaluation of team products.

challenges. We standardized all independent variables to reduce possible multicollinearity and facilitate interpretation. In step one, we entered control variables only. Step two added main effects to test the first hypothesis. Step three added two-way interactions testing hypothesis 3. Table 4.2 summarizes those results.

Results of main effects analysis suggested that team cognitive diversity was positively related to role differentiation: teams high in cognitive diversity were more likely to have high level of role differentiation ($B = 1.06, F(9,52) = 1.49; SE = 0.50, p = .04$). Hypothesis 1 was therefore supported. Transactive memory system, by contrast, was not related to role differentiation ($B = -0.37, SE = 0.57, p = .51$). We also observed that team size was positively related to role differentiation: larger teams were more likely to differentiate roles ($B = 0.92, SE = 0.42, p = .04$).

Results of the two-way interaction analysis indicated that the interaction effect of team cognitive diversity and transactive memory system was significant ($B = 0.68, F(10,51) = 1.82; SE = 0.23, p = .004$). For teams with low level of transactive memory system ($-1 SD$), the relationship between cognitive diversity and role differentiation was not significant ($B = 0.20, SE = 0.61, p = .74$). By comparison, for teams with high level of transactive memory system ($+1 SD$), cognitive diversity was positively related to role differentiation ($B = 1.59, SE = 0.50, p = .002$). In other words, team cognitive diversity led to a higher level of role differentiation only when transactive memory system was high. Hypothesis 3 was therefore supported. Figure 4.2 illustrates the interaction effect between cognitive diversity and TMS on role differentiation.

TABLE 4.1

Means, Standard Deviations, and Correlations

Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10
1. Team ranking												
2. Cognitive diversity	0.86	0.06	-.36**									
3. Role differentiation	-7.53	3.63	-.20	.25*								
4. Transactive memory system	4.29	0.46	-.20	.12	-.12							
5. Team size	5.98	0.65	.18	.04	.23 [†]	.07						
6. Problem construction	3.76	0.58	-.18	.03	-.02	.24 [†]	-.20					
7. Information search & encoding	3.63	0.53	-.20	-.06	-.10	.04	-.19	.74**				
8. Idea generation	3.66	0.54	-.05	-.07	-.06	.13	-.01	.52**	.57**			
9. Idea evaluation and selection	3.60	0.46	.09	.04	-.05	.13	.11	.09	.06	.51**		
10. Idea development	3.63	0.48	-.08	.06	-.05	.19	.10	.21 [†]	.22 [†]	.36**	.52**	
11. Idea implementation	3.50	0.56	-.07	.15	-.21 [†]	.30**	.04	.17	.04	.22 [†]	.45**	.56**

** $p < .01$, * $p < .05$, [†] $p < .10$

TABLE 2
Results for Linear Regression Analysis for Role Differentiation

Variables	Model 1		Model 2		Model 3	
Intercept	-7.56**	(0.48)	-7.52**	(0.46)	-7.64**	(0.47)
<i>Control variables</i>						
Team size	1.10*	(0.45)	0.92*	(0.42)	1.03*	(0.42)
Problem construction	0.86	(0.53)	0.63	(0.46)	0.77	(0.48)
Information search & encoding	-0.81	(0.50)	-0.42	(0.46)	-0.10	(0.45)
Idea generation	-0.15	(0.59)	-0.04	(0.50)	-0.16	(0.44)
Idea evaluation & selection	-0.12	(0.47)	0.22	(0.48)	0.21	(0.41)
Idea development	0.33	(0.28)	0.20	(0.32)	0.12	(0.22)
Idea implementation	-1.19**	(0.37)	-1.19*	(0.53)	-1.14*	(0.51)
<i>Independent variables</i>						
Cognitive diversity			1.06*	(0.50)	0.87†	(0.51)
TMS			-0.37	(0.57)	-0.08	(0.53)
Cognitive diversity × TMS					0.68**	(0.23)
R^2	0.13		0.21		0.26†	

** $p < .01$, * $p < .05$, † $p < .10$

Notes: Standard errors are in parentheses.

FIGURE 4.2
Interaction of Cognitive Diversity and Transactive Memory System on Role
Differentiation

Hypotheses 3 and 4 predicted that role differentiation would be positively associated with team performance, and that transactive memory system (TMS) would moderate the relationship between role differentiation on team performance. Given that we used judges' rankings as a measure of team performance (lower rankings represent higher performance), the strategy we used was to analyze how role differentiation and TMS (and their interaction) affect the likelihood of each team being ranked above the other teams in each competition (or challenge). Since teams participated in precisely one competition, we assumed the rankings to be independent between competitions. In addition, the ranking of a team depended on juries' assessment of other teams, meaning that there was dependence in the dependent variable within each challenge. To deal with the ranking data and dependence between observations, we modeled the determinants of a particular ranking using a rank-ordered logit (ROL) model (Fok, Paap, & Van Dijk, 2012). The model analyzes how certain factors affect the likelihood of items (i.e., teams) being selected, which can be used for analyzing

individual preferences among a group of items, and has been used in fields of marketing, applied economics, and business management (e.g., Dissanayake, Zhang, & Gu, 2015; Schu & Morschett, 2017). As the ROL model is a logit model, results do not imply a linear relationship between the dependent and independent variables, but how likely it is that one team ranked better than others. In our case, we ran three models in R software. In step one, we entered control variables only. Step two added main effects of role differentiation and TMS to test the hypothesis 3. Step three added the two-way interaction between role differentiation and TMS to test hypothesis 4. Results are summarized in Table 4.3.

TABLE 4.3
Results for Ranked Order Logit Models on Team Performance

Variables	Model 1		Model 2		Model 3	
<i>Control variables</i>						
Team size	−0.37	(0.33)	−0.69 [†]	(0.37)	−0.67 [†]	(0.37)
Problem construction	0.45	(0.47)	−0.25	(0.53)	−0.26	(0.53)
Information search & encoding	0.44	(0.63)	0.67	(0.71)	0.84	(0.71)
Idea generation	−0.58	(0.61)	−0.05	(0.63)	−0.23	(0.62)
Idea evaluation & selection	−0.51	(0.62)	−0.89	(0.63)	−0.79	(0.62)
Idea development	0.32	(0.63)	0.45	(0.64)	0.31	(0.63)
Idea implementation	0.42	(0.46)	0.30	(0.50)	0.32	(0.49)
<i>Independent variables</i>						
Role differentiation			0.18 [*]	(0.08)	0.12	0.53
TMS			0.82	(0.54)	0.62	1.00
Role differentiation × TMS					0.02	0.12

** $p < .01$, * $p < .05$, † $p < .10$

Notes: Standard deviations are in parentheses.

The model with control variables showed that teams' average levels of six activities did not affect team rankings. No influence was found for team size on rankings either ($B = -0.37$, $SE = 0.33$, $p = .26$; see Table 4.3, Model 1). Results of main effects analysis suggested

that role differentiation significantly predicted team rankings: teams with a higher level of role differentiation were more likely to rank above other teams in the same challenge ($B = 0.18$, $SE = 0.08$, $p = .02$). Hypothesis 3 therefore was supported. In addition, team size showed a marginally significant influence on performance rankings: teams with fewer members were more likely to be ranked above other teams ($B = -0.69$, $SE = 0.37$, $p = .06$; see Table 4.3, Model 2). Results of two way interaction analysis suggested that the interaction between role differentiation and TMS was not significant ($B = 0.02$, $SE = 0.12$, $p = .90$). Hypothesis 4 therefore was not supported. The effect of team size was marginally significant in this analysis ($B = -0.67$, $SE = 0.37$, $p = .07$; see Table 4.3, Model 3).

These results together suggest that role differentiation may mediate the effect of cognitive diversity on team performance (ranking), which would be consistent with the idea that role differentiation may act as an alternative approach that links team cognitive diversity and team performance. To compute the indirect effect, we performed a Sobel test, which can be used to test the significance of an indirect effect based on the coefficients of the two pathways (i.e., independent variable to mediator and mediator to dependent variable; (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002; Sobel, 1982).⁸ Results suggested that the indirect effect of cognitive diversity on team performance via role differentiation was significantly different from zero (test statistic = 4.29, $SE = 0.12$ $p < .001$), which supported our model.

DISCUSSION

Organizational teams often work in a high-pressure environment that requires them to come up with non-routine solutions and innovative products in a short time span. In these situations, it is not only the diversity in cognitive resources that is critical to team

⁸ Although the Sobel test has disadvantages, other methods such as bootstrapping or Monte Carlo simulations are not available for our situation in which we rely on a rank-ordered logit model for one of the pathways.

performance (Bechky & Okhuysen, 2011; Hoisl et al., 2017; Klein, Ziegert, Knight, & Xiao, 2006), but also the way that teams coordinate individual inputs in different processes. Our work aimed to shed more light on the processes that help teams perform well under challenging conditions. In particular, this article developed a configural approach to study the effects of diversity on individuals' differentiated participation in taskwork processes. We examined whether and when team cognitive diversity affected role differentiation, and whether and when role differentiation benefited team performance in a high time pressure context.

Our analysis of teams working on a 48-hour high-pressure Hackathon event produced two main findings. First, we found that team cognitive diversity led to a higher level of role differentiation and that this effect was stronger when teams had high levels of transactive memory system (TMS). Second, we found that role differentiation positively influenced team performance. Together, these findings suggest that role differentiation mediated the indirect effect of cognitive diversity on team performance, and that this was the case especially for teams that had a strong TMS.

Although these findings were largely consistent with predictions, we did not find that the effect of role differentiation on team performance was stronger when teams had a stronger TMS. This interaction was predicted based on the assumption that a stronger TMS would imply that the different activities are performed by those team members who are most able to perform them, making role differentiation more effective. There may be several reasons why this interaction was not found. The first reason is that our measure of TMS did not (fully) capture the accurateness of the TMS, and therefore that a higher TMS in combination with role differentiation did not necessarily imply that members who were good at an activity also perform that activity. Alternatively, given at least sufficient skills, it may be the case that role differentiation is effective even when tasks are not performed by those who have the highest

ability. For example, it may be the case that as long as activities are performed at a reasonable level, teams benefit from role differentiation. Future research may look more closely at the importance of an accurate role assignment for team performance.

Theoretical Implications

The present paper has several theoretical implications. First, current team diversity research has mostly focused on diversity in terms of differences in individual attributes, perception or states (e.g., in fault-line research; Lau & Murnighan, 1998; Van Knippenberg & Mell, 2016), but has not examined differences in the roles that members have during task performance. Our conceptual development of role differentiation adds to this body of literature and focuses on the diversity of individual's actual inputs (participation) in different problem-solving processes. Recent research found that some members participate and contribute more to team tasks compared to others ("strategic core roles"), calling for more attention to role composition rather than individual attribute composition (e.g., Humphrey et al., 2009). We built on those insights and provide a new approach to the diversity of members' roles in team processes. Our theory of role differentiation also brings new insights to the team creativity literature (and other work on non-routine task performance), which has (implicitly) assumed that members indiscriminately participate in different processes (e.g., problem construction, idea generation, idea development) to the same extent. Future research may extend this to include other taskwork processes, such as idea championing and idea endorsement, which are two important activities to get ideas accepted by others.

Second, the current paper contributes to the team diversity literature by suggesting role differentiation as an alternative mediating pathway that explains the effects of cognitive diversity on team performance. In exploring the mechanism underlying the effects of diversity on team performance, past research has suggested that diverse teams need to increase the elaboration and exchange of cognitive resources (e.g., knowledge, information,

ideas) to enhance team performance (Tasheva & Hillman, 2019; Van Knippenberg et al., 2004; van Knippenberg & van Ginkel, 2010). Our paper offers new insights into how those diverse cognitive inputs can be utilized and coordinated in teams working in demanding contexts in which thorough collective information elaboration is less feasible. These two approaches both treat teams as information processing systems, but emphasize different configurations of team processes (i.e., collective processing versus role differentiation). Although adequate processing of information (e.g., sharing and communication of knowledge, ideas, skills) is necessary for every taskwork process, it may not always be needed that all members do this for every process. Through role differentiation, members can concentrate on a few activities, which increases a thorough elaboration of information. It is important to note, however, that we do not imply that role differentiation is always the superior option, but we highlight that role differentiation may in particular benefit diverse teams facing a high-pressure environment. Collectively processing information as a team may hold other benefits, and for example allows team members to learn from each other or develop a shared understanding of their task (see also Nijstad & De Dreu, 2012).

Third, our paper provides insights into how teams can juggle the challenges of high pressure contexts in which thorough information processing is difficult. Although the importance of information processing in non-routine and complex events has been emphasized (e.g., Rico, Sánchez-Manzanares, Gil, & Gibson, 2008), little is known about how diverse teams can accomplish this. A few researchers have discussed different ways that allow teams to quickly utilize cognitive resources when responding to a demanding task environment (e.g., Uitdewilligen & Waller, 2018), but apart from this, the issue has largely remained unexplored (Bechky & Okhuysen, 2011). Drawing from an information processing perspective, we offer an alternative approach to how teams can exploit member inputs in challenging situations. In particular, in demanding situations, diverse teams were found to

engage in role differentiation, which ultimately allowed them to perform better. This is important, because prior studies have suggested that team diversity affects team performance in extreme conditions differently than in more ordinary conditions (Hoisl et al., 2017; Klein et al., 2006). The current paper therefore suggests a novel approach to this issue.

Lastly, our paper underlined the importance of shared cognition in resource-limited situations and especially for diverse teams. Our paper revealed that a well-developed TMS was needed to allow members to differentiate roles across different activities based on their diverse skills. This is in accordance with the recent call for TMS research on *multi-processes* tasks (e.g., Lewis & Herndon, 2011). In addition, some researchers have explored the importance of TMS for team performance in extreme conditions (e.g., Smith-Jentsch et al., 2009; Zheng & Mai, 2013). We argued that knowing other members' expertise more accurately would help teams to quickly distribute roles to the right person in high-pressure circumstances. We suggest that future studies can further investigate the role of TMS for teams that perform complex tasks under extreme conditions, and in particular focus on how team members organize diverse members' inputs when performing their tasks.

Managerial Implications

Often, teams have to make use of members' diverse cognitive resources under high pressure conditions, such as in health care, multi-disciplinary, railway operations, and R&D teams. It is important to consider how teams can benefit from diverse inputs in such contexts. Work teams can use the results of our study to leverage members' inputs in different processes to improve their problem solving ability and performance in other non-routine tasks. One option is to enhance the knowledge about team members' expertise and skills, which helps members distribute roles to the right person within a short time. This can be achieved through collective training or reflection on previous working experience (e.g., Marks, Sabella, Burke, & Zaccaro, 2002), in which team members should establish some

practices to find out each other's specialty and to undertake roles without much coordination cost.

Limitations and Future Directions

Although we took great care in avoiding single source and method bias by using data that was collected from various sources and over time (i.e., registration forms, a pre- and post-Hackathon survey, and jury decisions), our research design is essentially cross-sectional and does not allow for causal conclusions. Furthermore, all teams functioned in the same context (the Hackathon event) and there was no systematic variation in, for example, the amount of time pressure that teams experienced. To establish causality and to examine the assumed importance of time pressure, future research on the effectiveness of role differentiation may benefit from experimental designs in which factors such as time pressure and transactive memory are manipulated and in which effects of role differentiation on team performance are assessed.

Team performance in this article was assessed by experts, who ranked teams in each challenge based on four different performance dimensions. Ranking as an indicator of team performance has been widely used in team research, for example when examining the performance of crowd funding teams and when examining innovation tournaments (e.g., Dissanayake et al., 2015; Dissanayake, Zhang, Yasar, & Nerur, 2018). In the present study, different juries were involved in different challenges, and although they were all given the same set of four criteria, they may have made their judgments based on a different weighing of these criteria. Although we acknowledge that this is not ideal, it would mainly lead to more error variance in the data and a higher chance of type II errors; in other words, it would not undermine confidence in our results. Future research may analyze more generalized and systematic evaluations of team performance, or more specific performance dimensions, for example by using Likert scales. In addition, team performance in the Hackathon was assessed

following criteria that emphasized especially the contribution and applicability of products. Considering what defines a good product/solution, team performance can also be evaluated against other dimensions such as originality.

In this paper, we used a novel approach to quantify team role differentiation, inspired by geometrical methods of Euclidian distance among vectors. This is a relatively objective measure derived from members' self-reports on their engagement in each process.

Nevertheless, it is possible that members perceive their own participation differently, which may give rise to concerns about the validity of the measure. An alternative that researchers in the future may use is peer ratings to assess members' participation in different processes.

However, the use of peer ratings also raises questions, such as whether members can accurately recognize the participation of others in the team in all processes. We suggest that future studies adopt and compare multiple approaches, such as self-report, peer rating, and video/audio coding to increase the validity of the measure.

We controlled for team size and the mean level of members' participation in each of six processes to test hypotheses. However, there might be other team characteristics that potentially covary with important variables in the model, such as team and organizational tenure. Team members who have more co-working experience might be more aware of others' expertise compared to newly-founded teams, which may affect the development of TMS and may also have an influence on team performance. In addition, we had little quantitative information on the challenge-level that would allow us to control for potential differences among challenges. Perhaps somewhat reassuringly, ANOVA tests on the current data showed no significant differences between challenges in terms of teams' cognitive diversity ($F = 0.87, p = .61$), role differentiation ($F = 1.09, p = .39$), and TMS ($F = 0.61, p = .88$). Furthermore, we also performed our analyses with specified robust standard errors at

the challenge level to account for possible heteroscedasticity. Nevertheless, we suggest future studies consider and control for more relevant factors, both at the team and contest level.

In the current paper, we proposed role differentiation as an alternative way to exploit members' cognitive inputs in challenging situations. We examined hypotheses in a specific setting, a Hackathon event, which we assumed that teams would experience as challenging (i.e., high-profile and high pressure). High pressure environment for some work teams, however, can be much more demanding and acute, and may even involve life danger and physical risk (e.g., spaceflight teams, polar research teams; Ellis, 2006). Research has defined extreme environments as settings that “entail high levels of risk and increased consequences for poor performance” (Driskell et al., 2018). We recommend future research to examine whether and how role differentiation serves as an effective approach to reap the benefit of cognitive diversity in such extreme task settings.

Finally, our study focused on one specific type of cognitive diversity (technology skills) that is highly relevant for an AI and blockchain Hackathon event. We note, however, that the findings in this article may not necessarily generalize to other types of cognitive diversity (e.g., functional backgrounds, perspectives, and values). Future research may extend our results to a wider range of types of diversity. Furthermore, our paper proposed that role differentiation allowed for an elaborate processing of information within each taskwork process and effective coordination of members' inputs between different processes. This, however, was not tested in our analysis. Future studies could measure and analyze team information processing and coordination and further explore the underlying mechanism of role differentiation in a high pressure context.

CONCLUSIONS

Our findings based on a high time pressure Hackathon event support the idea that (diverse) teams develop role differentiation during taskwork processes, which was found to

benefit team performance when team members were more aware of others' expertise. In our view, role differentiation acts as an alternative approach that enables teams to exploit members' diverse cognitive inputs when a high level of collective information processing is not possible for all individuals (e.g., due to time constraints). A well-developed TMS increases the possibility that roles are specialized. The present study advances our understanding of the mechanism through which team performance benefited from cognitive diversity in challenging task environment and how teams manage time and expertise. We hope that future research will continue this exploration in the mediating processes of the diversity-performance link, and in identifying factors that affect role differentiation in high-pressure task contexts.

APPENDIX 4.A

Examples of Role Differentiation Matrices

The role ratings matrix of a team with *low* level of role differentiation (role differentiation score = -10.58):

Member	Problem construction	Information search and encoding	Idea generation	Idea evaluation and selection	Idea development	Idea implementation
A	4	4	5	4	5	5
B	4	4	4	5	5	5
C	4	4	5	5	5	5
D	4	4	5	5	5	5
E	5	5	5	5	5	5
F	4	4	5	4	5	5

The role ratings matrix of a team with *high* level of role differentiation (role differentiation score = -5.97):

Member	Problem construction	Information search and encoding	Idea generation	Idea evaluation and selection	Idea development	Idea implementation
A	3	3	3	3	3	3
B	3	5	3	3	3	3
C	5	5	4	4	4	3
D	1	4	4	4	3	4
E	4	3	4	4	4	4
F	4	3	5	4	5	4

Chapter 5 General Discussion

Creative inputs that individuals bring to teams are often diverse and can take different forms, such as ideas, knowledge, perspectives, and expertise. When teams are designed as a primary mechanism for accomplishing creative or non-routine tasks, effective coordination of creative processes that allows individuals to make use of their inputs becomes an important organizational issue. To get a better understanding of the processes that teams use to convert individual inputs to collective outputs, this dissertation challenges the implicit assumption held in previous literature that team members indiscriminately participate in every creative process and that they devote the same amount time and effort to all processes. Although researchers have called for more research attention to individual differences during teamwork processes (e.g., Crawford & LePine, 2013; Humphrey & Aime, 2014; Reiter-Palmon et al., 2008), and have implied that teams working in challenging situations should engage in role specialization (e.g., Driskell et al., 2018), empirical research is scarce.

In response, this dissertation offered a new perspective and developed the concept of role differentiation, to study the distribution of members' engagement in different creative processes. This new approach expands our views on the configural characteristic of member inputs (i.e., the extent of role differentiation), and extends the focus of diversity research from individual traits and team attributes to members' creative engagement. This dissertation proposed and examined the emergence and influence of role differentiation from an information processing perspective, and also highlighted the importance of motivation for collective coordination. It dealt with both the necessities and benefits of role differentiation, as well as the ability and motivation of members to engage in specialized roles. I focused on teams that operate in less favorable situations, like high pressure contexts or situations in which teams lack resources for creativity. Integrating different theoretical perspectives and methodological strategies, this dissertation presents three empirical chapters to understand

team members' different roles in creative processes when teams perform creative and non-routine tasks. Results are summarized for each chapter.

SUMMARY OF MAIN FINDINGS

Chapter 2: Membership Change, Idea Generation, and Group Creativity: A Motivated Information Processing Perspective

Chapter 2 explored the effect of membership change on the generation and acceptance of team members' (newcomers and oldtimers) radical and incremental ideas, and their subsequent effects on team creativity performance. This chapter aimed to understand role differentiation derived from diversity of membership status (newcomers vs oldtimers), as well as the role of pro-social motivation in reaping the benefits of membership change. This chapter proposed that newcomers and oldtimers may play different roles in two different creative processes: the generation and acceptance of (incremental and radical) ideas. A laboratory experiment was conducted to test hypotheses, in which I manipulated membership change and pro-social motivation, had research assistances code team creative processes from recorded videos, and had judges assess the creativity of team products.

Results showed that membership change led group members to generate more incremental ideas, and incremental ideas transferred the positive effect of membership change to group creativity, but only when collective rewards were provided. It was also found that collective rewards led team members to accept members' incremental ideas more, which in turn benefited group creativity. Radical idea generation or the acceptance of radical ideas, by contrast, did not affect group creativity.

Together, these results suggest that membership change affects different team creative processes differently, including the generation of incremental and radical ideas, as well as the acceptance of the two types of ideas. In addition, it was found that newcomers' generation of incremental ideas (rather than radical ideas), in particular, contributed to group creativity.

Research findings also showed that collective rewards motivated teams to accept newcomers' incremental ideas, which in turn benefited group creativity. This suggests that the important role of newcomers in group creativity is to introduce incremental changes, whereas old-timers have as their major role to evaluate and accept the ideas from newcomers. While newcomers and old-timers played different roles in creative processes, this chapter also spoke to the importance of pro-social motivation in reaping the benefits of ideas and integrate contributions of both newcomers and old-timers to generate a creative outcome.

Chapter 3: Role Differentiation in Creative Processes: A Configural Approach to Team Creativity

Chapter 3 aimed to develop the conceptualization of role differentiation and to examine its influence on team creativity performance under resource scarcity. Role differentiation was derived from creative problem-solving processes, including problem construction, information search and encoding, and idea generation. This chapter proposed that role differentiation would benefit team creativity when teams lack resources for creativity, and that this positive influence should only occur when teams have decentralized decision making structure. I conducted a multi-source field study to test hypotheses and a follow-up qualitative study to obtain further understanding on role differentiation in real work teams.

Results suggested that creative role differentiation was positively related to team creativity. Moreover, this positive effect was stronger when teams lacked resources for creativity and at the same time had high autonomy to make decisions (i.e., low centralization of decision making). In a follow-up qualitative study, I developed an initial understanding on the emergence of creative role differentiation in teams. These qualitative observations provided further insights into what leads teams to differentiate roles, and how teams make

decisions to coordinate creative activities. This supported our arguments and findings that teams develop creative role differentiation as an efficient way to deal with scarce resources.

These results highlighted the importance of structuring distinct creative inputs of individuals to achieve team creativity, and suggested that not only the amount of attention given to different creative processes matters, but also how they are distributed among team members. The current chapter provided direct empirical evidence showing that role differentiation benefits creativity, but also provided qualitative data that suggests that teams differentiate roles based on members' expertise and skills.

Chapter 4: Exploiting Team Cognitive Diversity in Challenging Situations: The Role of Creative Role Differentiation and Transactive Memory System

This chapter aimed to examine both the antecedents and consequences of role differentiation for teams that perform non-routine tasks under highly demanding and high-pressure conditions, namely a two-day's hackathon event. I proposed that cognitive diversity has a positive effect of on role differentiation and through role differentiation on team performance, while considering the moderating effect of team transactive memory system (TMS). The empirical study considered six important taskwork activities to perform non-routine tasks, including problem construction, information search and encoding, idea generation, idea evaluation, idea development, and idea implementation.

Results of this chapter indicated that team cognitive diversity led to a higher level of role differentiation, in particular when teams possessed a higher level of TMS. This suggested that role differentiation can be triggered by members' diverse expertise, but at the same time requires team members to be aware of others' expertise so that they know how to distribute roles. In addition, I found that role differentiation positively affected team performance. This paper contributes to team diversity research, extending the current focus on diversity in

member attributes toward examining differences in members' cognitive inputs during task performance.

THEORETICAL IMPLICATIONS

First, this dissertation advances the research body about team creative process engagement. Previous research tends to assume that team members participate in creative processes such as problem construction and idea generation to the same extent. There have been studies on how to increase the overall level of engagement in those activities (e.g., Reiter-Palmon & Illies, 2004; Zhang & Bartol, 2010a), and on the composition of creative processes in terms of the sequence or duration of different activities (e.g., Harvey & Kou, 2013). This dissertation, by contrast, proposed that team members differentiate their participation both within and across different creative processes, which offered a new and more refined perspective to study the configuration of team creative processes. Moreover, it was found that role differentiation benefits team creative performance under some conditions, and was particularly helpful for teams facing high pressure. This also speaks the growing need for integrative views that explore individuals' engagement in creative activities when teams face demanding and challenging situations.

Second, this dissertation has implications for team diversity research. Team diversity refers to "variation among team members on any attribute on which individuals may differ, such as demographic background, functional or educational background, and personality" (Van Knippenberg & Mell, 2016). In the past decades, considerable research attention has been paid to examine the influence of the homogeneity or heterogeneity of team member characteristics on team processes and outcomes, and this work has yielded mixed findings (Kozlowski & Bell, 2013; Van Dijk et al., 2012; Van Knippenberg & Mell, 2016). Research in this stream has mostly focused on member differences in their traits or states as input variables that influence team processes and outcomes. Although recent literature on team

processes has called for more investigations on heterogeneous roles in the team process, few studies have looked such heterogeneity across multiple processes at the same time. This dissertation extends this notion of diversity in terms of members' participation in team creative processes, which broadens our understanding of team diversity.

Third, this thesis contributes to the diversity literature by proposing role differentiation as an alternative approach to link diversity and team (creative) performance. According to the Categorization-Elaboration Model (CEM) of team diversity, team diversity may benefit team creative outcomes through a crucial underlying process: information elaboration (Van Knippenberg et al., 2004). It is argued that the elaboration of members' diverse knowledge and perspectives can increase the quality of team outcomes and decision making (van Knippenberg & van Ginkel, 2010). Even though this effect may be stronger or weaker when considering different types of diversity or contextual factors, the generally accepted idea is that team members' overall level of information elaboration should be increased in order to reap the benefits of diversity. This thesis proposed that role differentiation may enable team members to thoroughly elaborate information in each creative activity, and our findings suggested role differentiation may act as an alternative mechanism that links diversity to performance, especially when teams face high pressure and resource scarcity (Chapter 2 and 3). Our work therefore contributes to the current literature by proposing a novel perspective on the relation between diversity and team performance, and also extends CEM theory to creative processes and to challenging task environment.

Fourth, this dissertation contributes to the motivated information processing model in groups. The MIP-G suggested that generating creative outcomes requires both high levels of epistemic motivation and pro-social motivation (Bechtoldt et al., 2010). Results of Chapter 2 provided empirical support that a combination of epistemic and pro-social motivation benefits group creative outcomes. This enriched the MIP-G studies in group creativity

research. Our findings implied that membership change stimulated group members' epistemic motivation to process ideas in a more thorough way, whereas collective rewards motivated members to integrate individual inputs into group outcomes. In addition, Chapter 2 examined the MIP-G theory in groups that experienced membership change, which applied MIP-G to a wider range of study context (i.e., unstable groups).

Finally, this dissertation also contributes to theories of shared cognition and transactive memory system (TMS). Results of Chapter 3 showed that diversity leads to higher role differentiation when teams had well-developed TMS. This dissertation argued that the awareness of others' expertise may encourage team members to take roles in their specialty area, and also to accept others' roles during different taskwork processes, which helps teams to form role differentiation. Although TMS researchers emphasized the awareness of specialized expertise, its influence on members' actual participation in different creative processes is less clear. Our work directly tested the link between TMS and role differentiation. Whereas the prior literature on TMS has mainly focused on single tasks, Chapter 3, in accordance with a recent call, extends TMS research to multi-process tasks, and also extends it to the complex task environments that are characterized as highly demanding and challenging (e.g., Lewis & Herndon, 2011).

MANAGERIAL IMPLICATIONS

The increasing use of organizational teams composed of diverse members strongly suggests that managers should learn more about how teams coordinate members' inputs to achieve creative performance. An important perspective that is often ignored is that team members may differentiate roles (in terms of their participation) in creative processes such as problem construction, idea generation, and idea development. Role specialization does not necessarily concur with job divisions or procedural routines predefined by managers, which

may bring additional difficulties for managing teams. Based on the findings of three chapters, this dissertation offers some practical implications for organizational teams and managers.

First, teams may pay more attention to different roles of newcomers and old-timers. Although teams rely on membership change (e.g., personnel rotation) to bring changes, newcomers may not necessarily contribute radical ideas. However, it seems that newcomers' incremental ideas add value to current work, and are more likely to be accepted by teams. If teams aim to improve existing products, membership change might act as a good way to achieve this, and teams can be encouraged to listen more to newcomers and use their ideas. In the meantime, members should be pro-socially motivated to work collectively in the interest of the team. Therefore, some incentives, such as collective rewards, can be applied to encourage team members to integrate and use ideas instead of focusing on individual work only.

Second, Chapter 3 and 4 together suggest how role differentiation is formed and how it contributes to team performance. Diverse teams may use role differentiation as an efficient way to cope with unfavorable conditions (e.g., scarcity in resources, high time pressure). The qualitative study of Chapter 3 implies a few ways through which teams coordinate role differentiation, such as weekly meetings, project meetings, and fixed routines in responses to customers' requirement. In addition, teams also need to consider who should take which roles. Cognitive styles and expertise are important clues to differentiate roles, but teams may also consider differentiating roles based on other factors, such as job obligations and task procedures. For example, in our study, team leaders or senior staff reported to often participate more in evaluating and selecting ideas, whereas team members often contributed more by proposing and elaborating new ideas.

Third, our findings are especially helpful for teams in a demanding environment, who may find it difficult to engage in thorough and in-depth processing and elaboration of

information. Those teams may consider to specialize roles to improve the efficiency of coordination of members' input. Finally, our findings implied that teams need to have developed a high level of TMS to reap the benefit of role differentiation, or create an accurate division of roles. Teams can achieve this through activities such as training, meetings, and prior working experience, which enable employees to build mutual trust and learn each other's' expertise.

LIMITATIONS AND FUTURE DIRECTIONS

This thesis adopted different research methods, including a laboratory experiment (Chapter 2), field survey studies (Chapter 3 and 4), and qualitative research (Chapter 3). In Chapter 2, membership change and pro-social motivation were manipulated, which allowed for causal conclusions and precise observations of group processes (i.e., idea generation and idea acceptance). However, the generalizability of the present findings of Chapter 2 to the real world is constrained. Real work teams may experience membership change and increase pro-social motivation in different ways. I encourage future researchers to examine the effects of membership change in ongoing teams in organizations. By comparison, the survey research in Chapter 3 and 4 examined antecedents and influence of role differentiation based on multi-source data collection, which ensures the external validity, but does not allow us to draw causal conclusions. Future research should adopt a longitudinal or experimental design to detect the causal effects of hypotheses proposed in those chapters.

In this thesis, I conceptualized role differentiation as a new approach to study the distribution of members' participation in different creative processes, and developed two different quantitative measures in Chapter 3 and 4. Role differentiation in Chapter 3 was measured as the diversity of leading individuals in terms of participation in each creative activity. In Chapter 4, I treated members' participation in creative processes as vectors in a multi-dimensional space and calculated a role differentiation index based on Euclidian

distance. Both measures aimed to capture the extent to which members' participation differ from each other in creative activities. However, it is not clear whether results would be robust if I use the other measure in those Chapters, or what the best way is to conceptualize and operationalize role differentiation. Future research may compare results generated from two measures in one study, or may develop more precise measures to capture role differentiation.

In addition, both measures of role differentiation were based on employees' self-ratings on survey questions. It is likely that individuals perceive themselves at different levels in terms of their participation in each creative activity, which may cause the concern of whether the score accurately reflected reality. To deal with this issue, I controlled for the average level of members' participation at the team level when testing hypotheses. One may also consider other types of measures than self-report ratings. For example, future research can adopt and compare multiple ways, such as self-ratings with peer-ratings or leader-ratings, or apply video coding by researchers, to develop out more objective and precise measures of role differentiation.

Taking the perspective of an idea journey, this thesis examined several processes relating to creative and non-routine tasks, such as problem construction, idea generation, idea acceptance, and idea development. An underlying argument is that creative activities may require different and even opposite expertise or cognitive styles (which individuals do not possess all), and that teams may thus benefit from differentiate roles in those activities. Since creative activities are defined in different ways, it is unlikely that this thesis has included and examined all important processes. One future research direction is to explore more creative processes that are important in some specific task, such as idea champion and idea endorsement, or activities that require unique expertise. It would be interesting to investigate whether our findings of role differentiation can be replicated when considering different sets of creative processes.

This dissertation extended our understanding of role differentiation, in particular when teams are in challenging task situations: Chapter 2 concerned unstable teams that experienced membership change. Chapter 3 explored the benefits of role differentiation when teams lacked resources to perform creative tasks. In Chapter 4 I highlighted the challenging task environment and examined hypotheses in a two-day's hackathon event that was high-demanding, high pressure. These contexts, however, were different in each of the studies. Related to this, our findings suggested that membership change triggered different roles between newcomers and oldtimers in idea generation and acceptance, whereas resource scarcity moderated the effect of role differentiation on team creativity. It is likely that challenging situations act both as an antecedent of role differentiation and as a moderator. I suggest that future research may consider other types of challenging situations, and extend our role differentiation approach to even more severe and extreme conditions (e.g., in emergency rooms). One may measure different dimensions of the task environment, such as dynamic, complex, and high-pressure characteristics, and further examine their relationship with role differentiation.

CONCLUSIONS

Teams composed of diverse members have high potential to generate creative outcomes or solve complex and non-routine problems through thorough information processing (Van Knippenberg et al., 2004; van Knippenberg & van Ginkel, 2010). Under challenging situations where information is less likely to be elaborated, however, teams may find it difficult to exploit members' diverse knowledge and expertise. Recent literatures, although calling for more attention to the individuals' differentiated inputs, have not systematically examined this in empirical research. Accordingly, this dissertation conceptualized role differentiation as a new approach, to examine the distribution of members' inputs. In particular, I proposed that individuals may differ in their engagement in

different creative processes, and that the extent of such differentiation may affect team creativity performance. Three chapters taken together explored 1) the effect of diversity of membership status and diversity of skills on the emergence of role differentiation; 2) the influence of role differentiation on team creativity and non-routine task performance; and 3) the contextual factors that affect the proposed relationships. Our findings provided support that teams specialize roles during creative processes (as a result of diversity), and such specialization benefited team performance especially when teams were under unfavorable situations (e.g., high pressure, lack of resources). In this regard, this dissertation has great practical implications in coordinating members' engagement in creative tasks, and also offers important theoretical implications for team diversity and team creativity research.

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Nederlandse Samenvatting

Veel creatieve taken worden tegenwoordig uitgevoerd door organisatieteams. Leden met uiteenlopende ideeën, expertise en perspectieven kunnen omgaan met complexe en niet-routinematige taken die individuen niet alleen kunnen uitvoeren (Basadur & Head, 2001). Onderzoeks- en ontwikkelingsteams worden bijvoorbeeld op grote schaal opgericht in sectoren zoals wetenschap, hightechproductie en consulting, waar creativiteit een essentiële rol speelt voor organisatiesucces omwille van van nieuwe producten of diensten. Mensen werken ook in groepen in de medische sector of bij defensie om op creatieve manieren om te gaan met lastige problemen (Driskell, Salas, & Driskell, 2018). In onderzoek wordt teamcreativiteit gedefinieerd als het genereren van zowel nieuwe als nuttige resultaten door een groep mensen die samenwerken, zoals oplossingen voor problemen, producten, voorstellen en diensten (Shin & Zhou, 2007). In de afgelopen decennia is de onderzoeksinteresse in het verkennen van het creatieve potentieel van teams blijven groeien (Mathieu, Hollenbeck, van Knippenberg, & Ilgen, 2017). Toch is ons begrip van hoe teams gebruik maken van de input van hun leden, zoals kennis en vaardigheden, om teamcreativiteit en probleemoplossingen te vergemakkelijken verre van compleet (Shalley & Gilson, 2004; Shin & Zhou, 2007).

In eerder onderzoek hebben creativiteitswetenschappers vooral het belang benadrukt van het genereren van ideeën (bijv. Amabile, 1998). Echter, om hoogwaardige resultaten te produceren voor creatieve taken (bijv. oplossingen, voorstellen, producten) moeten teams ook andere processen of activiteiten uitvoeren, zoals het evalueren en selecteren, het ontwikkelen en het implementeren van ideeën (Harvey, 2014; Perry-Smith & Mannucci, 2017). De huidige literatuur over teamcreativiteit gaat er echter (impliciet) van uit dat teamleden dezelfde rol spelen bij het uitvoeren van creatieve taken, waarbij de mogelijkheid wordt genegeerd dat individuen zich specialiseren en verschillen in de creatieve processen of

activiteiten die ze uitvoeren. Hoewel in sommige literatuur wordt gesuggereerd dat individuen zich in bepaalde activiteiten kunnen specialiseren (bijv. Crawford & LePine, 2013; Humphrey & Aime, 2014; Mathieu et al., 2017), is empirisch onderzoek schaars.

Als reactie hierop bood dit proefschrift een nieuw perspectief en ontwikkelde het concept van roldifferentiatie, om de verdeling van de betrokkenheid van leden bij verschillende creatieve processen te bestuderen. Roldifferentiatie wordt gedefinieerd als de mate waarin teamleden hun betrokkenheid of participatie specialiseren tijdens verschillende delen van een creatief proces. Een hoge mate van roldifferentiatie betekent dat leden niet alleen verschillen in hun deelname aan creatieve processen in het algemeen, maar ook in hun deelname aan één proces. Vanuit het perspectief van informatieverwerking behandelen drie empirische hoofdstukken de invloed van teamdiversiteit (in termen van lidmaatschapsstatus en cognitieve stijlen) op roldifferentiatie, en of en wanneer roldifferentiatie de teamcreativiteit ten goede komt.

Hoofdstuk 2: Lidmaatschapsverandering, het genereren van ideeën en groepscreativiteit: een gemotiveerd perspectief op informatieverwerking

Hoofdstuk 2 onderzocht het effect van veranderingen in teamlidmaatschap op het genereren en accepteren van radicale en incrementele ideeën van teamleden (nieuwkomers en oudgedienden), en hun daaropvolgende effecten op de creativiteit van het team. Dit hoofdstuk was gericht op het begrijpen van roldifferentiatie die voortvloeit uit de diversiteit van lidmaatschap statussen (nieuwkomers versus oldtimers), evenals de rol van pro-sociale motivatie bij het plukken van de voordelen van lidmaatschapsverandering. Nieuwkomers en oldtimers kunnen verschillende rollen spelen in twee verschillende creatieve processen: het genereren en accepteren van (incrementele en radicale) ideeën. Via een laboratoriumexperiment werden de hypothesen getest. De resultaten toonden aan dat lidmaatschapsverandering groepsleden ertoe bracht meer incrementele ideeën te genereren,

en incrementele ideeën brachten het positieve effect van lidmaatschapsverandering over op groepscreativiteit, maar alleen wanneer collectieve beloningen werden verstrekt. Er werd ook vastgesteld dat collectieve beloningen ertoe leidden dat teamleden de incrementele ideeën van leden meer accepteerden, wat op zijn beurt de creativiteit van de groep ten goede kwam. Radicale ideeën hadden daarentegen geen invloed op de groepscreativiteit. Dit suggereert dat de belangrijke rol van nieuwkomers in groepscreativiteit het introduceren van incrementele veranderingen is, terwijl oudgedienden vooral van belang zijn voor het evalueren en accepteren van ideeën van nieuwkomers.

Hoofdstuk 3: Roldifferentiatie in creatieve processen: een configuratiebenadering van teamcreativiteit

Hoofdstuk 3 had tot doel de conceptualisering van roldifferentiatie te ontwikkelen en de invloed ervan op de prestaties van teamcreativiteit bij schaarste van middelen te onderzoeken. Er wordt voorgesteld dat teamleden verschillen in hun input, zowel binnen als tussen verschillende creatieve activiteiten (d.w.z. probleemconstructie, zoeken en coderen van informatie en het genereren van ideeën). Op basis van inzichten uit de literatuur over teamcognitie en teamstructuur, beargumenteerde ik dat creatieve roldifferentiatie de teamcreativiteit ten goede komt omdat het een efficiënt gebruik van de expertise van leden mogelijk maakt. Deze voordelen zijn met name sterker wanneer de middelen voor creativiteit schaars zijn en wanneer teams een hoge mate van autonomie hebben bij het nemen van beslissingen (d.w.z. lage centralisatie). Resultaten van een veldonderzoek met een vervolg kwalitatief onderzoek suggereerden dat creatieve roldifferentiatie positief gerelateerd was aan teamcreativiteit. Bovendien was dit positieve effect sterker wanneer teams geen middelen hadden voor creativiteit en tegelijkertijd een hoge mate van autonomie hadden om beslissingen te nemen (d.w.z. lage centralisatie van besluitvorming). Deze resultaten leverden direct empirisch bewijs dat aantoont dat roldifferentiatie de creativiteit ten goede komt, en

benadrukte het belang van het structureren van verschillende creatieve input van individuen om teamcreativiteit te bereiken.

Hoofdstuk 4: Cognitieve diversiteit van teams benutten in uitdagende situaties: de rol van creatieve roldifferentiatie en transactief geheugensysteem

Eerder onderzoek heeft gesuggereerd dat cognitieve diversiteit van teams de teamprestaties ten goede komt. Hoe teams die in uitdagende situaties werken, gebruik maken van de cognitieve input van leden (zoals expertise en vaardigheden) is echter onontgonnen gebleven. Dit hoofdstuk onderzoekt teamprestaties op complexe en niet-routinematige taken in een steekproef van teams in een tweedaags (hoge tijdsdruk), kunstmatige intelligentie en blockchain hackathon-evenement. Ik voorspelde dat cognitieve diversiteit een positief effect heeft op roldifferentiatie en vervolgens, door roldifferentiatie, op teamprestaties, rekening houdend met het modererende effect van het transactieve geheugensysteem (TMS) van het team. De empirische studie beschouwde zes belangrijke activiteiten om niet-routinematige taken uit te voeren, waaronder probleemconstructie, informatie zoeken en coderen, ideegeneratie, idee-evaluatie, idee-ontwikkeling en idee-implementatie. De resultaten van dit hoofdstuk gaven aan dat cognitieve diversiteit binnen teams leidde tot een hoger niveau van roldifferentiatie, met name wanneer teams een hoger niveau van TMS hadden. Dit suggereerde dat roldifferentiatie kan worden veroorzaakt door de uiteenlopende expertise van leden, maar dat teamleden tegelijkertijd op de hoogte moeten zijn van de expertise van anderen (d.w.z. een hoge TMS hebben), zodat ze weten hoe ze rollen moeten verdelen. Daarnaast is gebleken dat roldifferentiatie de teamprestaties positief beïnvloedde. Dit artikel draagt bij aan onderzoek naar teamdiversiteit en breidt de huidige focus op diversiteit in kenmerken van leden uit naar het onderzoeken van verschillen in cognitieve input van leden tijdens taakuitvoering.

Conclusie

Teams bestaande uit diverse leden hebben een hoog potentieel om creatieve resultaten te genereren of complexe en niet-routinematige problemen op te lossen door middel van grondige informatieverwerking (Van Knippenberg et al., 2004; van Knippenberg & van Ginkel, 2010). In uitdagende situaties waarin het minder waarschijnlijk is dat informatie goed wordt verwerkt, kunnen teams het echter moeilijk vinden om de uiteenlopende kennis en expertise van de leden te benutten. Recente literatuur vraagt weliswaar om meer aandacht voor de gedifferentieerde input van individuen, maar heeft dit nog niet systematisch onderzocht in empirisch onderzoek. Dienovereenkomstig heeft dit proefschrift roldifferentiatie geconceptualiseerd als een nieuwe benadering om de verdeling van de input van leden te onderzoeken. In het bijzonder stelde ik dat individuen kunnen verschillen in hun betrokkenheid bij verschillende creatieve processen, en dat de mate van dergelijke differentiatie de prestaties van teamcreativiteit kan beïnvloeden. De drie empirische hoofdstukken samen onderzochten 1) het effect van diversiteit in lidmaatschapsstatus en diversiteit van vaardigheden op het ontstaan van roldifferentiatie; 2) de invloed van roldifferentiatie op teamcreativiteit en niet-routinematige taakuitvoering; en 3) de contextuele factoren die de voorgestelde relaties beïnvloeden. Onze resultaten boden ondersteuning voor het feit dat teams rollen specialiseren tijdens creatieve processen (als gevolg van diversiteit), en een dergelijke specialisatie kwam de teamprestaties ten goede, vooral wanneer teams zich in ongunstige situaties bevonden (bijvoorbeeld hoge druk, gebrek aan middelen). In dit opzicht heeft dit proefschrift grote praktische implicaties voor het coördineren van de betrokkenheid van leden bij creatieve taken, en biedt het ook belangrijke theoretische implicaties voor onderzoek naar teamdiversiteit en teamcreativiteit.

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