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Innovation in multidisciplinary teams: The moderating role of transformational leadership in the relationship between professional heterogeneity and shared mental models

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Research on the effectiveness of multidisciplinary teams has been equivocal. In an attempt to understand when a team's professional heterogeneity (PH) is positively related to innovation (INN), we proposed an integrative model in which shared mental models (SMMs) are theorized as a mechanism to leverage INN in highly multidisciplinary teams. In addition, we claim that transformational leadership (TL), which is usually regarded as a factor contributing to team effectiveness, will attenuate the effect of teams' PH on team SMM. In a field study of 55 R&D teams in Israel, we found that SMMs mediated the relationship between PH and INN, and that TL moderated the relationship between PH and Team SMM. We discuss the theoretical and practical implication of these findings.

Keywords: Shared mental models; Innovation; Multidisciplinary teams; Transformational leadership.

Organizations today seek to maximize their agility and ability to adjust to dynamic environments and to generate innovation (INN). Thus, multidisciplinary teams are becoming increasingly prevalent as their variety of knowledge, resources, and perspectives is suggested to enhance the ability of the organization to deal with such challenges. Along with this development, transformational leadership (TL) has been described as particularly important for modern work as what employees need in order to cope with the fast-paced change, pressures to innovate, and general uncertainty characterizing work today, is a leader who projects confidence and direction and instils motivation and commitment to organizational objectives (Lim & Ployhart, 2004).

Research on the effectiveness of multidisciplinary teams has emphasized the need for the team to possess shared mental modes (SMMs) (i.e., overlapping task and teamwork knowledge) to provide adequate coordination for the team to function smoothly as a collective entity (Mohammed & Dumville, 2001). Yet, are these SMMs important when the team outcome is INN? And if so what role does TL play in the process of creating SMMs? Will TL have the same effect on the relationship between professional heterogeneity (PH) and the extent to which mental models are shared as it does when other team outcomes are examined? Following the call of Drach-Zahavy and Somech (2001) to drop research attempting to draw general conclusions and "focus on the inhibiting and facilitating variables that help translate team heterogeneity into team innovation" (p. 113), we propose SMMs as a mechanism that explains the relationship between the extent of PH and INN. Furthermore, by drawing from the distinction between shared task mental models (TAMMs) and shared team mental models (TEMMs), we attempt to adhere to Kearney and Gebert's (2009) call to minimize the gap in the literature regarding how TL affects the balance between the negative and the positive effects of team heterogeneity. Relying on TL theory and on theories regarding the evolution of team-level cognitive constructs, we claim that highly transformational leaders emphasize the exchange and elaboration of task-relevant information. According to Kearney and Gebert (2009), TL fosters the utilization of the enlarged pool of ideas and perspectives the PH entails. This utilization and emphasis on task-related knowledge exchange enhances the likelihood for the emergence of shared TAMMs in highly professional heterogeneous teams. Yet, such leadership may actually attenuate the positive relationship between PH and shared TEMMs, as the emphasis on

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task-relevant information exchange may inhibit the naturally occurring effort to understand non-task-related information (e.g., how team members view interaction patterns or communication channels) in highly heterogeneous teams.

While PH enlarges the variety of knowledge and skills within teams, empirical findings regarding its impact on performance are inconsistent (Gebert, Boerner, & Kearney, 2006). The diverse professional backgrounds, different paradigms, and different terminology of the team members may cause disagreement and tension, which in turn is likely to harm communication and collaboration, therefore decreasing performance (Harrison, Price, Gavin, & Florey, 2002; Keller, 2001; Milliken & Martins, 1996; Olsen, Parayitam, & Twigg, 2006; Reagans & Zuckerman, 2001). In other words, to utilize and increase the benefits of professional diversity in general, and for INN in particular, diversity's disadvantages must be minimized. INN is not only a function of knowledge generation but also of knowledge integration (Sheremata, 2000). Harrison and colleagues' - (2002) claim that in order to enhance INN in multidisciplinary teams, it is necessary to identify a mechanism that implies maximal comprehension of task-related issues and minimizes the gaps in teamwork-related issues. Thus, we propose SMM as a mechanism which may explain, at least partially, the positive relationship between the extent of PH in teams and INN.

Mental models, at the individual level, are defined as psychological representations that allow people to describe, explain, understand and anticipate events and phenomena in their environment (Rouse & Morris, 1986). They are based on knowledge and information, and their "schematic" nature enables meaningful interpretation. Mental models are considered to be a dynamic mechanism and can be generated, structured, and shaped by training (Johnson-Laird, 1983). SMMs are described as common "road maps" that team members share, which allow them to understand and anticipate what their colleagues' next step ought to be, as well as to understand what is needed in order to enable it (Cannon-Bowers, Salas, & Converse, 1993; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000; Rico, Sanchez-Manzanares, Gil, & Gibson, 2008). Given the PH input, we propose that the more a team is professionally heterogeneous, the more likely team members are to develop a SMM regarding the task and the teamwork. We lean on Phillips, Northcraft, and Neale (2006), who claim that this is likely to occur when team members are aware of their surface-level diversity. According to Phillips et al. (2006), surface-level diversity refers to differences among team members in demographic characteristics such as age, gender, or profession. This is as opposed to deep-level diversity which refers to differences among team members' psychological characteristics, personalities, values, and attitudes (Phillips et al., 2006). According to Philips et al. (2006), when team members differ from each other at the surface level, they invest more efforts in getting to know one another better, as they understand that they cannot rely on common knowledge and perspectives, and thus pay attention to learn more about their colleagues' attitudes, perspectives, and ways of thinking. Respectively, when team members perceive themselves as a more homogeneous team, that is, they have more surface-level similarity, they assume that they are also similar on a deeper level, and therefore exert less effort at trying to understand one another (Phillips et al., 2006), thus resulting in fewer SMMs. We claim that SMMs result in more innovative performance as they serve as road maps regarding what and how things should be done, enabling team members to integrate knowledge and implement their creative ideas.

Nijstad and Stroebe (2006) proposed a cognitive model of idea generation in groups, which claims that the process of sharing and paying attention to one another's ideas is likely to lead to a mutually stimulating effect, resulting in a wider range of ideas. According to the TL theory, transformational leaders encourage what Nijstad and Stroebe (2006) propose by urging team members to welcome and take advantage of diverse knowledge bases and perspectives (Kearney & Gebert, 2009), so that individual team members are more willing to utilize the wide range of ideas within the professional diversity of the team (Shin, Kim, Lee, & Bian, 2012). Indeed, former research has found that TL moderated the relationship between PH and team performance (Kearney & Gebert, 2009), as well as the relationship between PH and team creativity (Shin & Zhou, 2007), and the relationship between PH and team INN (Somech, 2006). Yet, while all this research found that highly transformational leaders strengthen the positive relationship between PH and the performance-related outcome examined, TL may play a different role when it comes to outcomes that are not performance related, but rather related to a cognitive construct of the team. This may be especially relevant when the cognitive construct is related to how team members interact rather than to what needs to be done.

SMMs are considered cognitive-emergent states (Kozlowski & Klein, 2000) and are often described as two team-level constructs. One construct pertains to the shared views the team members have regarding the professional and operational dimensions of the task (TAMMs), and the other pertains to the shared views the team members have regarding the way the task is going to be carried out including the roles, responsibilities of team members, and interaction patterns (Team Mental Models (TEMMs); Mathieu et al., 2000). Drawing from the TL literature and from the SMM literature, we claim that as transformational leaders continuously inspire the team with their long-term vision, triggering team member's exploratory and critical thinking processes, creativity (i.e., the generation of novel ideas) is highly valued (Jung, Chow, & Wu., 2003), resulting in highly heterogeneous team members sharing their understanding regarding the task. But while making salient the relevance of professional skills for idea generation, when TL is high, the naturally occurring mutual team effort in professional heterogeneous teams, to better understand each other (Griffin, 1981), are inhibited as these are perceived as less important (Garcia-Prieto, Bellard, & Schneider, 2003). In addition, while transformational team leaders focus highly on heterogeneous team members on sharing information to better understand what should be done (i.e., strengthening the relationship between PH and TAMMs), they are also known for their individual consideration and recognition, which may inhibit a communal team effort of highly heterogeneous team members at trying to understand *how* others perceive the way the task should be done (i.e., attenuating the relationship between PH and TEMMs).

Thus, the aim in the current paper is two-fold. First, it will introduce SMM as a mechanism that explains how PH may contribute to heightened INN. Second, we propose TL as a moderator of the PH–SMM relationship and hypothesize in regards to this moderating effect for both TEMMs and TAMMs as dependent variables. In an attempt to adhere to these goals, we develop a model relating the extent of PH to INN and test hypotheses using a sample of 55 research and development teams from different high-tech companies in Israel. Our model adds to the equivocal literature on team diversity by proposing that a *positive* relationship is expected between the extent of PH in teams and INN to the extent that highly heterogeneous teams create SMMs. In regards to leadership theory, by proposing that the moderation effect of TL on the relationship between PH and SMM depends on whether the outcome variable is shared TAMMs and shared TEMMs, we highlight that at the team level this type of leadership may inhibit some team processes that are likely to evolve naturally if such leadership is not in place. Leaning on Grant, Gino, and Hofmann's (2011), findings regarding suboptimal performance when combining extraverted leadership and team proactive behaviour, we wish to enhance team-level leadership theories by shedding light on another combination of leader and team characteristics, which are very often promoted by organizations, namely heterogeneous teams and TL.

LITERATURE REVIEW AND HYPOTHESIS GENERATION

INN is considered one of the keys for organizations to secure a place in the competitive and uncertain environment that surrounds them today (Miron, Erez, & Naveh, 2004). INN is defined as the implementation of new ideas (Amabile, 2000) and is actually different from creativity, which is defined as the generation of new ideas (Miron-Spektor, Erez, & Naveh, 2011). While creativity refers more to the individual's cognitive style or personal tendency (Hirst, van Knippenberg, & Zhou, 2009; Miron-Spektor et al., 2011), INN focuses on the practical and operational dimensions of original ideas (West, 2002).

Gebert, Boerner, and Kearney (2010) define INN as the degree to which new and useful ideas are developed, taking budget and time constraints into consideration. They claim that "innovation is a function of both knowledge generation and knowledge integration" (Gebert et al., 2010, p. 594). Knowledge generation refers to the extent to which the team voices and develops new and potentially useful ideas. Knowledge integration refers to the extent to which the team makes use of the ideas brought up by team members and combines them into concrete, practical products, or processes (Sheremata, 2000).

Multidisciplinarity or PH refers to "the extent to which a team consists of members from different educational specializations" (Shin & Zhou, 2007, p. 1709). The advantages of such teams for knowledge generation are obvious as professionally diverse team members provide a wider variety of knowledge resources and perspectives (Harrison et al., 2002; Kearney & Gebert, 2009; Shin & Zhou, 2007; van der Vegt & Bunderson, 2005). Despite the folded promise of PH to promote one element of INN, that is, knowledge generation, it may not necessarily benefit knowledge integration. In fact, PH has been claimed to be a *"double-edged sword"* (Finkelstein & Hambrick, 1996; Miliken & Martins, 1996). While PH enlarges the variety of knowledge, perspectives, and experience within a team, the diverse professional backgrounds, the various paradigms, and different terminology of the team members may also cause disagreement and tension, which in turn may badly influence communication, collaboration, and integration (Ancona & Caldwell, 1992; Harrison et al., 2002; Keller, 2001; Milliken & Martins, 1996; Olson et al., 2006; Reagans & Zuckerman, 2001). Yet, research has found PH to be related to INN (Somech, 2006). As elaborated later, we argue that one way to understand this conundrum is to examine the extent of PH within a team and claim that the *extent* of PH is related to the degree to which a team is innovative and that SMMs may be a mechanism which explains this relationship.

Shared mental models

As mentioned, SMMs are described as a team property, allowing team members to anticipate their fellows' task-related requirements and to dynamically adjust to what must be done to fulfil these requirements (Cannon-Bowers et al., 1993; Klimoski & Mohammed, 1994; Mathieu et al., 2000; Rico et al., 2008). In the team literature, SMMs are sometimes alternately called TMM, but it should be clarified that while TMM refers to the extent of 'sharedness' and to the quality (i.e., accuracy) of the mental models, SMM obviously refers only to the extent to which the mental models are shared by the team members (Mohammed, Ferzandi, & Hamilton, 2010).

Though based on the individual's cognitive patterns, SMM is a team-level phenomenon (Kozlowski & Klein, 2000), enabling team members to have a common understanding of situations, and thereby to predict what must be done. SMMs are considered as a psychological/cognitive construct, as a team-level cognitive-emergent state (Kozlowski & Klein, 2000), and have great potential to help in promoting team adjustment and adaptation (Klimoski & Mohammed, 1994). It has been shown that SMMs are especially important when communication between team members is difficult, due to such factors as overload, emergency situations, pressing schedules, technical limitations, or diverse backgrounds and terminology (Stout, Cannon-Bowers, & Salas, 1996).

Within the SMM concept, it is common to distinguish between TAMMs and TEMM. While the former refers to shared perceptions regarding professional and operational dimensions (such as schedules, priorities, equipment, and others), the latter refers to such perceptions regarding interactions between team members (such as workload-sharing and coordination; Mathieu et al., 2000). It should be noted that TEMM does not express "common affection" between team members, and it is not equivalent to "team cohesiveness" (Mohammed et al., 2010) or "team collective identification," which is defined as the emotional sense of belonging to a specific team (van der Vegt & Bunderson, 2005). TEMM refers to the extent to which team members share perceptions regarding their colleagues behaviours concerning the mission at hand (Mathieu et al., 2000). In other words, while TAMM is helpful in understanding and predicting *what* has to be done, TEMM is helpful in understanding and predicting *how* things will be done (Marks, Mathieu, & Zaccaro, 2001).

In laboratory research conducted by Mathieu et al. -(2000) based on a sample of 56 teams (each team composed of two psychology students), a significant relationship between TEMM and performance was found, whereas no statistically significant relationship between TAMM and performance was found (Mathieu et al., 2000). In contrast, in a field study conducted among army units, a significant relationship was found between TAMM and performance, as well as between TEMM and performance (Lim & Klein, 2006).

According to McComb (2007), convergence of mental models into SMMs is created by a process of three phases: (1) orientation by acquaintance with the team's operational context; (2) differentiation by creating an individual perspective on situations; and (3) integration of the individual perspectives into the collective focus. This is a continuum of processes that begins with taking in information, interpreting it, organizing it in "schemas," and storing it as "insights" (Hinsz, Tindale, & Vollrath, 1997). This process occurs individually for each team member, but in a team context, these "insights" eventually serve as "road maps" concerning the duties, responsibilities, tendencies, and priorities of the other team members as well. The congruence of the "road maps" among the team members actually represents the sharedness of mental models.

Within the mental models concept, it has also been claimed that it is necessary to estimate not only the extent to which mental models are shared, but also how accurate they are. The argument suggests that even highly SMMs cannot guarantee optimal performance if they are of low quality (Smith-Jentsch, Campbell, Milanovich, & Reynolds, 2001). Responding to this argument, a number of scholars have empirically examined not only the extent to which the mental models of the team were shared but also the extent to which they were in accordance with what the right solution was. For example, in a field study based on a sample of basketball groups, it was found that the extent to which the mental models were shared significantly predicted performance, whereas accuracy of mental models had no effect on the performance (Webber, Chen, Payne, Marsh, & Zaccaro, 2000). Mathieu, Heffner, Goodwin, Cannon-Bowers, and Salas (2005) conducted a study on a sample of 70 teams—each team consisted of two psychology students who were trained to simulate an F-16 fighter aircraft on a simulator with a joystick and a PC screen. A significant relationship was found between the extent the TAMMs were shared and performance, regardless of the TAMM quality. For mental models regarding the team (i.e., as opposed to the task), even when they were high in quality, the extent to which they were shared was the variable which contributed to performance. On the other hand, Lim and Klein (2006) did find a relationship between the accuracy of mental models and performance in addition to the relationship between the extent to which mental models were shared and performance. Accuracy was examined by comparing the average TAMMs and TEMMs of the team members to that of a team of experts. However, in the present study, which examines INN as a specific team performance, we assume that the accuracy is less relevant as there is no "right" solution when an innovative solution is being sought (i.e., the aim in fact is to come up with a product or process that is new). This concurs with findings that indicate mental model accuracy as a performance predictor in routine environments (Lim & Klein, 2006), and the extent to which mental models are shared as a performance predictor in novel environments (Marks, Zaccaro, & Mathieu, 2000), which is more relevant to INN development-oriented teams.

The relationship between the extent of professional heterogeneity and SMMs

Social categorization theory claims that similarities and differences help people categorize themselves and others into groups, with this categorization differentiating between one's in-group and out-groups. People tend to favour and trust members of their in-group over those of the out-groups and, as a result, problematic inter-group relations arise between members (Williams & O'Reilly, 1998). However, social categorization theory also posits that the salience of social categorization is dependent on the extent to which the categorization provides a good indication of similarities and differences between people (van Knippenberg, de Dreu and Homan, 2004). In relation to PH, this means that when a team consists of members from many professional backgrounds (i.e., high heterogeneity), it is not easy to categorize oneself into the same professional subgroup as other team members, as opposed to when the team consists of people from only two professional backgrounds, for example. Thus, categorization and its negative consequences are less likely to occur. According to van Knippenberg et al. (2004) in such situations, team members are likely to engage in elaboration (i.e., exchanging information and perspectives, processing the perspectives, and integrating them into an optimal solution). Such elaboration is at the essence of what enables SMMs to occur (van Ginkel & van Knippenberg, 2003).

In addition, the distinction between surface-level diversity (i.e., differences among team members in demographic characteristics; Milliken & Martins, 1996) and deep-level diversity (i.e., differences among team members' psychological characteristics such as values, attitudes, and personalities; Harrison et al., 2002) has been shown to explain some of the mixed findings regarding diversity and team-level outcomes. As mentioned earlier, Phillips et al. (2006) showed that surface-level diversity (such as PH) increases the efforts that team members invest in better getting to know other team members, and in trying to understand each other's perspectives, abilities, skills, and knowledge. Their findings are grounded on the notion that surface-level diversity elicits expectations that informational differences may be present in the team, making it more legitimate for team members to raise and discuss unique information. Such discussions provide team members the opportunity to understand how others see the task and the way in which it should be carried out and are likely to promote an elaborative process as well as create adjustments of individual mental models to more shared ones. When team members perceive surface-level homogeneity, they assume that they also have deep-level homogeneity and therefore invest less effort in getting to know one another and one another's perspectives, abilities, skills, and knowledge, resulting in fewer SMMs. Using the same logic, when members have surface-level heterogeneity, they assume that they also have deep-level heterogeneity and therefore invest more effort in getting to know each other in-depth and understanding one another's perspectives, abilities, skills, and knowledge, which results in more SMMs.

Based on this logic, the working assumption of the present research is that the more professionally heterogeneous a team is, the more likely the team will invest in information exchange between team members, generating common TAMMs. In addition, they will exert effort in creating familiarity between team members, attempt to get to know one another's perspectives, norms, values, and styles as well as preferred ways of action, thereby also generating common TEMMs.

Hence, we proposed that the more heterogeneous a team will be, the more the mental models—TAMM and TEMM—will be shared among its members.

> *H1a: Professional heterogeneity (PH) will be positively related to TEMM, such that higher heterogeneity will be associated with more shared TEMM.*
> *H1b: Professional heterogeneity (PH) will be positively related to TAMM, such that higher heterogeneity will be associated with more shared TAMM.*

The relationship between SMMs and innovation

Many empirical findings in a variety of methodologies have revealed a positive relationship between SMM and several kinds of performance measures (Ellis, 2006; Gurtner, Tschan, Semmer, & Nägele, 2007; Lim & Klein, 2006; Marks, Sabella, Burke, & Zaccaro, 2002; Smith-Jentsch, Mathieu, & Kraiger, 2005). However, to the best of our knowledge, SMMs have yet to be investigated as related to INN as a specific kind of team performance. We claim that SMMs will enhance INN for two main reasons. First, the process in which ideas are generated (i.e., the first element of INN), such as a brain-storming session, is an opportunity for the team members to get to know the way the different team members think and the knowledge they have, and thus enables them to adjust their mental models regarding the task and the required team processes in a way that is more similar to those of the other team members. In other words, the very process that promotes bringing forward divergent ideas at the same time provides team members with an opportunity to get to know the way the other team members think enabling them to adjust their own mental models of the task and how it should be done to a more shared construct. Second, the practical idea integration element of INN (Amabile, 1988, 2000; West, 2002) implies that team members combine the ideas that were generated and find feasible and tangible ways of putting these ideas into practice (Gebert et al., 2010). For the actual implementation of a new idea (i.e., INN), beyond the generation of new ideas (i.e., creativity), team members must share their understandings regarding the way in which they see the task at hand as well as how they expect it to be performed (i.e., have shared TAMMs and TEMMs) .

Hence, we proposed a positive relationship between the extent to which mental models are shared and INN.

> *H2a: TEMM will be positively related to innovation, such that more shared TEMM will be associated with higher team innovation.*
> *H2b: Professional heterogeneity (PH) will be positively related to TAMM, such that higher heterogeneity will be associated with more shared TAMM.*

SMMs as mediating the relationship between extent of ph and innovation

Previous research has found SMM to mediate the relationship between given inputs and team performance outcomes (Gurtner et al., 2007; Marks et al., 2002; Mathieu et al., 2005, 2000). In the current study, we suggest that the relationship between the extent of PH and INN may be explained, at least partially, by the ability of team members from different disciplines and areas of education to develop a common cognitive structure regarding their mission and the way it should be achieved. We combine social categorization theory (Williams & O'Reilly, 1998) with theories regarding surface-level diversity (Phillips & Loyd, 2006) and claim that as the extent of PH grows, teams are likely to be more innovative as the high level of surface-level diversity encourages team members to speak up in the team, elaborate information, and get to know one another creating more shared TAMMs and TEMMs. These SMMs constitute the integration of ideas and increase the likelihood that the team will come up with feasible and tangible ways of putting the ideas generated by the team members into practice (i.e., INN). Thus, we proposed:

> *H3a: TEMM will mediate the relationship between professional heterogeneity (PH) and innovation.*
> *H3b: TAMM will mediate the relationship between professional heterogeneity (PH) and innovation.*

Professional heterogeneity, transformational leadership, and SMM

Transformational leaders transform individuals by going beyond the status quo (Ling, Simsek, Lubatkin, & Veiga, 2008). Such leadership is seen as a multifaceted meta-construct, consisting of interdependent attributes including charisma, inspirational motivation, intellectual stimulation, and individualized consideration (Bass, 1985).

Indeed, as mentioned earlier, TL has been found to moderate the relationship between PH and team outcomes such as INN (Somech, 2006), and creativity (Shin & Zhou, 2007), as well as between PH and team performance in general (Keraney & Gebert, 2009). Yet, the question remains as to if TL will have the same impact on the relationship between PH and the development of team cognitive emergent states.

Based on TL theory and findings, transformational leaders encourage their followers to share all their task-relevant information (Kearney & Gebert, 2009). Through charisma and inspirational talk, the transformational leader drives the sharing of knowledge and skill in the name of the common vision (Kearney & Gebert, 2009). Thus, it is very likely that having a transformational leader will strengthen the relationship between the extent of PH and TAMMs. While highly heterogeneous team members are likely to elaborate regarding the task at hand, the extra encouragement from the transformational leader to share knowledge is likely to enhance the extent to which team members understand the other team members' perspectives regarding the task. This will result in more shared TAMMs.

Yet, this same elaboration may have a different effect when examining shared TEMMs. As mentioned earlier, when teams are professionally heterogeneous, transformational leaders are likely to stimulate the elaboration of task-relevant information and perspectives in order for informational diversity to enhance performance (van Knippenberg et al., 2004). This stimulation makes task information exchange salient and is likely to signal to team members that this exchange is of high importance (Garcia-Prieto et al., 2003). In addition, TEMMs have been claimed to be particularly susceptible to shifts in attention (Ellis, 2006). Thus, given the salience of task-related information exchange when TL is high, it is likely that team members will pay less attention and effort in getting to know non-task relevant information such as how team members view interaction patterns or communication channels, which would naturally occur if this emphasis was not apparent.

In addition, TL theory emphasizes that the goal of the intellectually stimulating leaders is to help their followers reach their individual potential. Through individualized consideration, transformational leaders are very much in tune with their followers "needs for achievement and growth (Lim & Ployhart, 2004). Similarly, transformational leaders acknowledge and appreciate team members" unique contribution (Kearney & Gebert, 2009), emphasizing uniqueness and focusing on helping each member to reach their individual potential. This behaviour may encourage sharing ideas so that the leader and the team realize the contribution of each team member, enhancing the likelihood that shared TAMMs will evolve. Yet, such behaviour may inhibit the characteristic of natural process of heterogeneous teams in which team members try to understand how the other team members see things beyond the task, things such as action

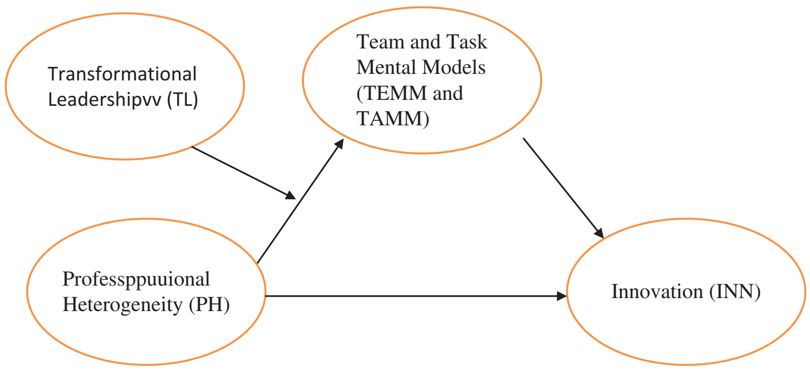

Figure 1. The proposed model.

patterns. This might be even more prominent when the task at hand is INN: desiring to coin and implement a unique contribution during a break-through process, may cause competition between team members (Jackson & Joshi, 2004), resulting in less willingness to communicate beyond the task requirements.

Therefore, it is likely that highly transformational leaders will strengthen the positive relationship between PH and task SMMs, whereas at the same time, they are likely to attenuate the positive relationship between the extent of PH and shared TEMMs. We hypothesize that

> *H4a: TL will moderate the relationship between PH and TAMM, such that under higher levels of TL a stronger positive relationship will be found between the extent of professional heterogeneity and TAMM.*
> *H4b: TL will moderate the relationship between PH and TEMM, such that under higher levels of TL the relationship between the extent of professional heterogeneity and TEMM will be attenuated.*

The proposed model is depicted in Figure 1.

METHOD

Sample and procedure

We collected data from 55 multidisciplinary research and development high-tech teams in Israel (244 respondents); each team included 3–12 members. The average number of respondents per team was 5, and the average team tenure was 4.5 years. We found that 48.7% of the respondents had Bachelor's degrees, 31.8% had Master's degrees, and 14.3% had PhDs. The vast majority of the participants were men (79.2%), Israeli born (78.8%), and married (78.2%). Mean age was 40.7 years (*SD* = 9.0).

The data collection took place in two phases. In the first stage, the team questionnaire was delivered to all team members 20 min before their weekly staff meeting. This questionnaire included the scenario-based questions described later as well as questions regarding professional background, demographics, and leadership style questions. Then, in the second stage, three experts from outside the organization who know the product and the relevant field were asked to evaluate the degree of innovativeness of the product by filling in an INN evaluation questionnaire which was delivered via e-mail.

Measures

The dependent variable. INN was evaluated using an eight-item questionnaire based on Arbel and Erez (2008). Three experts were asked to rate each product on a 5-point Likert scale, regarding its innovativeness. Example items are: "The solution creatively meets the required need", "The solution is technologically applicable", and "The solution is easy to use". As detailed in the forthcoming "Data Analysis" section, after obtaining justifying values for agreement between experts (r_{wg} = 0.94; ICC1 = 0.54; ICC2 = 0.75) (Bliese, 2000; James, Demaree, & Wolf, 1984), the mean of the ratings per product was used as an index of INN.

The independent variable. Heterogeneity was calculated using Blau's (1977) heterogeneity index: $H = (1 - \Sigma\, i^2)$, where *i* represents the proportion of the group in the "*i*"-th category. Categories were built-up using the data collected in the demographic section, regarding the participants' profession. There were nine categories including computer engineering, electronic engineering, physicians, biologists, mechanical engineering, marketing, designing engineering, economists, and general managers.

*The mediating variable. SMM was b*ased on Webber et al. (2000). We used a scenario-based team questionnaire that applied performance appraisal practices. When completing such a questionnaire, raters used a Likert-type scale to assess specific behaviours that may tap knowledge, attitudes, or competencies (Fleenor, Fleenor, & Grossnickle, 1996). The form presents scenarios that are based on critical incidents relevant to the issue at hand, and it focuses on behaviours that are usually generated by subject matter experts (SMEs) (Schneider & Schmitt, 1986).

With extensive help from SMEs (computer engineers, electronic engineers, and bio-medical engineers, all with extensive experience in R&D teams), we composed a scenario-based questionnaire. The questionnaire included four specific scenarios, each of which reflected a critical incident situation typically faced by R&D teams: two scenarios reflected TEMM and two reflected TAMM. The scenarios were followed by a list of five possible relevant behaviours that the team members could potentially demonstrate within the given situation. This list was also developed with assistance of SMEs (two other SMEs: a computer engineer and a physicist) and was then reviewed by the first group of SMEs who found the list relevant and suitable.

For example, one scenario for TEMM was "With about one third of the time for finishing the project left, a problem occurs that is likely to prevent the completion of the project in time." Participants were asked to rate five items regarding each scenario, on a 5-point Likert scale. For the earlier scenario, participants were asked, for example, "To what extent (5 = very much, 1 = not at all) will all members on your team try to solve the problem together", and "To what extent (5 = very much, 1 = not at all) will only those team members that are experts in the field of the specific problem handle it." For TAMM, a sample scenario was: "With about one third of the time for finishing the project left, a problem occurs that is likely to prevent the completion of project in time." Participants were asked to rate five items regarding each scenario, on a 5-point Likert scale. For the earlier scenario, participants were asked, for example, "To what extent (5 = very much, 1 = not at all) would you consider completely changing the idea of the project," and "To what extent (5 = very much, 1 = not at all) would you consider adding changes to the idea of the project."

The agreement measure, that is, the extent to which the team's mental models are shared, was calculated similar to Webber et al. (2000), using r_{wg}. Higher rates of r_{wg} expressed that mental models were shared to a greater extent. Thus, for each team, it was not the mean value of the answers given by the team members that constituted this variable, but rather for each team the mean r_{wg} over all item for both relevant scenarios constituted this variable. For each scenario, we calculated the $r_{wg}(j)$ index of agreement among team members ratings for the five parallel items. Then, we averaged the $r_{wg}(j)$ for the two scenarios relating to TAMM (Cronbach $\alpha = 0.803$) and for the two scenarios relating to TEMM (Cronbach $\alpha = 0.747$).

The moderating variable. Leadership Style was assessed in the last section of the questionnaire, using the short version of Bass and Avolio's (1990) Multifactor Leadership Questionnaire, which was translated into Hebrew, as used by Dvir, Eden, Avolio, and Shamir (2002). Perceptions about leadership style of the team's formal-nominated leader were collected from team members at the individual level and were aggregated to the team level using the mean, after obtaining justifying values for aggregation (r_{wg} = 0.82; ICC1 = 0.13; ICC2 = 0.40) (Bliese, 2000; James et al., 1984). Such justifications include: (a) intergroup agreement r_{wg} that exceeds 0.70. This measure regards the extent to which members of a single team agree in their ratings (James et al., 1984) and (b) Intermember reliability that is large enough to indicate ratings consistently vary across teams. According to LeBreton and Senter (2008), ICCs above 0.1 show a medium effect, whereas ICCs above 0.25 show a large effect.

Control variables. Team size, team tenure, and group cohesion—which were previously found to be associated with team performance (Ancona & Caldwell, 1992; Keller, 2001; Somech, 2006)—served as control variables in this study. In line with Kearney and Gebert (2009), team size was measured by the number of team members. In order to measure team tenure, every participant was asked how long he had been working with the current team. The index was calculated as the average of their answers (Shin & Zhou, 2007). Group cohesion was measured by the Hebrew version of the Group Environment Questionnaire (Carron, Widmeyer, & Brawley, 1985) that was used in a study in Israel (Cohen, Ben-Tura, & Vashdi, 2012). We first calculated the average of each participant's answer to the 18 questionnaire items (0.84 = α); then, after obtaining justifying values for aggregation to the team level (r_{wg} = 0.89; ICC1 = 0.19; ICC2 = 0.51), we calculated an average of the averages in each team to build the cohesion index. Since about one-third of the teams operated in public organizations, we also decided to control for whether the R&D team came from a public or private organization to make sure the observed effects were obtained earlier and beyond the impact the type of organization may have had on the team's INN.

Data analysis

Data analysis was performed using the SPSS program. Data were collected at the individual level and aggregated to the team level. As mentioned earlier for TL and group cohesion, this was done after obtaining sufficient intermember agreement (r_{wg}) as well as intermember reliability (ICCs; Bliese, 2000). The moderating effect of TL was included after grand mean centring of TL and PH was done. In order to understand the nature of the moderation effects, simple slope analysis (Aiken &

West, 1991) was performed. TL was divided into two categories: 1 *SD* above average was defined as "high TL," whereas 1 *SD* below average was defined as "low TL." To test the moderated–mediation effect, we used bias-corrected bootstrap based on the approach suggested by Preacher, Rucker, and Hayes (2007). We calculated the statistical significance of the indirect effect, with a confidence interval of 90%, as suggested by MacKinnon, Lockwood, and Williams (2004) for small sample analysis.

RESULTS

Table 1 presents the means, standard deviations, and correlations of all variables included in this study. As can be seen, there is a positive relationship between PH and the mediating variable TEMM (r = 0.361; $p < .01$) as well as between TEMM and the dependent variable INN (r = 0.343; $p < .05$). It is interesting to see that no significant correlation was found between TEMM and TAMM—which supports the discriminant validity of these two variables.

Hypothesis testing

As can be seen in Model II of Table 2, the positive relationship between PH and TEMM that was proposed in hypothesis *H1a* was found significant (β = 0.219; $p < .01$). The model explained 13.5% of the variance of TEMM and was significantly better than a model with only the control variables (ΔR^2 = 0.131; $F_{(1,50)}$ = 7.705; $p < .01$). Hypothesis *H1b* which proposed a positive relationship between PH and TAMM, was not confirmed.

Hypothesis*2a* proposed a positive relationship between TEMM and INN. To test this hypothesis, we regressed INN on TEMM. As can be seen in Model III of Table 3, TEMM was found to be significantly related to INN (β = 1.14; $p < .05$). This model explained 15.3% of the variance of INN and significantly (ΔR^2 = 0.124; $F_{(1,50)}$ = 7.29; $p < .01$) added to the explanation of the variance of INN earlier and beyond the model based on control variables only. Hypothesis*2b* which proposed a positive relationship between TAMM and INN was not confirmed.

Hypothesis*3a* proposed that TEMM would mediate the relationship between PH and INN. According to Preacher

TABLE 1
Means, Standard deviations, and intercorrelations among all variables

	M	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Variable										
1. Group size	5.35	2.1								
2. Tenure	4.51	3.1	0.082							
3. Team cohesion	2.6	0.41	0.269*	–0.089						
4. hublic/Private	0.29	0.45	–0.85	–0.48**	0.22					
5. Professional Heterogeneity	0.5	0.24	0.15	0.17	0.12	–0.015				
6. Shardness of team mental models	0.72	0.13	–0.052	0.025	0.234	–0.006	0.361**			
7. Shardness of task mental models	0.7	0.12	0.052	0.055	0.243	0.139	0.255	0.241		
8. Transformational leadership	3.91	0.37	–0.20	–0.12	–0.11	0.036	–0.52	0.287*	–0.13	
9. Innovation	4.08	0.43	0.048	–0.081	0.161	0.08	0.215	0.343*	0.014	–0.008

N = 55 **p* < .05; ***p* < .01.

TABLE 2
Summary of regression analysis results (TEMM as dependent variable)

	Model I		*Model II*		*Model III*	
N =	*55*		*55*		*55*	
	β	*S.E (β)*	*β*	*S.E (β)*	*β*	*S.E (β)*
Intercept	0.781***	0.159	0.635***	0.159	0.5651***	0.113
Team size	–0.001	0.004	–0.002	0.004	0.006	0.008
Tenure	0.001	0.006	0	0.005	0.0001	0.005
Cohension	–0.023	0.062	–0.005	0.059	0.076	0.041
Private/Public	–0.018	0.048	–0.015	0.045	–0.025	0.042
TL	0.077	0.042	0.078	0.044	0.0961*	0.038
PH			0.219**	0.084	0.199**	0.073
*PH*TL*					–0.375*	0.175
R^2	0.004		0.135		0.34	
ΔR^2			0.131**		0.165**[a]	

N = 55; **p* < .05; ***p* < .01; ****p* < .001.
[a]ΔR^2 was calculated between R^2 obtained from the same analysis conducted in Model III where variables were not centred and R^2 of Mode II.

TABLE 3
Summary of regression analysis results (INN as dependent variable)

	Model I		*Model II*		*Model III*		*Model IV*		*Model V*		*Model VI*	
	β	*S.E (β)*	*β*	*S.E (β)*	*β*	*S.E (β)*	*β*	*S.E (β)*	*β*	*S.E (β)*	*β*	*S.E (β)*
Intercept	3.9***	0.501	3.77***	0.511	3.12***	0.587	1.605	1.43	3.197	0.596	3.543***	0.513
Group size	0.014	0.013	0.011	0.013	0.012	0.013	0.009	0.014	0.011	0.013	0.0006	0.029
Tenure	−0.014	0.018	−0.018	0.018	−0.018	0.017	−0.016	0.018	−0.018	0.017	−0.019	0.020
Cohesion	0.033	0.197	0.05	0.195	0.066	0.188	0.05	0.193	0.07	0.19	0.003	0.191
												0.156
Public/Private	0.018	0.157	0.003	0.156	−0.012	0.152	0.006	0.154	−0.012	0.153	−0.036	0.153
TL			0.039	0.148	0.029	0.158	0.546	0.334			−0.051	0.148
PH			404^{+}	0.259			4.417	2.335	0.062	0.283	0.112	0.286
*TL*PH*							−1.013	0.586			−1.077	0.670
TEMM					1.144*	0.424			*1.107	0.469	0.897	0.544
R^2	0.029		0.075		0.152		0.13		0.154		0.192	
ΔR^2			0.046		0.124**				0.08*			
			(From Model I)		(From Model I)				(From Model II)			

$N = 55$; $^{+}p < .1$; $*p < .05$; $**p < .01$; $***p < .001$.

et al. (2007), in order to test this hypothesis, we first regressed TEMM on PH in a model with the control variables (Model II, Table 2) and found the value of the PH coefficient (β = 0.219; $p < .01$), ("a" in Figure 2). Then we regressed INN on the control variables, PH, and TEMM (Model V, Table 3) and obtained the value of the TEMM coefficient (β = 1.107; $p < .05$) ("b" in Figure 2). To test the statistical significance of the model, we calculated the indirect effect. According to this approach, to generate the estimate of the indirect effect, we multiplied the obtained regression coefficient "a" and "b" (0.219 × 1.107 = 0.242). A 90% CI, which was calculated through biased corrected bootstrapping as recommended by Preacher et al. (2007), indicated statistical significance since zero was not included within the confidential interval (0.011–0.70). The full model explained 15.4% of the variance of INN and significantly added ($\Delta R^2 = 0.079$; $F_{(1,49)} = 4.64$; $p < .05$) to the variance of INN and beyond the model based on PH and the control variables only.

Hypothesis*3b* which proposed that TAMM would mediate the relationship between PH and INN was not confirmed.

Hypothesis*4a* proposed that TL would moderate the relationship between PH and TEMM, such that high levels of TL would attenuate the relationship between PH and TEMM. As can be seen in Model III of Table 2, the interaction between PH and TL is

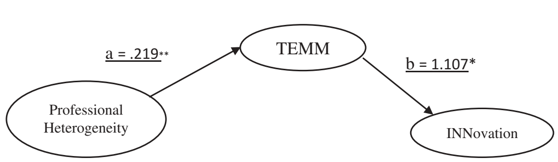

Figure 2. Bias-corrected boot strap analysis. $N = 55$; $*p < .05$; $**p < .01$.

significant (β = −0.375; $p < .05$). Figure 3 describes the results of a simple slope analysis (Aiken & West, 1991) that was performed as follows: TL was divided into two categories: 1 *SD* above average was defined as "high TL," whereas 1 *SD* below average was defined as "low TL." In addition, as PH has a mean of 0.5 and *SD* of 0.24, we chose to examine 1 *SD* above and 1 *SD* below the mean as points on the *X*-axis as these points constitute the higher and lower quartiles of heterogeneity. It is important to note that similar means and standard deviations were obtained in previous research examining PH (Kearney & Gebert, 2009; Shin & Zhou, 2007). As can be seen in Figure 3, when TL is low, there is a strong relationship between PH and TEMM (β = 0.33; $p < .01$). However, when TL is high, this relationship is attenuated and no longer significant (β = 0.025; ns).

Since we proposed an integrative moderated–mediation model, we checked the significance of the mediation in the presence of the moderation. The conditional indirect effect when TL is low was 0.3817. The 90% CI which was calculated by bootstrapping indicated statistical significance, since zero was not included within the confidential interval (90% CI: 0.0019–1.0863).

Hypothesis*4b* which proposed that TL would moderate the relationship between PH and TAMM was not confirmed since when we regressed TAMM on the interaction of PH and TL, it was not found statistically significant.

DISCUSSION

In the present study, we found that shared TEMMs mediated the relationship between PH and INN and that TL moderated the relationship between PH and

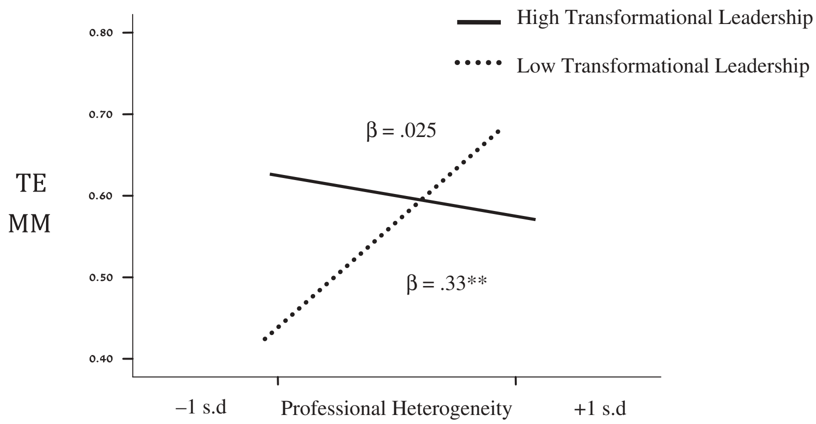

Figure 3. TL as moderating the relationship between PH and TEMM.

TEMM, such that higher levels of TL attenuated the positive relationship between PH and TEMM.

As INN is considered one of the keys for organizations to secure a place in the competitive and uncertain world of today, multidisciplinary teams are becoming increasingly prevalent as a structure that may enhance INN. The purpose of the present study was to broaden the conceptual framework of mechanisms that support and promote INN developed by multidisciplinary teams, as well as to examine the conditions that may impact the generation of such mechanisms. Specifically, we proposed an integrative moderated–mediation model, of SMM as a mediator—a mechanism that may offer an explanation for the relationship between the effect of PH and INN, and of TL as a moderator—a condition under which the relationship between PH and the generation of SMM may be strengthened or weakened.

First, as hypothesized, a positive significant relationship was found between the extent of PH and TEMM. TEMM concerns team members "perceptions regarding workload sharing, the distribution of responsibilities, coordination and communication patterns, colleagues" strengths, weaknesses, tendencies, and preferences (Canon-Bowers et al., 1993; Lim & Klein, 2006; Marks et al., 2001; Mathieu et al., 2005). It can be assumed that the greater the PH within the team, the more the team realizes that it must exert effort in a reciprocal process of getting to know each other and each other's ways of action, thus leading to generation of more shared TEMMs. This explanation gains support from the diversity literature, claiming that when surface-level diversity is high, team members assume that they also differ at the deep level, thus increasing the efforts they invest in getting to know each other's perspectives, skills, abilities, and knowledge (Philips et al., 2006; van Knippenberg et al., 2004), which leads to more TEMM.

This finding is important as most research on TEMM has been conducted using laboratory experiments (e.g., Ellis, 2006; Gurtner et al., 2007; Lim & Klein, 2006; Smith-Jentsch, Cannon-Bowers, Tannenbaum, & Salas, 2008). The present study reveals how important TEMMs are in real-work settings, within professional heterogeneous teams.

The fact that previous studies empirically support the theoretical distinction between TEMM and TAMM (Lim & Klein, 2006; Mathieu et al., 2000, 2005), might suggest an explanation for our finding, that as opposed to our hypothesis, no relationship between PH and TAMM was found. When it comes to TAMM, in highly multidisciplinary teams geared towards INN, it seems that team members are aware that they are appointed to the team on the basis of the *uniqueness* of their expertise. As a result they may hold on to their own perspectives regarding the task and not attempt to adjust their view to a more shared construct. However, it seems that the same team members understand that while they are highly diverse and hold different expertise and perceptions regarding the task, they will need to adjust their perceptions of *how* the team processes should unfold to a more shared construct.

As hypothesized, a positive significant relationship was found between TEMM and INN. This finding is in line with Lim and Klein's (2006) field study findings that showed a positive relationship between TEMM and performance although their measure of performance was not INN. It seems that the shared understanding of *how* the team will work to achieve the task, represented by TEMM, is important for achieving INN. More congruent road maps, that is, more shared TEMMs, enable the practical, applicable dimension of INN to occur.

We found no relationship between TAMM and INN. This indicates that when it comes to INN, the extent to which the team sees the task in the same manner does not matter. This is an interesting finding as it indicates that innovative products/solutions do not necessarily require the team to see the task (i.e., the problem) in the same way. This may be explained by our finding regarding TEMM. It seems that the given shared TEMMs, there is enough coordination for the team to function smoothly even when there is no shared perception of the task.

We found that TEMM mediated the relationship between PH and INN, indicating that PH, while it may encompass communication difficulties due to diverse professional education, terminology, and experience, enhances the need for generating a shared understanding of how the team will cooperate and dynamically adjust to actually implement the innovative idea.

We hypothesized that TL will moderate the relationship between PH and TEMM, such that TL will attenuate the relationship between PH and TEMM. Our findings significantly support this moderation hypothesis. We found no relationship between PH and TEMM when TL was high and found that in *lower* levels of TL, the relationship between PH and TEMM was positive and significant. Our findings may be explained by transformational theory itself. In the absence of the specific transformational qualities, such as high emphasis on *task*-related knowledge exchange and high individual consideration, team members conclude that because of the high PH and variety, in order to perform effectively, they have to get to know each other better and understand the way in which their colleagues see *how* the task will be executed. Yet, when TL is high, high heterogeneity is not related to TEMM as the earlier stated qualities of the leader interfere with this naturally evolving process.

Theoretical contribution and implications

Our study and its findings offer a number of theoretical contributions. First, we contribute to diversity literature. The literature regarding the relationship between team heterogeneity and performance focused mainly on (1) team processes and practices that support the mission such as team learning and team reflexivity (e.g., Somech, 2006), or communication and information exchange (e.g., Kearney & Gebert, 2009), to try and explain this relationship. The present study, on the other hand, suggests first and foremost a mechanism that represents a psychological/cognitive construct—SMM—as an explanation for the relationship between PH and INN. SMM as a team-level cognitive-emergent state provides a different perspective to the existing literature on heterogeneous teams and suggests an explanation to the contradictory findings regarding the relationship between PH and performance in general, and especially between PH and INN. Highly professional heterogeneous team members exert more effort in creating a shared TEMM that in turn enhances INN.

Second, this study adds to the literature on team INN by revealing that TEMMs are directly associated with INN and might serve as a factor that explains INN developed by multidisciplinary teams. Moreover, it emphasizes the need to understand that while INN involves creative thinking which may require divergent thinking and different perspectives, for the implementation aspect of INN, shared TEMMs are important.

Third, our findings contribute to the leadership literature by emphasizing that while much is known about the effects transformational leaders have at the individual level, there is still much to examine at the team level. More specifically, this study points to the need to broaden and deepen our understanding of how TL influences not only team outcomes, but also team process and team-emergent states, which are especially important for team dynamic adjustment. While many studies point at positive effect of TL, out findings suggest that, though not prominently disturbing, this type of leadership may not always necessarily help.

Fourth, following the line of research, Grant et al. - (2011) started this study provides another example of enhancing theories that consider the combination of leader characteristics as well as team characteristics. TL in multidisciplinary teams has a suboptimal effect on TEMMs as the salience of gathering task-related information exerted by the fact that the team is professionally heterogeneous and by the leader's direction, shifts attention from other important team processes.

Finally, our findings provide an empirical contribution as well: to the best of our knowledge, this is the first field study conducted on real R&D teams which both directly measured SMM, and objectively measured INN using three external judges.

Practical implications

The finding that TEMM is a mediator of the relationship between PH and INN provides an important practical tool that may help multidisciplinary teams in developing INN. For example, organizations may want to have multidisciplinary teams that go through specific training that is aimed at enhancing SMMs. This may be of great importance not only for R&D teams but also for highly heterogeneous teams who operate in very dynamic and uncertain environment such as surgical teams (Alonso et al., 2006; Vashdi, Bamberger, Erez, & Weiss-Meilik, 2007). In such teams, there is often a need to adjust and find non-routine through practical and applicable (i.e., innovative) solutions. While in such teams, every team member may know exactly what the task is from their own professional perspective (e.g., surgeons, anesthesiologists, nurses), training such teams on how shared TEMMs may enhance their ability to deal with novel and unexpected situations.

Our findings also indicate that under lower levels of TL, the more heterogeneous a team is, the more shared its mental models are. This may suggest that for more professionally heterogeneous teams, it might be more practical to assign leaders who are not very transformational in their style.

Limitations and future research

The pioneering nature of the present study combining leadership, SMM, INN, and the extent of PH in teams in an integrative moderated–mediation model, dictates much caution in the interpretation of its findings. First, the sample was based on R&D teams, which might limit the applicability to other types of teams. Future research may want to examine whether our findings also transfer to teams whose mission is of a less innovative nature. Second, the vast majority of the participants in this study were males. At least in Israel, this is characteristic of R&D teams, yet this may not be so in R&D teams in other countries. While this gave us the ability to observe the effects of PH on INN with gender heterogeneity being almost constant (a situation that is rarely possible in a field study), future research may want to pay attention to the interaction between different kinds of surface-level diversities and their influence on INN. Finally, we were limited to a rather small sample. However, much of the research conducted on similar teams relies on small sample sizes as well (e.g., 62 teams Kearney & Gebert, 2009 study; 75 teams in; Shin & Zhou, 2007; Study). Further investigation should be done using larger samples if possible.

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