UNIVERSITAT DE BARCELONA

Group development as a mediator of the effects of leadership style on team effectiveness in certain and uncertain team tasks

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Thesis presented by

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to attain the grade

Doctor per la Universitat de Barcelona

Director:

Dr. Rita Berger

2018

Acknowledgments

I could not have completed the work presented in this thesis without the support of several people. I owe them much more than the humble words of gratitude in the following paragraphs.

Rita Berger, the director of this thesis work. Thank you very much for your ideas, and feedback, as well as your readiness to provide these when I needed them. Writing a thesis means developing oneself, as a scientist and as a person. It was great to have your company and guidance on this way.

José Navarro Cid, my co-author. I am grateful for your reviews of my work throughout the course of the work. Your feedback was always very helpful, constructive, honest, and timely.

Joan Guàrdia, my co-author. Your advice and input to the validation studies has contributed to significantly improving this part of the work.

Manfred Scheifele and **Dominik Toussaint**. Without your extraordinary willingness to help me overcome bureaucratic burdens and master privacy requirements of organizational surveys, I would not have been able to conclude this work.

The directors who gave me permission to conduct my survey in their organizational units: you made it possible to complete this work. When I called you and asked for that favor, which would not result in any direct benefit for yourself or your institute, the easiest solution would have been to say “no” and end the call. Many of your colleagues did just that. You did not. Thank you for respecting and supporting my research.

The participants of the survey and the laboratory experiment. You have made this research possible. Thank you very much for your effort in the participation.

Simone Kauffeld has allowed us to use her instrument F-A-T short free of charge and **Felix Brodbeck** gave us his permission to use the TCL. I am grateful for this support.

My wife Fernanda, who sacrificed more than anyone else did, by letting me spend countless evenings, weekends, and holidays on this thesis. Without your support and understanding, I could not have completed this work. I love you.

My sons Theo and Ben. I am looking forward to spending much more time with you, now that the thesis is submitted. You both are my inspiration.

My family and friends. Angelika Banzer-Leuteritz and Michael Leuteritz, you are great parents that most people could only wish they had, and this thesis is also a result of the support I have received from you in my day-to-day decisions as well as the big choices in life. Alexander Nitsch, Sophie Kaczmarek-Nitsch, Sebastian Pohlack, Maria Puschbeck-Raetzell, Ines Hein, Carmen Sage, and Juliana Antola Porto, thank you for your scientific advice, [illegible]nd for giving me the extra push from time to time.

r 26, 2018

Preface

This doctoral thesis was realized at the University of Barcelona (UB) and it contributed to the line of research that produced the measurement framework of organizational behavior named *Human System Audit* (HSA; Quijano, Navarro, Yepes, Berger, & Romeo, 2008). In addition to the UB as my alma mater, my employers during realization of the research have also shaped this work: the Institute of Human Factors and Technology Management (IAT) of the University of Stuttgart and its associated Fraunhofer-Institute for Industrial Engineering (IAO). Both, UB and Fraunhofer IAO, research human work, and both seek ways to improve the conditions under which such work is done.

The Department of Social Psychology and Quantitative Psychology at the UB focuses on the analysis of psychosocial processes and organizational behavior. Its members develop measurement instruments, such as those of the HSA (Berger, Romeo, Guardia, Yepes, & Soria, 2012; Navarro, Quijano, Berger, & Meneses, 2011) and they investigate impact factors of successful teamwork. Thus, the UB mainly applies advanced psychological research methodology. Fraunhofer IAO, on the other hand, is a multidisciplinary institution dedicated to the direct transfer of its research results into working environments. Its main objective is promoting the adoption of new scientific findings or technological developments in industry. Fraunhofer IAO develops solutions for knowledge workers, applying methods from human factors and industrial engineering, from economics and business administration, as well as from industrial design. Therefore, the research topic relates to the UB and to my employers.

Being a doctoral thesis directed at the UB's Department of Social Psychology and Quantitative Psychology, the work presented here is psychological research, with respect to most literature and the methodology used. Nevertheless, it blended the perspectives of the two institutions: while it followed research paradigms of organizational psychology and while it was focused on psychosocial processes, it incorporated Fraunhofer IAO's perspective on knowledge work and it sought to produce results with industrial applicability. Furthermore, it

fits into the research lines of both institutions. Further down, we will introduce the research objectives and subsequently disclose their relationships to the ongoing research work at the UB and at Fraunhofer IAO. In summary, the project continued the research line of the HSA at the UB, and its findings complement theory in technology management, such as the innovation excellence model developed at Fraunhofer IAO (Spath, Linder, & Seidenstricker, 2011).

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Abstract

Teamwork is a crucial factor in achieving the constant innovation that modern knowledge-driven industries depend on. To understand how teams can create innovation, information on the underlying mechanisms is required. The main objective of this research project was to investigate the mechanisms linking two important psychosocial processes, transformational leadership and group development on the one hand, to team effectiveness in certain and uncertain team tasks on the other. By proposing task uncertainty as a key operationalization of work focused on innovation, this research contributed to building a bridge between organizational psychology and innovation research.

Although research had already shown that transformational leadership fosters innovation and creativity, these studies were restricted to specific samples, such as teams of designers. Therefore, it was still unclear whether transformational leadership has the same impact in teams whose tasks are meant to create innovation, compared to other types of teams. To close this gap, we researched the following main research question: do uncertain and interdependent tasks influence the relationships between the two team processes transformational leadership and group development, as well as team effectiveness; and do these tasks qualify only as input variables, which they are regarded as in contemporary models, or are they also influenced by other processes? We used data from a German Research and Development (R&D) organization, since Germany is highly dependent on technological innovation. This, in turn, required validating instruments to measure task uncertainty and group development in German samples; such instruments were not available and, as our results show, they are relevant for researchers and practitioners alike. Thus, we conducted three studies: two validation studies and one model test.

The objective of the 1st study was to analyze the psychometric characteristics of the Spanish Group Development (GD) questionnaire in a German sample. In the 3rd study, which addressed the main research question, we selected GD as an important process to represent a

team's capacity to work together as a team. We did so due to shortcomings of other available constructs or instruments, such as group cohesion or models of a team's developmental stages. To date, the GD questionnaire had been validated in Spain, Venezuela, and Brazil. In a German research organization, we collected questionnaire data through an online survey from 605 participants (501 team members and 104 team leaders), aged between 18 and 65 years. They answered the GD questionnaire and items related to other group processes (democracy, mutual trust, team spirit, and motivation/interest in team tasks). Confirmatory Factor Analysis (CFA) confirmed the unidimensional factor structure of the Spanish original for the German GD instrument. It showed good internal consistency and evidence of validity. The GD correlated as expected to constructs measured with other established instruments, including the selected criterion: team members' motivation and interest in team tasks ($r = .79$, $p < .01$). We also confirmed its measurement invariance regarding gender and job type. Consequently, the GD was available for use in the main study.

Analogously, the 2nd study was aimed at evaluating the psychometric quality of the Spanish group tasks' uncertainty model MITAG (Spanish: Modelo de Incertidumbre de las Tareas del Grupo) in a German sample. Previously, the MITAG had been validated in Spanish samples, only. Like the previously mentioned GD instrument, we needed the MITAG in the German language for the realization of the 3rd study, which was going to analyze the roles of task uncertainty and task interdependence with respect to transformational leadership, group development, and team effectiveness. The reason for selecting the MITAG for this purpose lay in the methodological issues or insufficient theoretical foundation of other available instruments. The participants were the same as in the 1st study. They answered the MITAG, as well as selected items from the Job Diagnostic Survey (JDS) and from the German instrument Ambiguitätsfacetten der Arbeit (AfA). Confirmatory factor analysis did not reproduce the original 4-factor structure of the MITAG in the German sample, although the 3 newly identified factors, unclarity of goals, new situations, and non-routine, showed a resemblance.

Compared to the Spanish participants, Germans seemed to focus rather on the source than on the type of task uncertainty. Additionally, results showed sound internal consistency as well as evidence supporting the validity of the new factors. Based on the results, measurements of unclarity of goals and new situations could be included in the third study. The same limitations apply to both validation studies: we used samples from only one organization and one country, and due to voluntary participation, self-selection biases cannot be excluded. The overrepresentation of males in the samples is a limitation with respect to the MITAG, which was not gender-invariant.

The objective of the 3rd study was to investigate the mechanisms linking transformational leadership, group development, task uncertainty, task interdependence and team effectiveness. For this purpose, we tested an Input-Mediator-Output (IMO) model of assumed relationships between these variables. In particular, we compared the effects of transformational leadership and group development between teams depending on their level of task uncertainty. Based on the literature, we considered an Input-Mediator-Output (IMO) model more suitable than an Input-Process-Output (IPO) model. Four hundred and eight members of 107 teams in a German R&D organization completed a web-based survey. In 54 of these teams, the respective leaders also answered a web-based survey on team effectiveness. We tested the proposed model with structural equations modelling, using the data from team members in the sample of 107 teams. We found that group development – as a mediating process – and the task uncertainty factor of new situations – a structural aspect that refers to unstable demands from outside the team – partially mediated the effect of transformational leadership on team effectiveness in R&D organizations ($p < .05$). Although transformational leaders reduced unclarity of goals ($p < .05$), this did not contribute additionally to team effectiveness. Using data provided by the 54 team leaders, we showed that the identified relationships were robust when checking for common source bias. Limitations include cross-sectional data and a lower than expected variance of task

uncertainty across different job types. The study contributes to understanding how knowledge worker teams deal effectively with task uncertainty and confirms the importance of group development in this context. To our knowledge, it was the first study to examine the effects of transformational leadership and team processes on team effectiveness while considering the task characteristics uncertainty and interdependence.

Through these studies, the research project made the following main contributions: based on the IMO-model, it showed that different aspects of task uncertainty (unclarity of goals and new situations) play different roles with respect to the positive relationships between transformational leadership, group development, and team effectiveness. It addressed the limitations of previous studies, which, for example, relied on homogeneous samples, and helped explain differences in obtained results regarding the effects of uncertainty. Furthermore, 2 measurement instruments became available for use in German samples: the GD and the MITAG. The results of all 3 studies emphasize their relevance for researchers and practitioners.

For future research, we recommend validating the GD in other cultures, as well as adapting and re-testing the MITAG in order to account for the cultural differences identified. Further studies regarding the requirements of knowledge workers could build upon the presented results by including uncertainty appraisal into the model, by applying a longitudinal design and thus specifically examining team adaptation over time, or by testing the impact of other aspects of task uncertainty. Another implication for future research is the operationalization of knowledge work through task uncertainty proposed here, by which we intended to build a bridge between innovation management and organizational psychology.

Resumen

El trabajo en equipo es un factor crucial para lograr la innovación constante, elemento del cual dependen las industrias basadas en el conocimiento. Para entender como los equipos innovan, se necesita información sobre los mecanismos subyacentes. El objetivo principal de este proyecto fue investigar los mecanismos que unen por una parte dos procesos psicosociales importantes, el liderazgo transformacional y el desarrollo del grupo, y por otra parte la efectividad de grupo en tareas inciertas y escasamente inciertas. Esta investigación contribuyó a tender un puente entre la psicología organizacional y la investigación en innovación al proponer la incertidumbre de tarea como operacionalización clave en el trabajo centrado en la innovación.

Aunque otros estudios ya habían mostrado que el liderazgo transformacional fomenta la innovación y la creatividad, dichos estudios se limitaron a muestras específicas, tal como equipos de diseñadores. Por tanto, no quedaba claro si el liderazgo transformacional tiene el mismo impacto en los equipos que deben crear innovación, cuando estos se comparan con otros tipos de equipos. Con el objetivo de abordar esta brecha en el conocimiento, buscamos la respuesta a la siguiente pregunta de investigación: ¿Las tareas inciertas e interdependientes influyen en las relaciones entre los siguientes dos procesos de equipo: tanto en la relación entre el liderazgo transformacional y el desarrollo de grupo, como con la efectividad del grupo; adicionalmente estas tareas sólo ejercen el ról de variables de entrada, tal como se les considera en modelos contemporáneos, o son también influenciadas por otros procesos? Utilizamos datos de una organización de investigación y desarrollo (I&D) alemana, ya que Alemania se caracteriza por una alta dependencia de la innovación tecnológica. Esto nos requería validar instrumentos para medir la incertidumbre de tarea y desarollo del grupo en muestras alemanas; dichos instrumentos no existían y, como demuestran nuestros resultados, son relevantes tanto para investigadores, como para profesionales. Consequentemente, realizamos tres estudios: dos estudios de validación y un test de modelo.

El objetivo del 1º estudio era analizar en una muestra alemana las características psicométricas del questionario Group Development (GD), que en su versión original viene en castellano. El 3º estudio se enfocó en la principal pregunta de la investigación, seleccionamos el GD como proceso importante para representar la capacidad de los miembros de un equipo de colaborar como una unidad. Lo hicimos por las deficiencias de otros constructos o instrumentos disponibles, tal como la cohesión de grupo o como modelos de etapas del desarollo grupal. Antes, el GD sólo había sido evaluado en España, Venezuela y Brazil. En una organización de investigación alemana, recolectamos datos a través de una encuesta en-línea de 605 participantes (501 miembros y 104 líderes de equipos), entre 18 y 65 años. Contestaron el cuestionario GD e ítems relacionados a otros procesos grupales (democracia, espíritu de equipo, motivación/interés en las tareas del grupo). Un análisis factorial confirmatoria (AFC) corroboró la estructura unidimensional del instrumento original en español. El instrumento mostró una buena consistencia interna y encontramos evidencia de validez. El GD se correlacionó de manera esperada a constructos medidos a través de otros instrumentos validados, incluyendo el criterio seleccionado: la motivación y el interés de los miembros hacia las tareas del equipo ($r = .79$, $p < .01$). También confirmamos su invarianza de medida con respecto al género y tipo de empleo. Como consecuencia, el GD quedó validado para su uso en el estudio principal.

De forma análoga, el 2º estudio apuntó a evaluar, en una muestra alemana, la calidad psicométrica de otro cuestionario validado en castellano: el MITAG (Modelo de Incertidumbre de las Tareas del Grupo). Anteriormente, el MITAG había sido validado solamente en muestras españolas. Tal como el instrumento GD mencionado arriba, necesitábamos el MITAG en alemán para realizar el estudio principal, que analizaría los papeles de dos factores – incertidumbre de tareas e interdependencia de tareas – con respecto al liderazgo transformacional, el desarollo del grupo, y la efectividad de equipo. Seleccionamos el MITAG para esta finalidad por los problemas metodológicos o la falta de

una base teórica bien elaborada en otros instrumentos disponibles. Participaron los mismos sujetos que en el 1º estudio. Respondieron el MITAG, junto a otros items del Job Diagnostic Survey (JDS) y del instrumento alemán "Ambiguitätsfacetten der Arbeit" (AfA, castellano: facetas de ambigüedad en el trabajo). En la muestra alemana, el análisis factorial confirmatorio no reprodujo la estructura original de 4 factores del MITAG, aunque los 3 nuevos factores identificados, "unclarity of goals" (falta de claridad de objetivos), "new situations" (nuevas situaciones), y "non-routine" (falta de rutina) resultaron parecidos a los factores originales. En comparación a los participantes españoles, los alemanes parecían enfocarse más en la fuente que en el tipo de la incertidumbre de tarea. Además, los resultados demostraron buena consistencia interna y evidencia para la validéz de los nuevos factores. En base de estos resultados, pudimos incluir medidas de "unclarity of goals" y "new situations" en el 3º estudio. Los dos estudios de validación tienen las mismas limitaciones: utilizamos muestras de una sola organización y de solamente un país, y como la participación fue voluntaria, no se pueden excluir sesgos por autoselección. La sobrerepresentación de participantes de género masculino en las muestras es una limitación de la validación del MITAG, que no resultó invariante con respeto al género.

El objetivo del 3º estudio era investigar los mecanismos presentes entre el liderazgo transformacional, el desarollo del grupo, la incertidumbre de tarea, la interdependencia de tareas y la efectividad grupal. Con tal fin, pusimos a prueba un modelo tipo Input-Mediator-Output (IMO, castellano: entrada-mediador-salida) de las supuestas interrelaciones entre dichas variables. En particular, comparamos los efectos del liderazgo transformacional y desarollo del grupo entre equipos, en dependencia a su nivel de incertidumbre de tarea. Siguiendo la literatura actual, consideramos más adecuado un modelo típo Input-Mediator-Output (IMO) que un modelo típo Input-Process-Output (IPO, castellano: entrada-proceso-salida). Cuatrocientos ocho miembros de 107 equipos en una organización de investigación y desarollo (I&D) alemana contestaron una encuesta en-línea. En 54 de estes equipos, el líder

también contestó un cuestionario sobre la efectividad de grupo. Pusimos a prueba el modelo propuesto aplicando modelos de ecuaciones estructurales (MES) con los datos de los miembros de 107 equipos. Resultó que dos variables median parcialmente el efecto del liderazgo transformacional sobre la efectividad en las organizaciones I&D ($p < .05$): el desarrollo del grupo, como proceso mediador, y también "new situations", un factor subordinado de la incertidumbre de tarea que representa un aspecto estructural que se refiere a demandas inestables llegando desde afuera del equipo. Aunque los líderes transformacionales redujeron la "unclarity of goals", y dejaron mejor definidos los objetivos del equipo ($p < .05$), esto no contribuyó a la efectividad del grupo. Utilizando los datos recogidos de los 54 líderes, mostramos que las relaciones identificadas eran robustas con respeto a posibles sesgos de fuente común. Las limitaciones incluyen datos transversales y una varianza menor de lo esperado en la incertidumbre de tarea entre los diferentes típos de trabajo. El estudio contribuye a comprender cómo los equipos de trabajadores del conocimiento enfrentan efectivamente las tareas inciertas. También confirma la relevancia del desarollo del grupo en este contexto. Según tenemos entendido este es el primer estudio que examinó los efectos del liderazgo transformacional y de los procesos en equipos hacia la efectividad de equipo, teniendo en cuenta las características de las tareas: incertidumbre e interdependencia.

A través de estos estudios, el proyecto de investigación hizo las siguientes contribuciones: basándonos en un modelo IMO, mostró que diferentes aspectos de la incertidumbre de tarea ("unclarity of goals" y "new situations") juegan papeles distintos con respecto a las interrelaciones positivas entre el liderazgo transformacional, el desarollo del grupo y la efectividad de equipo. Abordamos las limitaciones de estudios previos, que por ejemplo, se basaron en muestras homogéneas, y así ayudamos a explicar diferencias en resultados obtenidos con respecto a los efectos de la incertidumbre. Adicionalmente, 2 instrumentos psicométricos se validaron para el uso en muestras alemanas: el GD y el

MITAG. Los resultados de los 3 estudios enfatizan su relevancia tanto para investigadores como para profesionales, por ejemplo, en el área de los recursos humanos.

Para futuros proyectos de investigación, recomendamos validar el GD en otras culturas, y adaptar y reevaluar el MITAG para tener en cuenta las diferencias culturales identificadas. Otros estudios con respecto a los requerimientos de trabajadores del conocimiento podrían basarse en los resultados presentados y entonces incluir la evaluación subjetiva de la incertidumbre en el modelo. También sería recomendable usar diseños de estudio longitudinales y así examinar específicamente como los equipos se adaptan a lo largo del tiempo para enfrentar la incertidumbre, y adicionalmente, se podrían evaluar los impactos de otros factores subordinados de la incertidumbre de tarea. Otra implicación para investigaciones futuras es la operacionalización del trabajo del conocimiento a través de la incertidumbre de tarea, tal como lo propusimos aquí, y con lo cual intentamos tender un puente entre dos áreas de investigación: la gestión de la innovación y la psicología organizacional.

Chapter 1

Introduction and general theoretical frame

1.1 Project vision and approach

Many modern organizations, big and small businesses alike, depend on constant innovation (Reuveni & Vashdi, 2015). In developed economies, this is more than just a business-related imperative; it is a societal challenge: in 2010, the European Commission put forward three priorities of economic growth for the EU, the first of which was "developing an economy based on knowledge and innovation" (Barroso, 2010, p. 2). This particularly affects Germany, as its economy is highly dependent on innovation (Spath, Linder et al., 2011).

This doctoral research project addressed that challenge. Its foundation is the vision of a future in which organizations are empowered to be more innovative. We wanted to achieve this by providing organizations with insights into what makes teams innovative, and by delivering psychometric tools that they could use to go from insight to organizational intervention.

Organizations increasingly rely on teams to innovate (Edmondson & Nembhard, 2009). These knowledge worker teams face high task uncertainty (Spath & Hoffmann, 2009), and they need to deal with it efficiently and effectively to be productive. There is extensive research on the relationships between transformational leadership, teamwork, and team effectiveness (e.g., Bass, Avolio, Jung, & Berson, 2003; Jung & Sosik, 2002), as well as on the effects of transformational leadership on team innovation and creativity (e.g., De Jong & Den Hartog, 2007; Eisenbeiß, 2009). However, to our knowledge, the role of task uncertainty as an important input or process variable with respect to team outcomes has not yet been researched. Clarifying this role was of high relevance, as the literature was ambiguous about it, supporting either detrimental (Sicotte & Bourgault, 2008; Tatikonda & Rosenthal, 2000; Weiss & Hoegl, 2016) or moderating effects (Faraj & Yan, 2009; Frost, Osterloh, & Weibel,

2010; Gardner, Gino, & Staats, 2012; Wolfram & Mohr, 2008) of task uncertainty on team outcomes. Resolving this ambiguity regarding the effects of uncertainty in teams of knowledge workers is a current challenge (Um & Kim, 2018). The work presented here was a first step towards closing this gap. It improved our understanding of how transformational leadership affects teams that face different types of uncertainty. Instead of previous studies, which used restricted samples composed only of teams with creativity-related tasks, this study compared teams with different job types to investigate the roles of the different types of task uncertainty in the relationship between transformational leadership and team outcomes.

We also considered two coordination mechanisms: task interdependence at the structural level and group development as an interpersonal process. We included group development into our model since group processes such as group cohesion mediate the positive effects of transformational leadership on team outcomes (Jung & Sosik, 2002) and since in this context, we considered group development a more adequate construct than cohesion (Hogg, 1993). Additionally, theoretical reasoning (Navarro et al., 2011; Ven, Delbecq, & Koenig, 1976) and empirical evidence (Faraj & Yan, 2009; Gardner et al., 2012) supported the assumption that interpersonal coordination mechanisms, such as group development, help teams face uncertainty. We introduced task interdependence into the model as it was a potentially confounding variable that needed to be controlled: Ven et al. (1976) argued that both task uncertainty and task interdependence create a need for personal and group coordination mechanisms. Similarly, Mullen and Copper (1994) stated that task interdependence required groups to develop. Under these circumstances, groups with high task interdependence would supposedly profit from high group development, even when task uncertainty was low. This would mask relevant effects related to task uncertainty, and hence we needed to measure task interdependence. Although our study was not the first to consider team outcomes and structural and interpersonal coordination mechanisms altogether (Ven et al., 1976), this approach was, to our knowledge, unprecedented in leadership research. Unlike

previous authors (Andres & Zmud, 2002; Ven et al., 1976), we did not consider task interdependence only as a requirement for coordination but also as a consequence of the way work is organized through organizational rules. In our study, task interdependence was particularly meant to account for cooperation requirements in non-researcher teams, such as administration, in which formal rules define the sequence of work. Hence, we regarded task interdependence as a structural coordination mechanism.

To realize the vision of empowering organizations to be more innovative and to address the above-mentioned research gap regarding the roles of task uncertainty and task interdependence, the project made the following contributions. It provided validated measurement instruments of task uncertainty and group development in the German language, thus enhancing our knowledge about the intercultural applicability of these constructs and their relationships to similar measurement instruments. It was also, to our knowledge, the first study to address the impact of task uncertainty and task interdependence in the relationships between leadership, group development, and team effectiveness. The results show that different types of task uncertainty have different effects and that by fostering team development, transformational leaders help their team members cope with changing short-term demands from outside the team.

The following paragraphs serve the purpose of delimiting the research topic and clarifying how we developed specific research objectives from the above-named project vision. As these research objectives are repeated later in the respective chapters that describe the individual studies, redundancies are unavoidable with respect to the reasoning behind these objectives; arguments or references mentioned in this introduction will reappear in chapters further down.

1.2 Innovation

The research presented here proposes that innovation is created through knowledge work and that knowledge work is characterized by uncertain tasks. There are many definitions

of the term innovation (Baregheh, Rowley, & Sambrook, 2009). In order to increase the comparability of theoretical work and of operationalizations, Baregheh et al. (2009) reviewed 60 definitions of innovation from different disciplines and then proposed: “Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, services or processes, in order to advance, compete and differentiate themselves successfully in their marketplace” (p. 1334). We adopted this cross-disciplinary definition to help diminish the fragmentation of innovation research.

At Fraunhofer IAO, the definition by Schumpeter (1947, p. 151) is currently used predominantly: innovation is “the doing of new things or the doing of things that are already being done in a new way.” The definition by Baregheh et al. (2009) is compatible with this more generalized perspective but for its emphasis on innovation as a multi-stage process, it was a better fit for our work than Schumpeter’s. In contrast to other definitions, such as those by Schumpeter (1947), Damanpour (1996), or West and Anderson (1996), we did not stress the claim that an innovation is always completed through the application or implementation in the respective social entity, i.e. a team, an organization, or a society. This aspect is particularly important for research that intends to measure innovation, or to differentiate innovation from non-innovation, and in our research, we did neither. As we explain in more detail further down, previous research that focused on innovation as an outcome variable (e.g., De Jong & Den Hartog, 2007; Eisenbeiß, 2009; Reuveni & Vashdi, 2015) was limited to homogeneous samples. To overcome this limitation, we refrained from using innovation as an outcome variable. Instead, we assumed that some innovations require contributions from more than one team before they can be implemented. From an organizational perspective, we therefore considered it sufficient to measure whether each Research and Development (R&D) team completed its objectives. The definition by Baregheh et al. (2009) reflects this thought better; instead of stressing the need for final implementation, it emphasizes the fact that innovations are produced through several stages.

Choosing the definition by Baregheh et al. (2009) had further implications for our work: we limited our research to organizations and disregarded other possibly innovative environments. However, we accepted a large variety of outcomes (products, services, and processes). This reflects the vision of the research, which is not restricted to any specific area of application or economic sector (e.g., automotive engineering). Consequently, the research approach disregarded, for example, possible differences between product innovation and process innovation.

According to the definition, innovation is not the idea itself; the idea is a necessary input for innovation to happen and thus improved products, services, or processes to become accessible to users. There is an agreement that the term creativity refers to the creation of such ideas (Cheung & Wong, 2011; West, 2002). "Creativity is thinking about new things, innovation implementation is about doing new things […]. Innovation can then be defined as encompassing both stages – the development of ideas – creativity; followed by their application – the introduction of new and improved products, services, and ways of doing things at work." (West, 2002, p. 357). The reasoning that creativity is a relevant precondition of innovation shows that research on the factors that help teams realize their creative potential (e.g., De Jong & Den Hartog, 2007; Eisenbeiß, 2009) is relevant for innovation, which is why we took it into account when forming our hypotheses (see the section "Independent variables" in this introduction, or section 4.2.1). However, this research did not target creativity but the role of task uncertainty. Thus, with respect to the definition by West (2002), it was not relevant to our research to consider the creation of ideas as an integral part of the innovation process or rather a precondition to innovation. It was not our intention to compare different phases of the innovation process. Instead, we wanted to find out what made research teams successful, compared to other types of teams. Therefore, the relevant conclusion from the mentioned definitions was that creativity is a necessary yet not a sufficient condition for innovation to happen.

1.3 Team-based knowledge work

As stated above, we envisioned a future in which organizations are empowered to be more innovative. We wanted to achieve this by providing organizations with insights into what makes teams innovative, and by delivering psychometric tools that they could use to go from insight to organizational intervention.

Based on the chosen definition of innovation, one can render the project vision more precisely: organizations should be empowered to ideate and implement a broad bandwidth of innovative outcomes: processes, services, or products. Innovation is not a linear process and not discrete (Newell, Robertson, Scarbrough, & Swan, 2009). This means that true innovation requires many different types of activities by many different people. We needed a construct that was broad enough to cover a multitude of the activities required to innovate, and that would serve, at the same time, to delimit our focus and to link innovation work to psychosocial processes. Following the perspective at Fraunhofer IAO (e.g., Spath, Linder et al., 2011), we summarized these activities as *knowledge work*. This is in line with the literature: the term *knowledge work* describes the work that individuals or teams do in order to achieve innovation as its primary outcome (Drucker, 1999; Newell et al., 2009, p. 191; Willke, 1998). However, the term knowledge work is not restricted to work aimed at innovation and may be extended to a broader array of jobs: “knowledge workers research, develop, invent, teach, consult, sell, advertise, act as coaches or therapists, they program, plan, check, investigate, analyze, interpret, construct, conceptualize, entertain, design, organize, modernize, inform, communicate, etc.” (Spath, Bauer, & Braun, 2011, translated from German by the author).

The term knowledge work is well established in innovation research and technology management (e.g., Newell et al., 2009; Ramirez & Steudel, 2008), based on the importance of knowledge work for the productivity of today’s organizations (Drucker, 1999). However, psychological research has disregarded this term so far, probably because it is not a directly

observable or measurable construct (Davenport & Prusak, 2000) but rather represents a collection of different activities. Consequently, knowledge work is not directly accessible to psychological research. Based on the reasoning presented in the following paragraphs, we proposed to operationalize knowledge work through what we consider its key characteristic: task uncertainty. Indeed, organizational psychology regards task characteristics, for example in leadership research (Purvanova, Bono, & Dzieweczynski, 2006). To our knowledge, no other study has yet provided a viable operationalization of knowledge work through a defining task characteristic.

We assumed that providing an efficient operationalization of knowledge work would build a bridge between organizational psychology and innovation research, and that this would be beneficial for both research areas. For organizational psychology, it would provide access to a relevant phenomenon and interdisciplinary research field, and innovation research, in turn, would benefit from the results of such research.

Consequently, we had to identify a measurable construct to represent key aspects of knowledge work. Ramirez & Steudel (2008) proposed a measurement framework for knowledge work. However, with its eight sub-categories of autonomy, structure, tangibility, knowledge, creativity and innovation, complexity, routine and repetitiveness, and physical effort, such a framework is very difficult to apply in psychological research.

Thus, we analyzed a broader range of definitions to extract a key characteristic. In his book from 1957, Drucker (p. 19) already related innovation to uncertainty and risk-taking. Sanner and Bunderson (2015) operationalized the knowledge intensity of work through task complexity, creativity requirements, and sense-making requirements. While the three aspects named by Sanner and Bunderson (2015) may indeed be present in the daily work of many knowledge workers, the literature seems to stress another key characteristic: according to modern definitions, knowledge work is characterized by the search for solutions to unprecedented questions or issues in a complex environment (Spath et al., 2013, p. 17). Also

by definition, it is work realized without clear definitions of goals and outcomes (Spath & Hoffmann, 2009). Consequently, the tasks of knowledge workers fit the definition of task uncertainty in the MITAG (group tasks uncertainty model, by Navarro, Díez, Gómez, Meneses, & Quijano, 2008): unknown goals and processes both explicitly correspond to the MITAG dimension of *clarity*. The other dimensions seem to apply as well: innovating usually requires a great bandwidth or variety of tasks to be performed (*diversity*), many of which can only be done well by a certain specialized team member. While all human work is based on some sort of knowledge of how things are done, knowledge work is special in the sense that such procedural knowledge is not only acquired once in a worker's life time; instead, knowledge that serves as a resource of the work is regarded as always improvable and thus constantly being revised (Willke, 1998). This refers to the dimension of *novelty*: there are likely uncertainties about which method is the best, or team members have little experience with the most promising method. The last dimension, *conflict*, is also likely to score high in knowledge work: innovating usually means balancing the demands of different stakeholders and other restrictions, such as prioritizing among customer requirements, technical limitations, and production costs.

Based on the above-said, investigating the factors that increase the productivity of knowledge workers meant finding out how workers deal effectively with uncertain tasks. For the following reasons, we conducted this research at team level. Each knowledge worker is expected to be a specialist of what he/she does (Drucker, 1999). It is in the interaction between different knowledge workers where new knowledge is most likely to be generated (Spath & Hoffmann, 2009). Frost et al. (2010) suggested that "knowledge production is heavily dependent on voluntary contributions and the sharing of knowledge" (p. 126). Whilst team diversity is a research area of its own, which has found empirical evidence of both positive and negative effects of educational or other differences between team members (Horwitz & Horwitz, 2007), one may assume that in most cases, innovation cannot be

achieved by a single worker. Therefore, it is particularly interesting to research psychosocial processes in teams that do R&D work (Elkins & Keller, 2003).

Although some scholars have already proposed considering teamwork as a preferable method to deal with the challenges of uncertain work, or innovation work (Kozlowski & Bell, 2003, p. 4; Navarro et al., 2011), these assumptions have not yet been backed by any empirical evidence. From a theoretical perspective, innovation work with its uncertainties fits the category of tasks that are "too large or complex for a single individual to undertake", and which are therefore tackled by teams combining "diverse expertise, skills and resources" (Espinosa, Lerch, & Kraut, 2009, p. 107). Coordination mechanisms help teams effectively manage the large number of complex dependencies that result from this work (Espinosa et al., 2009). This is how teams can create the synergies that allow them to be more productive than the sum of their members working independently (Frost et al., 2010); this is called emergence (Salas, Rosen, Burke, & Goodwin, 2009). Two main types of such mechanisms are predominant in the literature: one is structural, impersonal, rule-based or administrative coordination, and the other is personal, group, or communication-based coordination. While both types seem to be necessary for teams to be productive (Espinosa et al., 2009), Ven et al. (1976) argued that with increasing uncertainty, personal or group coordination mechanisms would become more relevant to the team's success. Coordination mechanisms need to be studied at team level.

In addition to the assumption that innovation requires team level mechanisms which foster the collaboration of knowledge workers, there are two more reasons for us to conduct our research at team level: the increasing relevance of teams in organizations (Meneses, Ortega, Navarro, & Quijano, 2008), and the fact that other researchers have chosen a team level perspective on the factors influencing innovation (e.g., Eisenbeiß, 2009; Reuveni & Vashdi, 2015).

Thus, to realize the project vision of supporting innovation in organizations, we researched the factors that influence the effectiveness of teams working on tasks characterized by high uncertainty. Among the potential factors of interest were coordination mechanisms, particularly those at group or personal level.

1.4 Definition of the term team

Since the work presented here continues the line of research dedicated to the HSA, we worked with a definition of the term team that was compatible with the definition used in previous work by Meneses (2015). Based on Kozlowski and Bell (2013) and analogously to Meneses (2015), we used the terms team and work group interchangeably. This was also in line with the currently predominant definitions of the term team.

We followed the defining criteria by Kozlowski and Bell (2013) and added restrictions mentioned by Meneses (2015). Consequently, we understood a team as an official unit of the organization that is composed of at least two (Kozlowski & Bell, 2013) and not more than 15 individuals, who all report to the same leader (Meneses, 2015). Teams exist to "perform organizationally relevant tasks", represented by team goals, and they do so by interacting socially (Kozlowski & Bell, 2013, p.5).

This definition particularly excludes virtual teams or project teams composed of employees from different organizations. Virtual teams deserve specifically dedicated research, due to the differing conditions of work, for example, the shorter team lifespan or possible conflicts between the employer organization and the other participating stakeholders. In contrast to the definition by Kozlowski and Bell (2013), we also excluded the defining criterion of task interdependence and measured it as a separate variable. The reason is that we assumed it to vary across teams, even though the existence of common goals should imply at least some level of task interdependence in any team. Task interdependence refers to the way work is organized (Vegt, Emans, & Vliert, 2001). This assumption corresponds to the model presented by Navarro and colleagues (2011, p. 19). If, as Spath and Hoffmann (2009) suggest,

knowledge workers depend on each other's special knowledge or skills, then some degree of task interdependence is always present in knowledge work.

1.5 Research model

Research on leadership and team outcomes (e.g., Dionne, Yammarino, Atwater, & Spangler, 2004; Unsworth & West, 2000; West & Hirst, 2003) has largely relied on Input-Process-Output Models (I-P-O). Based on reasoning by Ilgen, Hollenbeck, Johnson, and Jundt (2005), we considered Input-Mediator-Output-Input (IMOI) models more adequate: they do not assume the mediator to be a process.

1.6 Independent variables

As a potentially beneficial coordination mechanism for teams working on uncertain tasks, we chose transformational leadership. Following Ven et al. (1976), transformational leadership qualifies as a personal coordination mechanism. We chose this construct for the following reasons. Transformational leadership has been researched extensively during the past three decades and there is experimental evidence that it has a positive effect on team outcomes (Avolio, Reichard, Hannah, Walumbwa, & Chan, 2009), across a variety of teams. Furthermore, as argued above, innovation requires creativity and transformational leadership has received considerable attention as a predictor of constructs that represent innovative team outcomes, such as group creativity (Eisenbeiß, 2009; Jung, 2001) or team innovation (Paulsen, Maldonado, Callan, & Ayoko, 2009). Finally, literature suggests that transformational leadership is more effective in turbulent organizational environments (Felfe, 2006). To our knowledge, the assumption that it is also more effective in uncertain tasks (Frost et al., 2010) had not yet been tested. In the third study (chapter 4), we tested this assumption. Chapter 4 contains a more detailed overview of the state of the art with respect to research on the relationship between transformational leadership and team creativity.

Transformational leadership is not the only leadership style that has been related to creative or innovative outcomes. Participative leadership styles (Somech, 2006) or shared leadership (Sun, Jie, Wang, Xue, & Liu, 2016) have also been discussed and investigated. Other supposedly relevant variables that may influence innovation in teams are team heterogeneity (Somech, 2006) or diversity (Horwitz & Horwitz, 2007), and team size (Weiss & Hoegl, 2016). We decided to include transformational leadership into our model, based on the reasons named above. This leadership style is characterized by the following four leader behaviors (Bass et al., 2003):

- *Idealized influence*: the leader serves as a role model regarding ethical conduct and principles; followers admire, respect and trust the leader.
- *Inspirational motivation*: the leader motivates followers through a meaningful vision of a positive future.
- *Intellectual stimulation*: the leader encourages the followers to find their own solutions, and thus "to be innovative" (Bass et al., 2003, p. 208).
- *Individualized consideration*: the leader acts as a coach or mentor to further the development of the followers; the individual needs of the followers are taken into account.

We understood transformational leadership as a one-factorial construct. Berger et al. (2012) provided empirical support for this assumption, and other authors have reported high correlations among these four characteristics (Avolio, Bass, & Jung, 1999; Bycio, Hackett, & Allen, 1995; Rowold & Heinitz, 2007). Thus, we refrained from modeling effects of these leadership behaviors separately. This is also a common approach in the literature on transformational leadership and innovative outcomes (Eisenbeiß, 2009; Jung, Chow, & Wu, 2003; Reuveni & Vashdi, 2015). The HSA provides such a one-dimensional measurement of transformational leadership: the HSA-TFL short-scale by (Berger & Guàrdia, 2017).

With respect to the effects of transformational leadership on knowledge work, research has to our knowledge always focused on outcome variables such as team innovation or team creativity (De Jong & Den Hartog, 2007; Eisenbeiß, 2009; Jung, 2001; Paulsen et al., 2009; Pundt & Schyns, 2005). This approach has an important limitation: it is necessarily restricted to specific environments or samples that are expected to be creative or innovative. While this is not a problem for practitioners who want to draw conclusions for similar environments or samples, at a scientific level it does not provide insights into possible differences of the way transformational leadership affects knowledge worker teams, compared to teams in other fields of work. In our opinion, this was a gap in the existing literature (De Jong & Den Hartog, 2007; Eisenbeiß, 2009; Jung, 2001; Paulsen et al., 2009; Pundt & Schyns, 2005) and this was the reason we decided to research the relationships between transformational leadership and team effectiveness in a heterogeneous sample, while including task uncertainty in the measurement model and thus distinguishing between knowledge worker teams and non-knowledge worker teams. As mentioned above, the literature indeed suggests that transformational leadership may be more effective in teams of knowledge workers (Frost et al., 2010). As far as we know, this assumption has not yet been tested.

Furthermore, factors that may mediate the relationships between transformational leadership and team creativity or innovation have been investigated; among them are cohesiveness (Eisenbeiß, 2009), team identity (Paulsen et al., 2009), engagement and knowledge sharing (Edmondson & Lei, 2014), and shared mental models (Reuveni & Vashdi, 2015). Measurements of cohesiveness have been used particularly often as a mediator of the relationships between transformational leadership and team outcomes (Bass et al., 2003; Jung & Sosik, 2002). Because of the limitations of the construct of cohesiveness (Hogg, 1993), with respect to differing operationalizations and interpretability at a theoretical level, we opted for measuring Group Development (GD; Navarro, Meneses, Miralles, Moreno, & Campelo, 2015) instead, thus relying on another measurement from the HSA. We considered

it beneficial to rely on measurements from the same measurement framework, as this improves the theoretical basis for interpreting the results. In addition to the generally expected beneficial influence of GD on team outcomes, we considered GD as a particularly relevant process to help teams confront uncertainty (e.g., Navarro et al., 2011; Ven et al., 1976). Recent research by Dingsøyr, Moe, and Seim (2018) confirmed claims by Ven et al. (1976): under conditions of high task uncertainty, coordination mechanisms based on cooperation among group members (i.e. horizontal coordination mechanisms and group meetings) tend to substitute impersonal coordination mechanisms. In other words: group members increase cooperative activities that involve direct interaction among them to tackle task uncertainty. Group Development is yet another interpersonal or group level coordination mechanism.

1.7 Dependent variable

As stated above, we took a different approach than previous research (Eisenbeiß, 2009; Jung, 2001; Paulsen et al., 2009): instead of restricting ourselves to a sample just consisting of knowledge workers, we collected data from different types of teams: teams presumably working on high-uncertainty tasks and teams working on what we assumed to be low-uncertainty tasks. Then, we compared the teams based on their level of task uncertainty. That required choosing a dependent variable that could be applied to any kind of team, whether it was supposed to produce innovation (i.e. research) or not (i.e. mechanical work, administrative tasks). For this purpose, we chose yet another HSA measurement: team effectiveness. This measurement, based on Hackman's (1987) model, is common in team research (e.g., Kozlowski & Bell, 2003) and thus increased the comparability of our results.

1.8 Research objectives

As a result of the above-stated, the main objective of this research project was to investigate the relationships between transformational leadership, group development, team effectiveness, and task uncertainty. Chapter 4 contains a more detailed reasoning of why we

chose this research question. Researching such a comprehensive model of the relationships between key variables from the HSA was a logical next step in the development of this measurement framework. Knowing how three of its key variables are interrelated enhances its practical applicability and creates a basis for further theoretical development. As the HSA and its measurement instruments were developed in Spain and Latin America (Navarro et al., 2011), it was reasonable to test the hypotheses in another national culture. Germany is the biggest economy in Europe and its national culture differs substantially from the Spanish, particularly regarding power distance, individualism, and long term orientation (Hofstede, Hofstede, & Minkov, 2010), all of which might have an impact on how teams work. We therefore decided to test the model in Germany.

In order to do this, it was necessary to validate two of the measurement instruments from the HSA in a German sample: the GD questionnaire and the MITAG questionnaire. In addition to serving the purpose of providing the measurement instruments necessary for answering the main research question, with these validation studies we also intended to broaden the evidence base with respect to the intercultural applicability of these constructs.

The detailed research hypotheses are given in chapter 4, as the variables used depended on the outcomes of the validation studies described in chapters 2 and 3. In summary, the alternative research hypotheses (H_1) of the three studies were:

1. Study 1: the GD instrument will show acceptable psychometric characteristics in a German sample.
2. Study 2: the MITAG instrument will show acceptable psychometric characteristics in a German sample.
3. Study 3: group development and a certain subordinate type of task uncertainty (i.e. *unclarity of goals*) will mediate the positive relationship between transformational leadership and team effectiveness, while a different subordinate type of task

uncertainty (i.e. *new situations*) and task interdependence will moderate the relationship between group development and team effectiveness.

1.9 The contribution to leadership research

As detailed above, research evidence indicates that transformational leadership can foster the creative and innovative outputs of teams (De Jong & Den Hartog, 2007; Eisenbeiß, 2009; Paulsen et al., 2009; Pundt & Schyns, 2005; Reuveni & Vashdi, 2015). However, it appears that transformational leadership can, at the same time, also diminish team creativity (Eisenbeiß, 2009), for example if followers become too dependent on their leader and new ideas are suppressed. In addition to these effects specifically related to creativity and innovation, there is an extensive base of correlational as well as experimental studies emphasizing the positive effects of transformational leadership on work groups (Avolio et al., 2009). Currently, the main research gap consists in our limited knowledge about the processes that cause these effects. Yukl (1999, p. 11) called this the "black box" of transformational leadership. Thus, researchers are now focusing on subsequent team level processes that may explain these effects (e.g., Eisenbeiß, 2009; Molero, Cuadrado, Navas, & Morales, 2007; Whittington, Goodwin, & Murray, 2004; Wolfram & Mohr, 2008). The high inter-correlations between the four facets of transformational leadership (Avolio et al., 1999; Berger et al., 2012; Bycio et al., 1995; Rowold & Heinitz, 2007) make it even more difficult to identify the involved mechanisms.

This is why the main research question refers to transformational leadership. We wanted to provide new insights into the way transformational leadership relates to team effectiveness, while considering task characteristics, and thus contribute to the state of the art in leadership research. To our knowledge, research relating transformational leadership to innovation or creativity (e.g., Eisenbeiß, 2009; Paulsen et al., 2009; Reuveni & Vashdi, 2015) ignored task characteristics; an exception is a model propagated by West (2002), who argued that team tasks needed to evoke task orientation or intrinsic motivation, through task

characteristics such as completeness, opportunities for learning, and varied demands. However, West (2002) also proposes team innovation as an outcome variable, and therefore the model does not allow for comparing knowledge workers to teams dealing with other task characteristics. Hence, this model has limited applicability: if one assumes that knowledge work is most likely characterized by task variety, it seems rather tautological to assume that such tasks will be positively related to innovative outcomes. In this research, we followed a different approach and regarded researchers and non-researchers, thus allowing for more variation in task characteristics and outcomes.

Although the existing research provides valuable insights for organizations about the factors that affect the innovative outputs of teams, we cannot conclude whether knowledge workers need more transformational leadership than others and if it has a different effect on them than on other types of teams. If research is restricted to, for example, teams of designers or researchers, then the results will not allow for this type of conclusion. We chose a different approach by comparing teams of knowledge workers to other teams, based on their level of task uncertainty. Apart from the general motivation to address the black box issue of transformational leadership, there was also a concise reason for including task uncertainty in our model (chapter 4) and thus comparing different types of teams: transformational leadership is more effective in uncertain organizational environments (Felfe, 2006) and we wanted to find out whether the same applied to uncertain team tasks. Frost et al. (2010) have made a similar argument, which supports our approach. In summary, the main contribution to leadership research was to test how transformational leadership affects team effectiveness in teams dealing with different aspects of task uncertainty, and thus to provide insights on the characteristics of transformational leadership that are likely to make knowledge worker teams more productive. This implied finding out if transformational leaders can reduce certain aspects of task uncertainty, or if certain aspects of task uncertainty rather boost the effects of

leadership style. To achieve this, we needed to address different types of task uncertainty, instead of just one global measure.

1.10 The contribution to teamwork research

Research on team effectiveness has a 60-year long history; most of it was based on McGrath's (1964) input-process-output (IPO) heuristic (Kozlowski, 2015). One example is the model by West & Hirst (2003). IPO models have been criticized for not representing the dynamic nature of team processes: processes were measured as static constructs, neglecting the way they develop and change over time (Kozlowski, 2015). There are currently attempts to address this complex issue (Cronin, 2015), which results either from neglecting how the team process, measured as a team-level construct, emerges and varies over time, or from disregarding the accompanying factors that go along with fluctuations in such manifest process variables (Kozlowski, 2015).

We share this perspective and also advocate addressing team dynamics. However, due to the resulting complexity, it appears that IPO models or input-mediator-output-input (IMOI; Ilgen et al., 2005) models are an appropriate choice to explore the relationships between key constructs before creating the complex models that include process dynamics. In this research, we considered group processes in our model relating transformational leadership to task uncertainty and team effectiveness. The results may serve as a stepping stone for subsequent analyses on the dynamics involved in the identified relationships, for example in research on team adaptation.

As uncertainty is becoming more prominent in the modern working world (Navarro et al., 2011), we need to find out how teams deal with these aspects of uncertainty. Navarro et al. (2011, p. 20) argued that uncertain tasks require teamwork, for various reasons: teamwork provides a mix of knowledge and skills that helps team members cope with diverse requirements; additionally, social processes in teams create shared meanings that help cope with the anxiety caused by ambiguous or complex tasks. However, this hypothesis has

apparently not been researched to date so we put this assumption to the test. The results can provide valuable input to research on team adaptation. Knowing what aspects of uncertainty affect the work of teams, and how leadership and group processes affect team outcomes under such conditions will help formulate hypotheses. Maynard, Kennedy, and Sommer (2015) argued that research should pay greater attention to "the nature of the triggers that give rise to team adaptation and how such triggers may shape the specific processes that need to be adapted by the team" (p. 664). Task uncertainty may be one such trigger, and consequently, the work presented here contributes to team research.

1.11 The perspective of the involved research institutes

This work relied on research methods from organizational psychology. In addition to answering currently pressing research questions in the areas of leadership and teamwork, this study also continues the HSA research line at the UB (Navarro et al., 2011). It investigates the relationships between five key constructs in the HSA: transformational leadership, group development, team effectiveness, task uncertainty, and task interdependence.

We chose the HSA as we did not find any other measurement framework that contained more of the relevant variables. For example, Dickinson and McIntyre (1997) presented a framework for developing teamwork measures. However, the framework does not contain measurements but, rather, guidance on how to develop them. Furthermore, it does not consider task characteristics. Ramirez and Steudel (2008) presented a framework for operationalizing knowledge work through a combination of eight measurement dimensions. However, the measurements they proposed, such as MTM analyses, were too difficult to obtain in our study. The framework developed by del Rey Chamorro, Roy, van Wegen, and Steele (2003) is focused on knowledge management and targets the organizational level and performance evaluation; it lacks representations of leadership and team processes.

Despite the strong relationship to the UB, this research is also a continuation of work at Fraunhofer IAO. From the latter we imported our understanding of knowledge work, which

we placed at the center of the work, instead of focusing on innovation as the desired outcome variable like other researchers have done (De Jong & Den Hartog, 2007; Edmondson & Lei, 2014; Eisenbeiß, 2009; Jung, 2001; Paulsen et al., 2009; Pundt & Schyns, 2005; Reuveni & Vashdi, 2015). Thus, we avoided limiting our research to homogeneous samples and we were able to compare the effects of different coordination mechanisms, such as group development, across different job types. Another benefit of developing our research questions based on the concept of knowledge work was to build a bridge between innovation research and organizational psychology and thus to emphasize the relevance of this research for the broad array of work activities named by Spath, Bauer et al. (2011, p. 25). The work presented here contributed to the line of research on the HSA by studying the relationships between its key variables. Its results could also add to models of technology management, such as the innovation excellence model, which today only contains *innovation culture* as a psychosocial construct (Spath, Linder et al., 2011, p. 199).

1.12 Summary

We conducted the research presented here to investigate what makes teams of knowledge workers innovative. To this purpose, we argued that knowledge workers are, by definition, exposed to high task uncertainty. Evidence shows that transformational leadership has a positive impact on the desired outcomes of knowledge worker teams: innovation and creativity. However, research had not yet compared the effects of transformational leadership between teams of knowledge workers, who deal with highly uncertain tasks, and other teams. We addressed this research gap. We considered group development as a mediator, using it as a replacement for the commonly used construct of group cohesion, and we took task interdependence into account, as a possible confounding variable. We collected data from a German sample and before addressing the main research question, we validated two instruments, the Group Development questionnaire and the MITAG questionnaire for measuring task uncertainty, in German samples.

1.13 Structure of the thesis

The previous paragraphs serve as a general introduction to the research topic, including background information on the research questions and the chosen constructs. The subsequent second chapter depicts the first study, the validation of the German GD questionnaire. The third chapter describes the second study, the validation of the German translation of the MITAG. The fourth chapter reports the third study, which refers to testing the research model. The fifth chapter discusses strengths and limitations, and the sixth chapter summarizes the results and merges the implications of the three studies. The thesis ends with a list of references.

Chapter 2

Study 1: Validation of the German Group Development (GD) questionnaire

2.1 Theoretical background

Group development models such as the ones described by Tuckman and Jensen (1977), Wheelan (1994), and Morgan, Salas, and Glickman (2010) focus on a group's life cycle or developmental stages. Such categorical models are sometimes difficult to fit into test designs, as they assume linear development (Miller, 2003) and thus do not provide insight into what happens after a team has reached the final stage. This could cause ceiling effects or eliminate variance in teams with a longer history. Consequently, researching factors that influence group performance may require measuring a group's capacity to create emergence or work as a team as a continuous outcome variable. In the past, researchers have frequently used measurements of group cohesion for this purpose. As a direct predictor of group performance, cohesion has thus gained a prominent role, for example in leadership research (Jung & Sosik, 2002) as well as diversity research (Webber & Donahue, 2001). However, there are some issues with the concept of group cohesiveness and the way it is measured (Hogg, 1993). The main issue lies in its different operationalizations: cohesion can be restricted to commitment to the team task (Carron, 1982), it may additionally include interpersonal attraction and group pride (Mullen & Copper, 1994), or it can primarily represent team structure (Lickel et al., 2000). Valid alternative instruments for use in diverse cultural contexts are missing. To resolve these issues and to provide an instrument for the continuous measurement of group development, Meneses et al. (2008) developed the GD questionnaire.

The construct of group development as represented in the GD questionnaire is based on the shared aspects of two main approaches (Meneses et al., 2008): the classic stage approach of an evolving group (Tuckman & Jensen, 1977; Wheelan, 1994) and the approach

behind the concepts of *entitativity, groupness,* and *groupality* (e.g., Arrow, McGrath, & Berdahl, 2000; Hamilton & Sherman, 1996; Lickel et al., 2000). Following Meneses et al. (2008), the relevant shared aspects are the consideration of a group as a continuum in the sense of *groupality* and core characteristics of a defined group. The GD instrument consists of one factor and measures group development as the degree to which a group shows the following properties: 1) interpersonal relationships among its members; 2) identification of the members with the group; 3) coordination of behaviors, resources, and technologies; 4) meaning or value ascribed to the shared task; and 5) members being geared toward achieving group goals (Navarro et al., 2015). Validation studies in Spain, Brazil, and Venezuela resulted in the final GD questionnaire appearing in Spanish and Portuguese; exploratory (EFA) and confirmatory factor analysis (CFA) verified the unidimensional structure. Correlations with other measures at individual level, as well as correlations with performance indicators at team level are evidence of the tool's validity (Navarro et al., 2015).

Specifically, the GD predicted group performance, as operationalized by a questionnaire based on Hackman's (1987) criteria and by the organizational indicators *absenteeism* and *order and hygiene* (Navarro et al., 2015). In another Spanish sample, Navarro, Meneses, Nadal, and Landsberger (2016) assessed the incremental validity of the GD instrument with respect to the traditional stage-based model of group development as reflected in Wheelan and Hochberger's (1996) questionnaire. Both instruments correlated highly (r = .74) and the GD indeed explained additional variance of a group's self-rating of effectiveness, based on Hackman's (1987) criteria.

Regarding the generally increasing importance of teamwork (Meneses et al., 2008), the GD instrument would most likely provide added value to organizations in other cultures too. Furthermore, consisting of only eight items, the GD questionnaire conveniently short for practitioners to use and as it measures group development on a continuum, it complements the existing measurement models focused on developmental stages or a group's life cycle.

We selected Germany as a contrast culture to validate the GD instrument, since it is the biggest economy in Europe. Additionally, the German national culture differs substantially from the Spanish, particularly regarding power distance, individualism, and long term orientation (Hofstede et al., 2010), all of which might have an impact on how teams work. In order to add to theoretical knowledge about the intercultural relevance of the construct, and to make the instrument available for use in German-speaking populations, we translated the GD questionnaire and validated it in a German sample.

Apart from the source constructs of entitativity, groupness, and groupality, other constructs also relate to the GD at theoretical level. One is team climate, defined as a shared subjective perception of the situation in the team, created through the social interaction required to achieve the group's common objectives (Brodbeck, Guillaume, & Winkler, 2010). To assess the GD's relationship to team climate variables, we chose the *Team Climate for Learning* questionnaire (TCL; Brodbeck et al., 2010), as it comprises a broad range of teamwork aspects, some of which we expected to relate more strongly to group development than others. As a validity criterion, we chose the variable of *motivation and interest*, which refers to the team members' interest in the team's tasks, or the motivation to engage in them. Both the construct itself and the respective items share low resemblance with the GD instrument. Nonetheless, we assumed that if a group is well-developed, as delineated by the four characteristics described above, then its members should be highly engaged in the team's tasks. As a variable with a supposedly moderate relationship to the GD, we picked *mutual trust*. This refers to the expectation that the other team members' future actions will be in one's favor. It corresponds to the GD characteristic of good interpersonal relationships among team members. Another TCL dimension, *democracy*, operationalizes the absence of dominance by one particular member or leader. Democracy thus has no conceptual overlap with the characteristics measured by the GD. Nevertheless, dominant leadership may lead to decreased information sharing among team members, consequently deteriorating cooperation

and hampering emergence (Brodbeck et al., 2010). Therefore, we expected democracy to correlate moderately to the GD.

The GD's predecessor constructs of groupness and entitativity make reference to the salience of the group. Other models of teamwork make reference to salience by the extent which group members "overtly reflect upon, and communicate about [...] the social processes within the [team]" (Widmer, Schippers, & West, 2009). This is for example represented as *social reflexivity* in a model by West (1994), and as *person-orientation* by Beckhard (1972). In German, a measurement instrument based on these concepts was available: the *Fragebogen zur Arbeit im Team - Kurzversion* (F-A-T short) by Kauffeld and Frieling (2001). We picked the dimension *Zusammenhalt* (German: solidarity, team spirit) to represent social reflexivity. We expected Zusammenhalt to correlate moderately to the GD, as it represents good personal interrelationships among team members.

Another construct also regarded by Navarro et al. (2015) was group-potency. As the GD represents key requirements of a team to create emergence, it is positively related to team effectiveness. Thus, one can assume that the team members' expectations of group effectiveness will also correlate to the GD. As another variable that would correlate only moderately to the GD, we picked the *Skala zur arbeitsbezogenen kollektiven Wirksamkeitserwartung* (SABKWSE) by Moser, Schaffner, and Heinle (2005) as a German measurement of group potency. It refers to the group members' subjective certainty of being able to master work-related demands as a team, because of shared competences. The conceptual overlap with the GD instrument thus lies in the sharing of competences among team members, and presumably, higher expectations of group-efficiency would be related to higher identification with the group.

2.2 Methods

2.2.1 Participants

We invited employees of a German research organization to complete an online

survey. We selected this organization since it was one of the largest research institutions of Europe, serving as a key innovator for the German industry; our selection criterion was a size of at least 5,000 employees. Furthermore, it employed team structures, and the teams worked in many different research areas. The organization was composed of divisions at different locations in Germany, each of which works fairly independently. For this reason, we considered it well-representative of the R&D context.

Table 1

Sample description

	1 (team members) (N = 501)		2 (team leaders) (N = 104)	
	N	per cent	*N*	per cent
Male participants	343	68.5%	87	83.7%
Female participants	158	31.5%	17	16.3%
Job: researcher	423	84.4%	88	82.2%
Job: other	78	15.6%	19	17,8%

Note. N = Number of individuals.

To finish the questionnaire, we required the users to answer all items. Out of the 2030 employees (1737 team members and 293 team leaders) that we invited, 28.8% of the members and 35.5% of the leaders returned a completed questionnaire, resulting in the sample described in Table 1. We provided a longer questionnaire for team members and a shorter one for team leaders, which may have accounted for the higher response rate among the latter. Leaders answered the GD questionnaire only, whilst members also responded to items representing group potency, team spirit, democracy, mutual trust, and motivation and interest, which we used in construct validation. In the sample of team members (sample 1), mean age

was 34.3 years (*SD* = 11.8). The leaders (sample 2) had a mean age of 41.4 years (*SD* = 9.5). Four main categories of jobs were represented in the sample: research and development, administration, IT services, public relations, and one category combining mechanical work and facility services. The samples contained more researchers than other job types and more male than female participants. Mean team size was 7.9 members when including the leader in the count.

2.2.2 Measures

Group Development. The GD questionnaire consists of eight items. They come with a 5-point Likert-scale and form a single factor. Cronbach's α was between .70 and .85 in previous validation studies (Navarro et al., 2015). The items are displayed in Table 2.

In English, item 7 says for example, "We share tools, resources and information." To assess the validity of the GD, we examined its correlations to similar constructs, measured with the following validated instruments. The respective internal consistency coefficients and correlation coefficients, as resulting from our data, are given in the results section in Table 3.

Zusammenhalt. We administered three of four available items measuring the factor of *Zusammenhalt* (German: solidarity; team spirit) in the *Fragebogen zur Arbeit im Team – Kurzversion* (F-A-T short) by Kauffeld and Frieling (2001), using the original answer format: a 6-point semantic differential. As the items had similar discrimination indices, we chose the items that appeared to be most similar regarding their contents. An example item reads "Wir fühlen uns untereinander verstanden und akzeptiert" ("We feel understood and accepted among one another").

Group potency. We picked three items from the one-dimensional *Skala zur arbeitsbezogenen kollektiven Wirksamkeitserwartung* (SABKWSE) by Moser et al. (2005) and kept its original scoring format: a 4-point Likert scale. An example item says "Ich habe Vertrauen, dass wir es gemeinsam schaffen können, Projekte auch unter Schwierigkeiten in

Table 2

GD items

No.	German	Spanish
	In meiner Arbeitsgruppe…	
1	haben wir eine Art gefunden wie wir gewöhnlich als Gruppe funktionieren.	Tenemos una forma habitual de funcionar como grupo.
2	fühlt sich jeder als ein wichtiger Teil dieser Gruppe.	Nos sentimos parte importante de este grupo.
3	sind wir als Gruppenmitglieder alle ständig miteinander verbunden.	Todos los miembros estamos relacionados constantemente.
4	fühlen sich die Mitglieder verpflichtet die gesteckten Gruppenziele zu erreichen.	Los miembros se sienten comprometidos en la consecución de las metas del grupo.
5	besteht nur wenig Verbundenheit unter den Gruppenmitgliedern.	Hay una baja interrelación entre todos los miembros.
6	teilen wir in Bezug auf die Arbeit dieselben Werte.	Compartimos los mismos valores de trabajo.
7	teilen wir untereinander Instrumente, Ressourcen und Informationen.	Compartimos herramientas, recursos e información.
8	ist es eine grundlegende Aufgabe, uns um unsere eigene Entwicklung als Gruppe zu kümmern.	Una tarea fundamental es cuidar de nuestro propio desarrollo como grupo.

die Tat umzusetzen" ("I am confident that together, we can realize projects even under difficulties"). We selected the items with the highest discrimination indices.

Democracy, mutual trust, and interest. From the Team Climate for Learning questionnaire (TCL) by Brodbeck et al. (2010), we measured the subscales democracy (both items) and mutual trust (all four items), as well as the subscale motivation and interest (all four items). The latter served as an external criterion variable. We administered all TCL items with the original 7-point Likert scale. An exemplary item of democracy is "Ein Teammitglied dominiert die Gruppe" ("One team member dominates the group"). An item from the subscale mutual trust reads "Unter den Teammitgliedern gibt es einen ausgeprägten Sinn für Hilfsbereitschaft" ("There is a distinct sense of helpfulness among the team members"). Support for innovation is measured by items such as "Das Team bewegt sich ständig auf die Entwicklung neuer Antworten zu" ("The team is constantly moving towards the development of new ideas").

2.2.3 Procedure

A Spanish organizational psychologist translated the GD questionnaire into German. To comply with the guidelines by the International Test Commission (ITC, 2017) a German organizational psychologist and a bilingual native speaker then translated it back to Spanish and checked for possible cultural or linguistic differences.

We collected the necessary permissions from the head of the organization, from the directors of the 12 divisions participating in the survey, and from the workers' council (German: Gesamtbetriebsrat). Based on the organizational chart of each division, we then identified the teams that were eligible for the survey: teams had to consist of at least three members (maximum: 15) and only one leader. This was in line with our *definition of the term team*, as detailed above in the respective section of the introduction; it ensured the comparability of our research to previous studies. Then we sent personalized access codes to

the participants via email. Participation was voluntary. All participants who completed the questionnaire could participate in a lottery to win one of several monetary prizes.

In summary, the sampling procedure combined the convenient, purposive, and voluntary approach: convenient, since we collected data from only one organization; purposive, since we pre-selected participants based on our definition of the term team; and voluntary, since participation was not mandatory for any participant.

While we performed all analyses in the team members dataset (sample 1), the data provided by the leaders (sample 2) served for complementary factor analysis and reliability assessment and thus to broaden the evidence. We realized the CFA in AMOS version 22. For evaluating the Structural Equation Models (SEM), we chose χ^2, χ^2/df ratio, Root Mean Square Error of Approximation (RMSEA: Steiger, 1990), and TLI (Tucker-Lewis-Index: Bollen, 1989) as reference statistics. We followed Kenny (2016) and preferred the more conservative TLI over CFI (Comparative Fit Index: Bentler, 1990). We refrained from using NFI, as it does not penalize model complexity (Kenny, 2016), and from using GFI and AGFI, following Sharma, Mukherjee, Kumar, & Dillon (2005). However, we report NFI, GFI, and AGFI further down, to allow for a comparison with the results from the Brazilian sample (Navarro et al., 2015). To evaluate the GD's relationships to other instruments, we relied on Pearson correlations.

2.3 Results

2.3.1 Confirmatory Factor Analysis

In the CFA, we accepted TLI at 0.95 or greater, RMSEA at 0.06 or lower (Hu & Bentler, 1999), and χ^2/df ratio at 5 or lower (Schumacker & Lomax, 2004). Based on this, the unidimensional structure of the GD questionnaire was confirmed in both samples. Additionally, we obtained NFI, GFI and AGFI similar to those found by Navarro et al. (2015) in a Brazilian sample (Table 4).

To assess validity at item level, we used Composite Reliability (CR) and Average Variance Extracted (AVE), which we calculated in sample 1, using a tool by Gaskin (2012). We accepted validity with CR > .7 and AVE > .5 (Fornell & Larcker, 1981). These criteria were partially met, as AVE missed the quality criterion by .02, while CR met the defined quality standard (Table 5).

Cronbach's α was our choice to assess the internal consistency of each scale. For the complete eight-item scale, Cronbach's α was greater than .80 in both samples (Table 5) and thus acceptable.

Table 3

Pearson correlations among GD and selected criteria

		1	2	3	4	5	6
1	GD	(.87)					
2	TCL Mutual trust	.76**	(.89)				
3	TCL Democracy	.23**	.31**	(.66)			
4	FAT Zusammenhalt	-.64**	-.75**	-.30**	(.89)		
5	SABKWSE	.64**	.63**	.24**	-.61**	(.87)	
6	TCL Motivation	.79**	.77**	.23**	-.67**	.71**	(.86)

Note. ** indicates significance at $p<.01$. The main diagonal contains Cronbach's α (members sample).

We regarded models as invariant if the difference in CFI was .01 or smaller (Cheung & Rensvold, 2002). In sample 1, the GD showed invariance between the group of researchers and the group of other job types, as well as between male and female participants: ΔCFI was .002 in both invariance tests. Sample 2 was too small to repeat the measurement invariance test.

Table 4

Model fit parameters

Country	Sample	χ^2	*df*	χ^2/df	*p* (χ^2)	TLI	RMSEA	NFI	GFI	AGFI
DE	1 (members)	35.32	18	1.96	.01	0.98	0.04	.98	.98	.97
	2 (leaders)	9.48	18	0.53	.95	1.06	0.00	.96	.98	.96
BR	Navarro et al.						0.01	.98	.99	.98

Note. DE = Germany; BR = Brazil. χ^2 is the Chi-Square statistic (CMIN in Amos 22), and *df* is the respective number of degrees of freedom. *p* (χ^2) is the significance level of the χ^2 statistic, named P in Amos 22. TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; NFI = Normed Fit Index; GFI = Goodness-of-Fit Index; AGFI = Adjusted Goodness-of-Fit Index (Arbuckle, 2013).

Table 5

The GD's validity at item level

	M_1	SD_1	α_1	α_2	CR_1	AVE_1
GD	3.68	0.62	.87	.81	.88	.48

Notes. α is Cronbach's α. CR is Composite Reliability. AVE is Average Variance Extracted. Index 1 indicates data from the members' sample (*N*=501), index 2 refers to data from the leaders' sample (*N*=104).

Using the data from sample 1, we also assessed the validity of the GD scale by correlating its sum-score to the scores obtained from other instruments. The GD's high correlation with the TCL dimension of mutual trust shows its strong reference to high-quality interpersonal relationships and proactive commitment to team purposes. Its correlations with the SABKWSE items, representing group potency, and the solidarity factor from the F-A-T short were lower, yet still relevant. The GD correlated lowest with the TCL factor of

democracy, which is a specific team process not directly covered by the GD instrument (Table 3). Its high correlation ($p < .05$) with the criterion motivation and interest (Table 3) added to the evidence of the GD's validity.

2.4 Conclusions

The GD questionnaire enhances the toolbox of researchers that intend to measure the capacity of a team to work together. It overcomes the limitations of other group development instruments, since it measures a continuous variable instead of developmental stages, and it covers more relevant characteristics of well-developed groups than, for example, group cohesiveness. The main contribution of this article lies in making the GD questionnaire available for use in German samples too. Our results also provide support for the intercultural applicability of the construct.

2.4.1 Main findings

The results confirmed the GD questionnaire's construct validity in German samples: its one-factorial structure was reproduced in the CFA. We found evidence of the GD questionnaire's validity, since it correlated as expected to similar constructs from group psychology. The high correlation of the GD scores with the team members' motivation to engage in the team's tasks, which we had chosen as our central validity criterion, adds to this evidence. Across the different subgroups in the sample, the instrument showed measurement invariance. The good internal consistency matches findings from other cultures. Except for a marginally insufficient AVE, the instrument met all defined quality criteria.

The results show that the construct of GD is applicable across different cultures, genders, and job types. The finding that the mentioned characteristics of well-developed groups go together as a single factor in Spanish, Brazilian, and German samples emphasizes a broad applicability of this concept. This may be relevant for theoretical advancements in the research field of group work.

2.4.2 Limitations

Nevertheless, there are some limitations to this study. The results stem from two samples from the same research and development organization, while the validation studies of the original instrument (Navarro et al., 2015) included participants from different organizations and industrial sectors. It would be advisable to test the German version in diverse organizations and sectors to verify the broad applicability of our results. The imbalance in the sample towards a majority of male participants and a majority of researchers was apparently not critical, as the model was invariant across job types and genders. However, other job types than the ones involved here, or other grouping variables not represented here could have an as yet undetected influence on the measurement model. Additionally, the sampling procedure may have influenced the outcomes. As participation was voluntary, we cannot exclude that self-selection effects may have occurred. Another limitation is the criterion variable, since we collected its measurement from the same source. Thus, a single-source bias may have inflated the correlation between the GD and its criterion. For future studies, we recommend collecting external data to serve as a validation criterion of successful teamwork, such as financial figures or efficiency measures based on stakeholders' opinions.

AVE was probably low because the instrument represents four semantically different characteristics of well-developed groups. Although these characteristics form a common factor, the items were not designed to be parallel. In our opinion, this does not do any damage to the validity and applicability of the questionnaire.

2.4.3 Summary of results

In summary, we recommend the German translation of the GD questionnaire for use in German samples. In our opinion, this instrument should be translated into more languages to provide an even better basis for further international research, as well as for its application by practitioners, for example in Human Resources.

Chapter 3

Study 2: Validation of the German version of the Group Tasks Uncertainty Model (MITAG)

3.1 Theoretical background

Modern working contexts are increasingly affected by task uncertainty. Unclear objectives, time pressure, and polyvalence are rising across different job types (Navarro et al., 2011). Research is required to find out how individuals and teams deal effectively with uncertain tasks and this requires measuring task uncertainty.

Several measurements of task uncertainty were created in the past decades, and they have methodological weaknesses and lack conceptual foundations. For example, Perrow (1967) defined task uncertainty by *task variety* (or *number of exceptions*) and *task analyzability*. Other researchers took this work up. Ven and Ferry (1980), for instance, created a questionnaire based on the dimensions *task variability* and *difficulty*. Combining measures of difficulty and uncertainty may however not be advisable, as task difficulty refers to the worker's knowledge, skills, and abilities, whereas task uncertainty may instead rather depend on external factors. However, the idea that difficulty is a defining aspect of task uncertainty is still propagated in research, e.g. by Dingsøyr et al. (2018), referencing the work by Ven et al. (1976). Withey, Daft, and Cooper (1983) compared 12 task uncertainty measurement instruments, targeting *task variety* or *variability*, *difficulty*, *analyzability*, and *predictability* or *insufficient knowledge*. Based on their exploratory factor analysis, they created a 10-item task uncertainty scale, measuring the factors *exceptions* and *analyzability*. However, this instrument has a questionable factor structure; their analyzability scale did not differentiate well between teams and convergent validity was inflated due to shared items (Withey et al., 1983). They created the scale based on existing items, instead of a comprehensive theoretical framework of task uncertainty. The validity issues of the instruments analyzed by Withey et

al. (1983) have affected researchers in need of a short, effective measurement of task uncertainty. Some resolved to pick out small numbers of items from the instruments published by Ven and Delbecq (1974) or by Withey et al. (1983). Even though these items apparently reflected different subordinate dimensions of task uncertainty, the factor structure of these reduced instruments was disregarded. This imposes severe limitations, for example in the articles by Nidumolu (1995) and by Gardner et al. (2012).

Hence, the measurement of task uncertainty is still an unresolved issue. To fill this gap, Navarro et al. (2008) developed the MITAG (full Spanish name: Modelo de Incertidumbre de las TAreas del Grupo). They created a new set of items, taking additional literature on task characteristics into account and providing a more comprehensive conceptual model of task uncertainty that distinguishes better between different dimensions of uncertainty and thus presumably differentiates better between certain kinds of teams or job types than previous models.

The MITAG pertains to the measurement framework named *Human System Audit* (Navarro et al., 2011) and defines task uncertainty as "the existence of unclear connections or links between what the group must do (work) and the result it will achieve from this work (results)" (Navarro et al., 2011, p. 19). Navarro et al. (2011) developed it as a synthesis of different task characteristics models. Particularly, the MITAG is based on a review of McGrath's (1984) circumplex model, Campbell's (1988) task complexity model, and the organizational assessment instrument by Ven and Ferry (1980, Navarro et al., 2008). Instead of the circumplex model, which provides a typology of tasks, the MITAG measures the different characteristics of a task, which are defined as requirements related to the behaviors required for achieving optimal performance, on a continuum (Navarro et al., 2008). Compared to the models presented by Campbell or by Van de Ven and Ferry, the MITAG excludes aspects such as complexity, opacity, or difficulty (Navarro et al., 2008), which may be criticized for blending objective and subjective operationalizations.

Navarro et al. (2008) defined six initial dimensions of uncertainty and created a set of items, which they validated in a Spanish sample; their exploratory factor analysis resulted in four factors: clarity (six items), diversity (three items), novelty (six items), and conflict (three items). Ferràs (2009) confirmed this four-factor model in a second Spanish sample (Navarro et al., 2011). The factors were defined as follows. (1) Clarity refers to the team members' knowledge about which objectives they have to meet and which procedures they can apply to that purpose (Navarro et al., 2011). Thus, this factor relates to the success criteria and the possibly unpredictable relationship between a given method and its desired outcome. (2) "Diversity makes reference to the quantity and variety of tasks the work group has to perform" (Navarro et al., 2011, p. 19). (3) Novelty refers to the team's experience with the procedures to be applied toward reaching the goal, which, in contrast to clarity, describes the uncertainty of knowing how to apply the method and which may force the team to select from a variety of methods based on subjective criteria. (4) "Task conflict refers to the possible incompatibilities regarding tasks that are presented to the group, whether it is due to discrepancies among different tasks or within one same task, as performing a task efficiently can mean not attending to other tasks the group must also perform" (Navarro et al., 2011, p. 19-20).

Navarro et al. (2011) reported high cross-loadings between the factors of clarity and conflict, which is understandable as both factors refer to the team's objectives. An English translation of the MITAG is available in the English version of the article published by Navarro et al. (2011); however, it has not yet been validated in an English-speaking sample.

All previous validation studies of the Spanish MITAG were conducted in Spain (Ferràs, 2009; Navarro et al., 2008). Compared to Spain, Germany is characterized by a lower power distance (Hofstede et al., 2010), which may lead to a different perception of uncertainty and consequently affect the factor structure of the questionnaire. Although the exploration of cultural effects on the MITAG was beyond the aim of this article, we expected that finding

sound psychometric results in German samples could contribute to fostering its cross-cultural validity.

Beyond measurements of task characteristics, an alternative approach to assessing uncertainty at work is available: role ambiguity. This construct describes the extent of uncertainty experienced because of missing information with respect to what is expected of a person in the work context. Its supposedly best-known operationalization is the RHL scale, named after its creators Rizzo, House, and Lirtzman (1970). The subordinate dimensions of role ambiguity, named *aspects* or *facets*, include uncertainty about responsibilities and criteria for the assessment of the individual's performance, as well as the uncertainty of not knowing objectives of the work or the required methods (Schmidt & Hollmann, 1998). With respect to the latter, role ambiguity overlaps with the construct of task uncertainty. We concluded that role ambiguity facets that refer to the objectives or methods of the work would be highly related to task uncertainty and that evaluating this relationship would contribute to the theoretical knowledge about the constructs represented in the MITAG. The other facets of role ambiguity are rather focused on social or inter-personal phenomena, which is reflected in the mostly negative correlates of such ambiguity, as reported in the literature of the 1980s (Schmidt & Hollmann, 1998). These other facets should thus not be interchangeable with task uncertainty.

With other established measures of task characteristics, a measurement of task uncertainty such as the MITAG would not have an overlap but a likely statistical relationship: one can assume that jobs characterized by high uncertainty regarding work methods or work objectives do not offer sufficient feedback, as operationalized in the Job Diagnostic Survey (JDS, German version by Schmidt, Kleinbeck, Ottmann, and Seidel, 1985). Another differentiated relationship pattern may be expected for worker autonomy: tasks characterized by the MITAG dimensions of clarity and conflict may affect workers with high and low autonomy alike. However, in tasks characterized by high diversity and high novelty, a certain

extent of worker autonomy is required: workers need to choose one of many possible methods and autonomously adapt their strategies as they use novel methods.

The purpose of the present study was to analyze the psychometric characteristics of the MITAG two samples of German employees working in a research context. We used confirmatory factor analysis (CFA) to assess the instrument's factor structure. Additionally, we tested internal consistency. We explored the validity of the MITAG by analyzing the relationships between its subscales and concepts thought to be associated with uncertainty.

3.2 Method

3.2.1 Participants

Team members and team leaders from a German research organization[1] completed an online survey (Table 6).

Table 6

Sample description

	Sample 1: team members (N = 501)		Sample 2: team leaders (N = 104)	
	N	per cent	*N*	per cent
Male participants	343	68.5%	87	83.7%
Female participants	158	31.5%	17	16.3%
Job: researcher	423	84.4%	88	82.2%
Job: administration	42	8.4%	8	7.7%
Job: IT / PR	13	2.6%	4	3.8%
Job: Facility/Workshops	23	4.6%	6	5.8%

Note. N = Number of individuals.

[1] Note: the samples are the same as in chapter 2 (Table 1).

Among all invited teams, minimum team size was three members and a leader; mean team size was 6.9 members without counting the leader. Members (sample 1) answered the MITAG questionnaire and the other instruments mentioned below used for evaluating the MITAG's validity; leaders (sample 2) answered only the MITAG items, due to an agreement with the organization to provide a shorter questionnaire for leaders. Mean age was 34.3 years (*SD* = 11.8) in sample 1 and 41.4 years (*SD* = 9.5) in sample 2. Most participants were researchers, while the others worked in the administration, IT departments, public relations (PR), or mechanical workshops. The majority was male.

3.2.2 Measures

As discussed above, the MITAG consists of 18 items and based on its validation in a Spanish sample (Navarro et al., 2011), the following dimensions emerged: clarity (Cronbach's α = .65), diversity (α = .63), novelty (α = .68), and conflict (α = .63). The following list contains examples from the German item set (Navarro et al., 2011, p. 21).

Clarity: "In meiner Arbeitsgruppe ist es für uns ganz klar was wir mit unserer Arbeit erreichen sollen" (English: "We are very clear on what we must achieve with our work".

Diversity: "In meiner Arbeitsgruppe gibt es unterschiedliche Arten unsere Aufgabe gut zu erledigen und wir sollen dabei die effizienteste auswählen" (English: "There are different ways of doing our job well and we shall select the most efficient one").

Novelty: "In meiner Arbeitsgruppe treten oft neue Probleme und Situationen auf, bei denen wir nicht wissen wie wir sie am besten erledigen" (English: Frequently, new problems and situations arise, in which we feel confused about the best way of working.)

Conflict: "In meiner Arbeitsgruppe müssen wir um eine Aufgabe gut zu erledigen immer wieder andere Aufgaben vernachlässigen" (English: "From time to time, doing one task well requires us to neglect another task").

To analyze the validity of the MITAG's factors, we prioritized well-established instruments in German with peer-reviewed validation studies. We measured: (1) the factor of *Klarheit über die Arbeitsmethoden* (work method ambiguity, WMA) in the instrument Ambiguitätsfacetten der Arbeit (AfA, Schmidt and Hollmann, 1998), consisting of three items (α = .91); and (2) the dimensions *autonomy* (α = .76) and *feedback on the job* (α = .87) from the German version of the Job Diagnostic Survey (three items each, JDS, Schmidt et al., 1985). An example item of the WMA subscale reads "Ich weiß genau, auf welche Art und Weise ich meine Arbeit zu erledigen habe" ("I know exactly which way I need to do my job"). Autonomy was measured by items such as "Meine Arbeit gibt mir beträchtliche Gelegenheit, selbst zu entscheiden, wie ich dabei vorgehe" ("My work gives me a considerable opportunity to decide by myself how to proceed with it"), and feedback on the job by items including the following: "Bei der Ausführung meiner Arbeitstätigkeiten kann ich gut feststellen, wie gut ich arbeite" ("During my working activities, I can easily assess how well I am working").

3.2.3 Procedure

A Spanish psychologist with expertise in organizational psychology translated the MITAG questionnaire into German; then, to ensure cultural and linguistic differences were taken into account (ITC, 2017), a German organizational psychologist and a bilingual native speaker translated it back to Spanish. As in the original version, we combined the items with a 5-point Likert-scale.

To collect the data, we identified the teams of sufficient size based on organization charts, and sent personalized access codes to the online survey via encrypted email. Participation was voluntary. As an incentive, participants who returned a completed questionnaire could participate in a lottery. The workers' committee of the organization checked for ethics and data privacy issues and approved the study.

We used AMOS version 22 for the CFA. We chose χ^2, χ^2/df ratio, Root Mean Square Error of Approximation (RMSEA: Steiger, 1990) and TLI (Tucker-Lewis-Index: Bollen, 1989) for evaluating the SEM. We preferred TLI over CFI (Comparative Fit Index: Bentler, 1990) as it is more conservative (Kenny, 2016). To calculate CR, AVE, ASV, and MSV we used a tool by Gaskin (2012) and we chose Cronbach's α to assess internal consistency. We used the sample of leaders (sample 2) for exploratory factor analysis and reliability assessment and we based all other analyses on the data from the members (sample 1).

3.3 Results

3.3.1 Factor structure

With respect to CFA, we set the cut-off-values at 0.95 for TLI and at 0.06 for RMSEA (Hu & Bentler, 1999). We accepted χ^2/df ratio below 5 (Schumacker & Lomax, 2004). We used χ^2 only for model comparisons, since it becomes significant in larger samples, even when model fit is acceptable (Bentler & Bonett, 1980).

In the CFA, the factor structure identified by Navarro et al. (2011) in a Spanish sample, containing the four dimensions of clarity, diversity, novelty, and conflict, could not be reproduced in the German sample 1 (Table 7). Neither fitted a model based on the original six theoretical dimensions (Navarro et al., 2008), from which these four factors had emerged (Table 7).

We therefore performed an exploratory Oblimin-rotated principal axis analysis on sample 2 (leaders). The requirements to perform the EFA were met: the Kaiser-Meyer-Olkin Index, which had to be greater than .50, was .69, and Bartlett's test of sphericity was significant as required ($\chi^2(153) = 542.29$, $p < .001$). Six factors with an eigenvalue above 1 were identified (Table 8). However, many items showed high cross-loadings. We deleted nine items and preserved three factors.

Table 9 shows the factor loadings after restricting the EFA to the three well-identified factors, as well as the difference in Cronbach's α if the item were deleted. Although Cronbach's α rose when deleting item 9, we maintained the item as this difference was marginal. The selected items also showed a consistent correlation pattern with respect to AfA's WMA scale and Autonomy from the JDS (Table 9). A new CFA in sample 1 confirmed the new model. The differences in χ^2 between the four-factor model and the new model (Table 7) justified accepting the latter. The new factors are:

Table 7

MITAG CFA - model fit parameters

Model	Factors	Sample	χ^2	*df*	χ^2/df	*p* (χ^2)	TLI	RMSEA
Empirical	4	Members	410.12	118	3.48	.00	0.82	0.07
		Leaders	213.84	118	1.81	.00	0.71	0.09
Theoretical	6	Members	509.3	120	4.24	.00	0.76	0.08
		Leaders	219.21	120	1.82	.00	0.70	0.09
New	3	Members	53.00	22	2.41	.00	0.95	0.05

Note. χ^2 is the Chi-Square statistic (CMIN in Amos 22), and *df* is the respective number of degrees of freedom. *p* (χ^2) is the significance level of the χ^2 statistic, named P in Amos 22. TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation (Arbuckle, 2013).

Factor 1: *unclarity of goals*. Items 3, 15, and 18 either refer to a lack of definition or a conflict between goals, or to a very general idea of what the group is expected to achieve in the long run. If a person scored high on factor 1, one would assume that the team leader had failed to set team goals well.

Factor 2: *new situations*. Items 5, 8, and 14 refer to short-term demands or situational changes that produce uncertainty or conflict concerning the chosen method or prioritized

objective. High scores on factor 2 would presumably result from the organizational environment rather than from within the team, contrary to factor 1.

Factor 3: *non-routine*. Items 6, 13, and 17 relate to automated and routine work, or to monotonous demands and simple information. Therefore, high scores on this factor represent a lack of standardization, predictability, or routine of the task contents and procedures.

Table 8

Principal Axis Factoring - structure matrix

	M (*SD*)	1	2	3	4	5	6
Item 3	2.01 (0.68)	.42	-.01	.09	.11	**.72**	.01
Item 9	1.83 (0.74)	.09	-.11	-.28	.12	**.54**	.06
Item 15	2.36 (0.83)	.39	-.05	.18	.08	**.85**	.02
Item 18	2.81 (0.86)	.38	-.11	.28	-.02	**.66**	-.11
Item 5	3.26 (0.94)	**.65**	-.05	.00	.04	.33	-.25
Item 8	3.49 (0.81)	**.64**	.23	.16	.31	.26	-.14
Item 14	3.13 (0.69)	**.66**	.17	.21	.13	.31	.13
Item 6	4.53 (0.57)	.21	.11	**.60**	.04	.02	.18
Item 13	4.37 (0.70)	.15	.10	**.53**	.18	-.09	-.41
Item 17	3.82 (0.87)	-.02	.15	**.65**	.16	.15	-.15

Notes. Items were recoded according to instructions. Surviving items only. Sample 2 (N = 104 leaders).

Table 9

Principal Axis Factoring restricted to 3 factors, structure matrix and item indices

	M (*SD*)	1	2	3	Δ α	*r* (AfA)	*r* (Aut)
Item 3	2.01 (0.68)	**.78**	.08	.41	-.08	-.59	-.03
Item 9	1.83 (0.74)	**.67**	-.36	.05	.03	-.54	.09
Item 15	2.36 (0.83)	**.86**	.16	.36	-.14	-.52	.01
Item 18	2.81 (0.86)	**.74**	.29	.30	-.05	-.62	.09
Item 5	3.26 (0.94)	.31	-.03	**.72**	-.01	-.50	-.04
Item 8	3.49 (0.81)	.18	.16	**.84**	-.17	-.51	-.17
Item 14	3.13 (0.69)	.29	.17	**.77**	-.08	-.44	-.06
Item 6	4.53 (0.57)	.06	**.70**	.09	-.17	-.11	.19
Item 13	4.37 (0.70)	-.14	**.68**	.26	-.03	-.14	.23
Item 17	3.82 (0.87)	.16	**.78**	.03	-.06	-.19	.24

Notes. Items were recoded according to instructions. Surviving items only. Sample 2 (N = 104 leaders). Δ α is the difference in Cronbach's α (new – old) in case the item is deleted. *r* (AfA) and *r* (Aut) are the Pearson correlations between the respective item and the scale mean of AfA's WMA scale and Autonomy from the JDS.

3.3.2 Characteristics of the new model

Internal Consistency. We calculated Cronbach's α in both samples. It was highest at .77 and lowest at .58 (see

Table 10), which corresponds to findings by Navarro et al. (2008).

Validity of the MITAG. In sample 1, we calculated Composite Reliability (CR), Average Variance Extracted (AVE), Average Shared Variance (ASV), and Maximum Shared Variance (MSV). We accepted CR > .7 and AVE > .5; furthermore, we required MSV < AVE, ASV < AVE, and the square root of AVE to be greater than the inter-factor correlations

(Fornell & Larcker, 1981). The selected set of items met all these criteria (Table 10), with these exceptions: CR and AVE were below the thresholds for new situations, and non-routine.

Table 10

The MITAG's validity at item level

	M_1	SD_1	α_1	α_2	CR_1	AVE_1	MSV_1	ASV_1
MITAG - unclarity of goals	2.33	0.67	.77	.80	.79	.55	.37	.25
MITAG - new situations	3.22	0.70	.68	.68	.68	.41	.37	.21
MITAG - non-routine	4.04	0.58	.64	.58	.63	.36	.13	.08

Notes. α is Cronbach's α. CR is Composite Reliability. AVE is Average Variance Extracted. MSV is Maximum Shared Variance. ASV is Average Shared Variance. Index 1 indicates data from sample 1 (members, N=501), index 2 refers to data from sample 2 (leaders, N=104).

Table 11

Pearson correlations among MITAG and selected criteria in sample 1

	1	2	3	4	5	6
1 MITAG – unclarity of goals	(.78)					
2 MITAG – new situations	.47**	(.68)				
3 MITAG – non-routine	.22**	.21**	(.64)			
4 AfA – work method ambiguity	-.59**	-.39**	-.09*	(.91)		
5 JDS – autonomy	-.12**	-.09	.23**	.22**	(.76)	
6 JDS – feedback on the job	-.30**	-.14**	.10*	.38**	.38**	(.87)

Notes. ** indicates significance at $p < .01$. * indicates significance at $p < .05$. The main diagonal contains Cronbach's α.

Unclarity of goals correlated highest with AfA's WMA, which particularly represents work ambiguity or uncertainty. It was also moderately related to the JDS measure feedback on the job, a specific work characteristic that induces a certain type of ambiguity. Unclarity of goals was less associated with autonomy, a measure less likely to show such a direct relationship to task uncertainty. This pattern repeated itself with smaller correlation coefficients for the MITAG factor of new situations: it correlated moderately with AfA's WMA, lower with JDS's feedback on the job, and insignificantly with JDS's autonomy. Non-routine showed a higher correlation with autonomy than with feedback on the job or with the WMA. This is plausible, as one can expect non-routine tasks to require more autonomy of the individual worker. The MITAG dimensions were reverse coded compared to all other measures used, which accounts for nearly all correlations being negative (Table 11). We used sample 1 to calculate these correlation coefficents. In sample 2, measures of AfA and JDS were not available.

Measurement invariance. We regarded models as invariant if ΔCFI was .01 or smaller (Cheung & Rensvold, 2002). The MITAG showed configural invariance with respect to job type and gender. ΔCFI was acceptable at .008 when testing for invariance between researchers and the group of other job types (administration, IT, PR, and workshops). However, the factor loadings differed between men and women (ΔCFI = .04).

Criterion-based validity. As an external validation criterion, we tested in sample 1 whether the MITAG distinguished between researchers and administration staff. We expected the latter to score lower on all task uncertainty dimensions, since we assumed their work to be more routine-based and predictable, and their objectives to be rather well-defined compared to researchers. We set the Type I error at $\alpha = .05$ and checked for normal distribution using the KS test and for homoscedasticity using Levene's test. As the respective preconditions were met, we applied *t*-tests with Bonferroni-corrected significance levels for the three outcome variables. Indeed, compared to their colleagues in administration, researchers scored higher

on unclarity of goals ($t(463) = 5.22$, $p < .017$), new situations ($t(463) = 3.00$, $p < .017$), and non-routine ($t(463) = 7.48$, $p < .017$).

3.4 Conclusions

3.4.1 Contribution

This study contributed to the state of the art by providing a new instrument for measuring task uncertainty in German-speaking samples and by advancing our understanding of cultural factors that influence the measurement of this multifaceted construct. Until today, common instruments for the measurement of task uncertainty either lacked a sound theoretical framework, for example when combining the incompatible constructs of difficulty and uncertainty, or they had methodological weaknesses, such as problematic factor structures or validity problems. With this work, a shortened version of the MITAG became available for German-speaking samples. It distinguishes between different job types and measures 3 factors of task uncertainty, while avoiding the problematic dimension of difficulty. It features an elaborated conceptual framework (Navarro et al., 2008) and thus allows for interpreting results in a greater theoretical context.

The new factor structure furthers our understanding of how task uncertainty reflects the cultural or organizational context in which it is measured. The relevance identified here of the source of uncertainty has, to our knowledge, not yet been taken into account in any other relevant instrument.

3.4.2 Main findings

The main finding is the new factor structure, composed of the three dimensions: unclarity of goals, new situations, and non-routine. The first factor, unclarity of goals, joins items that refer to the extent to which the team leader has failed to define general or long-term goals or objectives. The second factor, new situations, refers to the uncertainty produced by conflicting or fast-changing short-term demands from outside the team. Non-routine is the

extent to which processes, methods, and input information are standardized or well-known to the team members.

However, the factor structure identified in the German sample is not as different from the original four-factor structure as it may appear: Navarro et al. (2008) also reported cross-loadings between the clarity dimensions and the conflict dimension; in the German samples, such items were joined to the new factor of unclarity of goals. Nevertheless, the factor of new situations indicates a possible cultural difference: while Spanish participants seemed to base their answers rather on the type of uncertainty experienced, German participants appeared to focus on the source of the uncertainty. This may have been due to the differences in power distance between the Spanish and German samples. With a lower power distance in Germany (Hofstede et al., 2010), employees may be more inclined to demand good leadership, including well-defined objectives. They apparently reflect more openly on who is responsible for their uncertainty. While, initially, the items had been created only to distinguish types of uncertainty, some of them also reflect the source of uncertainty. Possibly, these two dimensions of item similarity influenced the inter-item correlations simultaneously. Under such circumstances, the items are unlikely to be parallel or interchangeable. Thus, we expect this effect to have caused the validity issues described above of the factors of new situations and non-routine, regarding CR and AVE.

3.4.3 Limitations

The first limitation of the present study refers to the composition of the samples. They contained many more men than women, which is relevant since the MITAG failed to prove gender-invariant. The overrepresentation of researchers compared to other job types was uncritical, due to the demonstrated measurement invariance. Furthermore, some team members (sample 1) from the category of other jobs scored higher than expected on the MITAG. However, this may not be an issue of the instrument itself but of the selected sample. To address these limitations, future studies should collect data from samples with a better

gender balance, and data should include a large sample of employees working in jobs in which low task uncertainty can be more safely assumed, such as product assembly or other highly structured work.

Second, the sampling procedure may have led to unknown self-selection effects among participants, thus introducing bias into the scores. However, the MITAG differentiated well between job types, which means there was not, at least, any ceiling effect caused by self-selection.

As argued above, the results suggest that the factor structure of the MITAG may depend on the cultural or organizational context. We collected data from an organization highly engaged in knowledge work and innovation. This may even have had an impact on employees in jobs we assumed to be characterized by lower task uncertainty, such as administration. This is yet another reason for collecting more data from a larger variety of jobs, particularly with presumably lower task uncertainty, and thus enhancing the evidence base.

For future research, we further recommend adapting the MITAG questionnaire to resolve the identified validity issues, and to create an instrument with a factor structure that holds in different national cultures. This could possibly be achieved by rephrasing the items that we deleted for not fitting into the new factor structure. In our opinion, items 2, 7, 10, 11, and 12 should reflect the distinction between source and type of uncertainty better than they do now. Items 1 and 7 should not mention team objectives anymore, to emphasize what they are actually about: diverse requirements. Item 4 could be rephrased to address the construct of novelty without mentioning the topic of work autonomy. These changes might result in a new instrument with a factor structure that is applicable across cultures.

Despite the specified limitations and the recommendation to rephrase and retest some of the items, the results support the use of the MITAG in German-speaking samples, following the approach presented here and using the new factor structure.

3.4.4 Theoretical and practical implications

The results presented above show that measurements of uncertainty likely depend on cultural factors. This finding is relevant for researchers working with measurements of uncertainty, particularly if these measurements are used across cultures. For practitioners who measure task uncertainty in the context of organizational evaluations or interventions, the finding is important that task uncertainty is, in any case, a multidimensional construct and that different subordinate factors may play different roles. The instrument that resulted from this validation study is short and practical for use in German samples and has a solid theoretical foundation.

3.4.5 Summary

The MITAG showed a different factor structure in the German samples than the one obtained from Spanish samples. The German translation produced a sound factor structure and evidence of validity in the given samples. However, it may still be improvable. For future research, we recommend adapting the MITAG questionnaire to increase its validity, and to create an instrument with a factor structure that holds in both national cultures. Additionally, the results indicate that Germans rather distinguish by the source of uncertainty than by what is uncertain about the task.

Chapter 4

Study 3: Transformational leadership, group development, and task uncertainty

4.1 Introduction

Uncertainty is growing in modern working contexts. Polyvalence, time pressure, unpredictable environmental conditions, and the relevance of knowledge and distributed skills drive this development (Navarro et al., 2011). Knowledge workers are particularly exposed to uncertain tasks and the relevance of knowledge work is rising in the developed economies (Spath & Hoffmann, 2009): today's organizations need constantly to innovate (Reuveni & Vashdi, 2015), and they increasingly rely on teams for this purpose (Edmondson & Nembhard, 2009). Consequently, organizations need to enable their teams to deal with uncertainty and to create the synergies necessary to innovate. Although the literature on leadership is extensive, the role of leadership with respect to the demands of increasingly uncertain tasks has not yet been investigated. We therefore researched the role of leadership with respect to different types of task uncertainty, taking interpersonal and structural coordination mechanisms into account and addressing limitations of previous research. "Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, services or processes" (Baregheh et al., 2009, p. 1334). Creativity is defined as the generation of such ideas (Cheung & Wong, 2011). Thus, innovation requires creativity. Work meant to produce innovation as its primary outcome has been labelled knowledge work (Drucker, 1999; Willke, 1998). Definitions of knowledge work stress the continuous requirement for learning (Drucker, 1999; Willke, 1998), unclear objectives, processes, or outcomes (Spath & Hoffmann, 2009), or the fact that knowledge is always connected to the unknown and always improvable (Willke, 1998). The common characteristics across these definitions are uncertain objectives, a lack of familiarity with the methods required to achieve the objective, and an unclear connection between method and

outcome of the work. This matches the operationalization of task uncertainty by Navarro et al. (2011, p. 19). Knowledge work is characterized by uncertain tasks.

Consequently, two approaches are available to investigate the factors that help teams innovate: (1) examining which factors influence outcomes such as team innovation or team creativity, and (2) exploring which factors increase the effectiveness of teams working on uncertain tasks.

With respect to the first approach, research evidence is available. It indicates that transformational leadership is particularly beneficial to the workers in teams focused on innovation: leaders should serve as role models (idealized influence), communicate a positive vision (inspirational motivation), take care of followers individually (individualized consideration), and encourage them to find their own solutions (intellectual stimulation; Bass et al., 2003). They thereby foster individual worker creativity (De Jong & Den Hartog, 2007), individual employees' engagement in idea management (Pundt & Schyns, 2005), as well as group creativity (Eisenbeiß, 2009; Jung, 2001) and team innovation (Paulsen et al., 2009). Research indicates that the positive effect of transformational leadership on team innovation and team creativity is mediated by group processes such as cohesiveness (Eisenbeiß, 2009), team identity (Paulsen et al., 2009), engagement and knowledge sharing (Edmondson & Lei, 2014), and development of shared mental models (Reuveni & Vashdi, 2015). These findings integrate well into what is generally known about the effects of transformational leadership on teams: transformational leadership augments the positive effects of transactional leadership on team performance (Avolio et al., 2009) and group processes such as cohesiveness are mediators of this relationship (Bass et al., 2003; Jung & Sosik, 2002).

However, existing research does not clarify whether transformational leadership plays a special role in teams with high task uncertainty, such as teams of knowledge workers, compared to teams in other types of work. Answering this question requires evidence based on the second approach, which is not available as far as we know. The literature indicates that

transformational leadership is more effective when the organizational environment is uncertain (Bass & Riggio, 2006; Felfe, 2006) and the same could apply to uncertain tasks: Frost et al. (2010) assumed that teams of knowledge workers require transformational management solutions. To test these assumptions, we investigated a model of the relationships between transformational leadership, group processes, and task uncertainty. In contrast to previous studies, we compared teams across different job types. Like other studies in this field (e.g., Eisenbeiß, 2009; Reuveni & Vashdi, 2015), this research was focused on the team level.

The work presented here is, to our knowledge, the first study to investigate the relationships between transformational leadership, task uncertainty, and team effectiveness. We tested assumptions derived from Frost et al. (2010) and we addressed the limitations of previous studies resulting from the use of homogeneous samples. In the model, we considered both interpersonal (group development) and structural (task interdependence) coordination mechanisms.

4.2 Theoretical background and research model

4.2.1 Research model and independent variable: transformational leadership

As argued above, there is exhaustive evidence that transformational leadership has positive effects on team performance (Avolio et al., 2009) and that group processes such as cohesiveness mediate this relationship (Bass et al., 2003; Jung & Sosik, 2002). While prior research relied on Input-Process-Output Models (I-P-O, e.g., West & Hirst, 2003), Input-Mediator-Output-Input (IMOI) Models are the most appropriate choice: I-P-O models assume the mediating variable to be a process, which is inadequate in many cases; in IMOI, it can be an emergent state too (Ilgen et al., 2005). As longitudinal data was not available, we integrated the aforementioned relationships into an Input-Mediator-Output model and added measures of task uncertainty. In the following paragraphs, we provide the reasoning for the choice of constructs and hypotheses.

4.2.2 Dependent variable: team effectiveness

To research the relationships between transformational leadership, group processes, and task uncertainty, the outcome variable must be applicable to any kind of team, no matter whether such team is intended to produce innovation or not. Therefore, we chose team effectiveness (Hackman, 1987) as our outcome variable: a team is considered effective if (1) it meets the success criteria defined by stakeholders, (2) the team members benefit from the outcomes of the team's work, and (3) the team's ability to work together in the future is maintained. As a criterion of team performance, team effectiveness has a long tradition in team research (e.g., Kozlowski & Bell, 2003).

4.2.3 Mediator: group development

In the majority of reported models, instead of other processes or emergent states, cohesion is considered the direct predictor of team effectiveness (Bass et al., 2003; Jung & Sosik, 2002). However, the concept of group cohesiveness, the different ways it is measured, and how it is used in research have been criticized (Hogg, 1993). We thus replaced cohesion with *group development* (GD; Meneses et al., 2008). This construct represents the degree to which a set of people functions as a real team, defined by these characteristics of well-developed groups (Navarro et al., 2015): (1) there are regular personal interrelationships between the members; (2) the members are working or oriented towards shared goals; (3) the members identify with the group; and (4) the group has a high level of coordination. In contrast to group cohesion, GD refers to the group's goals and to the group's coordination, which we considered highly relevant to explaining the effects of leadership on team outcomes as mediated by group processes.

Existing theory further justifies the assumption that transformational leadership leads to increased group development: transformational leadership is supposed to raise the acceptance of group goals (Podsakoff, MacKenzie, & Bommer, 1996), which is a requirement of group development (Navarro et al., 2015). Additionally, individual consideration might

reduce conflict among the team members and thus positively affect their interpersonal relationships. Finally, individual consideration and intellectual stimulation could make team members feel appreciated and their contributions valued, which may strengthen their identification with the team. Based on this reasoning and literature (Bass et al., 2003; Jung & Sosik, 2002), we set the following hypothesis:

> H_1. Group development will at least partially mediate the positive relationship between transformational leadership and team effectiveness, with all variables being positively interrelated. Hence, transformational leadership will relate positively to team effectiveness (H_{1a}); transformational leadership will relate positively to group development (H_{1b}); group development will relate positively to team effectiveness (H_{1c}); and including group development into the model, the positive relationship between transformational leadership and team effectiveness will become weaker (H_{1d}).

Despite its similarities to previous research, this model has, to our knowledge, never been tested.

4.2.4 The role of task uncertainty

The next step was adding task uncertainty to the model. Based on the literature, it could be mediator or a moderator, depending on its operationalization. Sicotte and Bourgault (2008), for example, reported some dimensions of organizational and environmental uncertainty to directly predict a decrease in team performance, while other dimensions of uncertainty moderated the effects of organizational interventions on team performance. We intended to represent both potential roles in the model by including *new situations* and *unclarity of goals* from the German version of the MITAG instrument. We had previously validated this instrument in a German sample, which had resulted in a reduced set of items and a new factor structure. From the three newly identified factors, we picked new situations and unclarity of goals. For reasons of model parsimony, we disregarded the third factor

named *non-routine*, which on a theoretical level was more difficult to relate to the other constructs.

Previous studies (Faraj & Yan, 2009; Gardner et al., 2012) relied on short questionnaires that did not distinguish between different types of uncertainty, although some were limited to specific work settings. We decided to use measurements that are applicable across different job types while specifying subordinate factors of task uncertainty.

4.2.5 Task uncertainty as a moderator

As task uncertainty is a necessary requirement of knowledge work (Spath & Hoffmann, 2009), some uncertain aspects of the team's task cannot be proactively reduced by the team itself. Variables that measure these types of task uncertainty consequently qualify either as independent or as moderator variables. The model by West and Hirst (2003) supports this perspective by restricting task characteristics to the category of input variables.

There is evidence that transformational leadership is more likely to emerge and is more effective, when the environment is complex (Felfe, 2006; Wolfram & Mohr, 2008), unstable, uncertain, or turbulent (Bass & Riggio, 2006). This means that environmental complexity and uncertainty moderate the relationship between transformational leadership and team outcomes (Wolfram & Mohr, 2008, p. 261). Consequently, uncertainty related to the team's task could also moderate this relationship. This hypothesis is further supported by Frost et al. (2010): they argued that knowledge work requires intrinsic motivation and voluntary contributions, which are fostered by transformational leadership. Consequently, we argue that there should be an interaction effect between transformational leadership and task uncertainty, which represents the characteristics of knowledge work.

If H_1 were true, task uncertainty could moderate either the influence of leadership on group processes, or the effect of group processes on team effectiveness. The literature suggests the latter: Navarro et al. (2011, p. 20) argue that the social support and sense-making activities of group-work are particularly beneficial when dealing with diverse, new,

incompatible, and ambiguous tasks. And evidence shows that boundary reinforcement, which refers to "sharpening team identity" (Faraj & Yan, 2009, p. 607), and relational resources such as familiarity among team members (Gardner et al., 2012) are more positively related to team performance when task uncertainty is high. Thus, we assumed that task uncertainty would moderate the relationship between GD and team effectiveness.

To represent this type of externally caused task uncertainty, we used the factor of new situations from the German version of the MITAG questionnaire, as resulting from our previous validation study. It refers to conflicting or fast-changing short-term demands from outside the team. Thus, it is a type of uncertainty that the team cannot avoid proactively. This type of task uncertainty requires performance adaptations, which have been defined as "altering behavior to meet the demands of the environment, an event or a new situation" (Pulakos et al., 2002, p. 615). Team adaptation requires coordination and information sharing (Maynard et al., 2015), which corresponds to the characteristics of well-developed teams, as measured by the GD instrument. So, we hypothesized that well-developed teams adapt more efficiently to such changing short-term demands.

4.2.6 Controlling for task interdependence

To test the moderating effect of the factor of new situations, we had to control for task interdependence. "Team members are task interdependent when they must share materials, information, or expertise in order to achieve the desired performance or output" (Vegt et al., 2001, p. 52). The commitment to a shared goal, group coordination, and strong interpersonal relationships can be expected to be helpful in interdependent tasks (Mullen & Copper, 1994), even when uncertainty is low. Consequently:

> H_2. New situations will moderate the relationship between GD and team effectiveness, while task interdependence will moderate this moderation effect: combinations of low scores on new situations and task interdependence will be

associated with weaker relationships between group development and team effectiveness.

4.2.7 Task uncertainty as a mediator

Task uncertainty can, however, be a mediator if team members or leader can actively reduce or increase a certain aspect of task uncertainty. Weiss and Hoegl (2016) hypothesized that increased task uncertainty will be detrimental to team performance. They argued that task uncertainty required more planning and "more frequent nonroutine decision-making", which would occupy additional team resources such as time and effort (p. 15). Such an effect may have led to Tatikonda and Rosenthal (2000) finding higher task uncertainty to be related to higher costs in technology innovation projects.

We chose the factor of unclarity of goals from the German MITAG questionnaire, which represents the extent to which general or long-term goals or objectives have not been well-defined by the team leader.

Transformational leaders motivate their co-workers through a vision, and intellectual stimulation means transformational leaders tell their followers what to achieve rather than how to do the job. Both should reduce unclarity of goals in the team. Provided with a general vision and long-term objectives, the team may achieve a higher level of coordination and emergence, increasing its effectiveness. Thus, we assumed unclarity of goals to be negatively related to team effectiveness.

> H_3. Unclarity of goals will partially mediate the relationship between transformational leadership and team effectiveness, with higher scores in transformational leadership associated with reduced unclarity of goals and thus to greater team effectiveness. Hence, transformational leadership will relate positively to team effectiveness (H_{1a}); transformational leadership will relate negatively to unclarity of goals (H_{3a}); unclarity of goals will relate negatively to team effectiveness (H_{3b}); and when including unclarity of goals into the model,

the positive relationship between transformational leadership and team effectiveness will become weaker (H_{3c}).

Figure 1 gives an overview of model one.

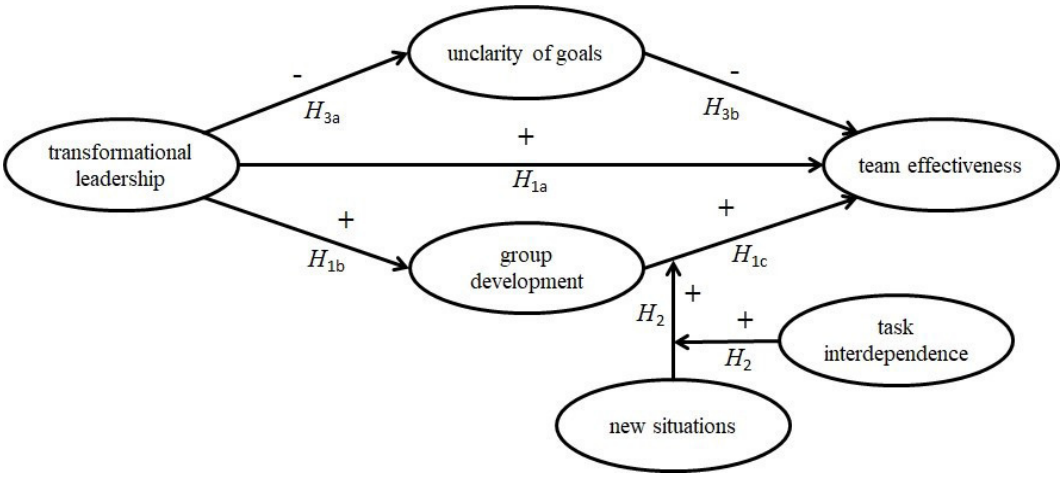

Figure 1. Model 1, representing the hypotheses H_1, H_2, and H_3.

Hypotheses H_1, H_2, and H_3 formed model 1. However, following Weiss and Hoegl (2016), new situations could also increase the team's need to adapt and thus decrease its efficiency. Sicotte and Bourgault (2008) found that fuzziness, which resembles the variable used here of new situations, correlated negatively to measures of performance. When a team scores high on new situations, then the team needs to adapt. The adaptation process will consume time and resources (Weiss & Hoegl, 2016), thus temporarily lowering performance. The more often a team needs to adapt, the lower its efficiency will be. New situations may also be detrimental to the team members' motivation, in cases where the adaptation renders work done previously useless: the expected reward for previous efforts is suddenly removed. This justifies an alternative hypothesis that introduces new situations as a factor that has a direct influence on team performance.

Furthermore, new situations is a subjective measurement. Independent of the true number of changing demands, the team's appraisal may protect it from the respective

negative consequences. Transformational leaders who motivate team members through a long-term vision may be able to buffer the presumed decrease in motivation that could result from frequently adapting project plans to changing outside demands. Intellectual stimulation and individualized consideration could further increase the team members' ability to deal with disruptions quickly and thus perceive them as less disturbing. A transformational leader's individually considerate behaviors could empower team members (Dionne et al., 2004). While research results at team level are still missing, Maynard et al. (2015) suspect empowerment to foster team adaptation and propose to research this topic further.

We assumed that transformational leadership could lead to a decrease in the measurement value of new situations, which in turn would correlate negatively with team effectiveness. Thus, new situations was also eligible as a mediator, and we created an alternative model 2 based on hypotheses H_1 and H_3 and substituting H_2 by $H_{4a\text{-}d}$.

> $H_{4a\text{-}c}$. New situations will partially mediate the relationship between transformational leadership and team effectiveness, with higher scores in transformational leadership being associated with a lower score in new situations and thus to greater team effectiveness. Hence, transformational leadership will relate positively to team effectiveness (H_{1a}); transformational leadership will relate negatively to new situations (H_{4a}); new situations will relate negatively to team effectiveness (H_{4b}); and when including new situations in the model, the positive relationship between transformational leadership and team effectiveness will become weaker (H_{4c}).

Adapting to a new situation requires behavioral changes (Pulakos et al., 2002). We assumed that clearly defined interdependencies among the team members would speed up the adaptation process. If interdependence is low, then the number of options is high; for example everybody might be eligible for a new task. If, however, a task needs to be fit into a neatly

organized set of interdependencies, then the available options are limited and the decision will be made faster, which saves resources. Additionally, we assumed that teams in which work was organized in a way that required team members to frequently exchange outputs among one another, adaptation would be easier to achieve. So, in teams experiencing new situations, we expected task interdependence to dampen the negative impact of uncertainty on team effectiveness. Therefore, assuming $H_{4a\text{-}c}$ to be true, we expected the structure of the team's work, as represented by task interdependence, to moderate the effect of task uncertainty.

> H_{4d}. Task interdependence will moderate the relationship between new situations and team effectiveness as stated in H_{1a} and $H_{4a\text{-}c}$, with greater task interdependence associated with a weaker relationship between new situations and team effectiveness.

Figure 2 depicts model 2.

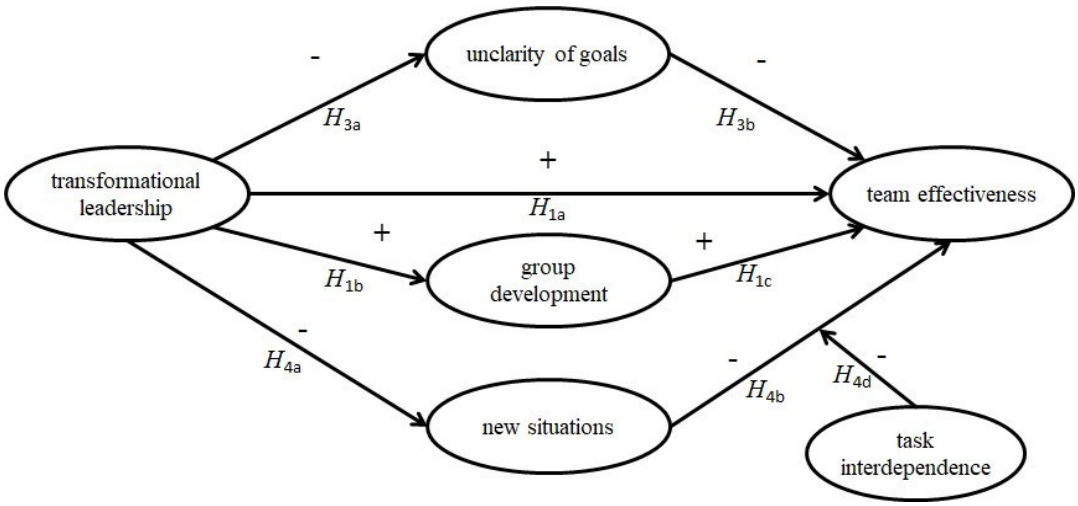

Figure 2. Model 2, representing the hypotheses H_1, H_3 and H_4.

4.3 Topic delimitation: uncertainty avoidance

Another variable that may determine how teams deal with uncertainty is uncertainty avoidance, as measured by tools such as the Uncertainty Avoidance Index (UAI, Hofstede et

al., 2010). Its origins are in cross-cultural psychology and the following paragraphs explain why it was not included in our model.

Uncertainty avoidance is "the extent to which the members of a culture feel threatened by ambiguous or unknown situations. This feeling is […] expressed through nervous stress and a need for predictability" (Hofstede et al., 2010, p. 191). Some researchers have argued that high uncertainty avoidance will hamper innovation (Shane, 1993). However, with regard to this assumption, research has produced contradictory outcomes (Hofstede et al., 2010, pp. 211): studies at national level have either found a negative relationship between uncertainty avoidance and innovation (Shane, 1993), or no relationship at all (Rinne, Steel, & Fairweather, 2012). Hofstede et al. (2010) argued that cultures with low uncertainty avoidance excelled at producing new ideas, while cultures with high uncertainty avoidance were better at implementing such ideas into new processes or products.

This is interesting in the sense that depending on national culture, teams or individuals may apply different strategies to cope with uncertainty, which may in turn have an impact on performance. However, as the study presented here is based on a sample from one national culture and from one organization, we did not include uncertainty avoidance into our model. If any effects exist, they will rather affect the international interpretability of the model.

In addition to studies at national level, Hofstede's UAI can also measure individual differences: Zhang and Zhou (2014) found that in followers with high uncertainty avoidance, empowering leadership is related to higher creativity – but only if they trust their superior. This finding is likely to apply to transformational leaders, as they are expected to empower followers through intellectual stimulation (Bass et al., 2003). However, as our model was to be tested at group level, we refrained from including individual level variables. Despite an individual's preference for avoiding or embracing uncertainty, different types of task uncertainty may have different effects in teams of knowledge workers. Such possible differences between sub-types of task uncertainty have been disregarded in previous research

(e.g., Faraj & Yan, 2009; Gardner et al., 2012). From the perspective of cross-cultural psychology, knowing the effects of different types of uncertainty on work processes or outcomes may also aid in resolving the above-mentioned dispute.

4.4 Method

4.4.1 Participants and procedure

Five hundred and one team members from 226 teams and 104 team leaders from a German research organization completed an online-questionnaire (Table 12).

Table 12

Sample description

	All team members (N = 501)		107 selected teams (N = 408)	
	N	per cent	N	per cent
Male participants	343	68.5%	277	67.9%
Female participants	158	31.5%	131	32.1%
Job: Researcher	423	84.4%	346	84.8%
Job: Administration	42	9.6%	34	8.3%
Job: Facility Management / Workshop	23	4.6%	17	4.2%
Job: IT-Services / PR-Services	13	2.6%	11	2.7%
0-2 years on the team	165	32.9%	133	32.6%
2-5 years on the team	178	35.5%	144	35.3%
5+ years on the team	158	31.5%	130	31.9%

Note. N = Number of individuals.

The organization was selected for being a relevant player at the European level, with more than 5,000 employees, having an organizational structure based on teams, and covering many different research areas. Submitting the questionnaire required answering all items. Thus, there were not any empty fields in the data matrix. Each team had at least three members, in addition to the leader. Mean age was 34.3 years (*SD* = 11.8). Among all participating team members, 32.9% had worked two years or less on their team, 32.5% between two and five years, and 31.5% more than five years. The study design was approved by the organization's works council (German: Gesamtbetriebsrat). Section 4.4.3 describes the data aggregation that resulted in (1) the final sample of 107 teams, composed by data from the team members, and (2) a sample of 54 of these teams, in which measurements of team effectiveness were provided by the leaders. We used the first sample for testing the model and the second sample to check for common source bias.

4.4.2 Measures

Transformational leadership. Most research on transformational leadership relied on the MLQ (Bass & Avolio, 1995). Yet its dimensionality has been questioned (Bycio et al., 1995), and Berger et al. (2012) showed that transformational leadership can be measured as a unidimensional construct. Thus, we used the German version of the HSA-TFL short-scale (eight items, Cronbach's α = .93). The instrument had previously been validated successfully in a German sample by Berger, Romeo, Brodbeck, Kolbe, and Yepes-Baldó. Example item of the follower questionnaire: "Ich vertraue auf seine/ihre Fähigkeiten, Hindernisse jeder Art zu überwinden" ("I have trust in his/her ability to overcome any obstacle.").

Group Development. We used the German translation of the Group Development questionnaire based on Navarro et al. (2015), which we had previously validated in a German sample (chapter 2). In the validation study, the unidimensional structure was confirmed and the internal consistency was good (eight items, Cronbach's α = .87). Example item: "In

meiner Arbeitsgruppe teilen wir untereinander Instrumente, Ressourcen und Informationen" ("We share tools, resources and information)."

Task uncertainty. We used the German version of the MITAG model (Navarro et al., 2011), as resulting from our previous validation study (chapter 3), to measure unclarity of goals (four items, Cronbach's α = .78), and new situations (three items, Cronbach's α = .68). Example item: "In meiner Arbeitsgruppe ist es für uns ganz klar was wir mit unserer Arbeit erreichen sollen" ("We are very clear on what we must achieve with our work").

Task interdependence. We translated the seven items developed by Vegt et al. (2001) into German, using a back-translation process to avoid translation errors based on cultural or linguistic differences (ITC, 2017). In our data, the internal consistency (Cronbach's α) of this one-dimensional measure was .76. Example item: "Bei der Erledigung meiner Aufgaben bin ich von meinen Kolleginnen / Kollegen abhängig" ("To complete my work I depend on my colleagues").

Team effectiveness. We translated the 12-item effectiveness-scale presented by Navarro et al. (2011) into German, following a back-translation process (ITC, 2017). These items are based on the normative model proposed by Hackman (1987). The internal consistency (Cronbach's α) of this one-factorial measure was .89 in our sample. Example item: "In meiner Arbeitsgruppe arbeiten wir wirksam" ("We are efficient performing our tasks").

Task Interdependence was measured using a 7-point Likert-scale, whereas all other instruments were presented with a 5-point Likert-scale.

4.4.3 Data aggregation

Team members answered all the instruments named above, while the team leaders answered only the items measuring team effectiveness. The data collected from the team members were aggregated at team level.

The widespread use of an equal distribution for calculating r_{wg} or $r_{wg(j)}$ has been

criticized (LeBreton & Senter, 2008), and it has been argued that .70 may be inadequate as a cut-off value for r_{wg} or $r_{wg(j)}$ (Biemann, Cole, & Voelpel, 2012). For ICC(1) and ICC(2), commonly accepted cut-off values do not exist either. Researchers are recommended to calculate different indicators, such as $r_{wg(j)}$, ICC(1) and ICC(2), to carefully pick null distributions, and to consider the level of agreement expected or required for the specific type of data, in comparison to other research in the area (Biemann et al., 2012). Based on these recommendations, we chose the following approach.

First, we calculated team means if at least two measurements were available from the same team, resulting in a sample of 133 teams (408 individuals). Mean age in this reduced sample was 34.3 years (*SD* = 11.9). Then, we calculated $r_{wg(j)}$ (Bliese, 2000) to delete the groups with the lowest agreement. While Biemann et al. (2012) recommend not deleting groups with low agreement, in favor of test power, we considered deleting such teams (and thus sacrificing test power) to be the more conservative approach. Despite the known criticism (LeBreton & Senter, 2008), in this case using an equal distribution was justified by three reasons: (1) we only used $r_{wg(j)}$ for comparisons among teams, which means that any bias introduced by a potentially inadequate null distribution would affect all teams equally; (2) none of the restrictions mentioned by Meyer, Mumford, Burrus, Campion, and James (2014) seemed applicable to our data and thus no other distribution was more favorable, and (3) the null distribution was frequently used in recent leadership research (Biemann et al., 2012), which increases the comparability among studies. We deleted 26 teams in which either one $r_{wg(j)}$ value was below .40, or in which four $r_{wg(j)}$ values were below .70. The latter cut-off was chosen since, despite the criticism mentioned, it is the most commonly used limit (Biemann et al., 2012); the former was chosen at will. The coefficients resulting after eliminating 26 teams are shown in Table 13.

Table 13

Intra-group agreement measures of 107 teams to undergo further analysis

Measure	Number of items	Mean $r_{wg(j)}$	ICC(1)	ICC(2)
Unclarity of goals	4	.83	.36	.64
New situations	3	.79	.13	.64
Group development	8	.80	.17	.50
Team effectiveness	12	.83	.23	.38
Task interdependence	7	.78	.35	.49
Transformational leadership	8	.88	.19	.63

Note. Mean $r_{wg(j)}$ is the arithmetic mean of the $r_{wg(j)}$ score, a within-group interrater agreement, over 107 teams (Bliese, 2000). ICC1 and ICC2 are the Intra-Class-Correlation Coefficients 1 and 2 (Bliese, 2000).

In the resulting sample of 107 teams, we calculated ICC(1) and ICC(2) (Bliese, 2000). We required ICC(1) to be above .10 and ICC(2) to be above .30. These values correspond to the indices obtained in other leadership studies (Biemann et al., 2012). As these criteria were met (Table 13), we assumed that in the remaining sample, the aggregation was adequate.

4.4.4 Datasets and missing data

We tested all hypotheses using the sample of 107 teams in which team effectiveness measures were provided by the team members. There were not any empty cells in the final dataset, as participants could only return completely answered questionnaires, and as the 26 teams with low agreement were fully removed during the aggregation process. Procedures for dealing with missing data were thus unnecessary. In 54 of the 133 aggregated teams, a measurement of team effectiveness by the team leader was available. Thus, by replacing the effectiveness measure from the members with that obtained from the leaders, we obtained a second dataset of 54 teams. We used this second sample to check for common source bias.

4.4.5 Analysis of data

We used IBM SPSS Amos version 22 for structural equations modelling (SEM). We chose SEM for hypothesis testing (all hypotheses: models 1 and 2) for its benefit of correcting for measurement errors through the use of latent variables (Preacher & Hayes, 2008).

At individual level, we conducted separate confirmatory factor analyses (CFA) on the task interdependence measure and the team effectiveness measure. To assess the impact of common source variance, we applied Harman's test of common method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). For the same purpose, we additionally substituted the team members' measures of team effectiveness with their leaders' judgements of team effectiveness and conducted a regression analysis on the resulting sample of 54 teams, using the PROCESS macro for mediation effects (H_1), version 2.13 (Hayes, 2015), and hierarchical regression analysis for moderation effects (H_4).

We tested for the requirements of mediation (Baron and Kenny, 1986), and examined the significance of the indirect effect and the single predictors using the Amos 22 BC-bootstrapping procedure (Preacher & Hayes, 2008). Moderation (H_2 and H_4) was tested by including latent interaction variables. We followed the approach proposed by Marsh, Wen, and Hau (2004), and the additional recommendations by Foldnes & Hagtvet (2014). We used the following cut-off-criteria for the SEM: RMSEA (< 0.08), based on MacCallum, Browne, and Sugawara (1996) and χ^2/df (< 5), based on Schumacker & Lomax (2004). In CFA, we additionally required TLI (> 0.95), following Hu and Bentler (1999). For model comparison, we used χ^2/df and RMSEA. For hypothesis testing, we set the Type I error at $\alpha = .05$.

4.5 Results

4.5.1 Confirmatory Factor Analysis

Both translated instruments, the task interdependence questionnaire (*Figure 3*) and the team effectiveness instrument (*Figure 4*), proved to be one-factorial (Table 14).

Table 14

Model fit parameters

Model	χ^2	*df*	χ^2/df	*p* (χ^2)	TLI	RMSEA
CFA - task interdependence	25.92	11	2.36	.00	0.97	0.05
CFA - team effectiveness	96.31	38	2.53	.00	0.96	0.06
model 1	649.28	422	1.54	.00	0.89	0.07
model 2	1016.52	655	1.55	.00	0.85	0.07

Note. χ^2 is the Chi-Square represented by CMIN in Amos 22, and *df* is the respective number of degrees of freedom. *p* (χ^2) is the significance level of the χ^2 statistic, named P in Amos 22. TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation (Arbuckle, 2013).

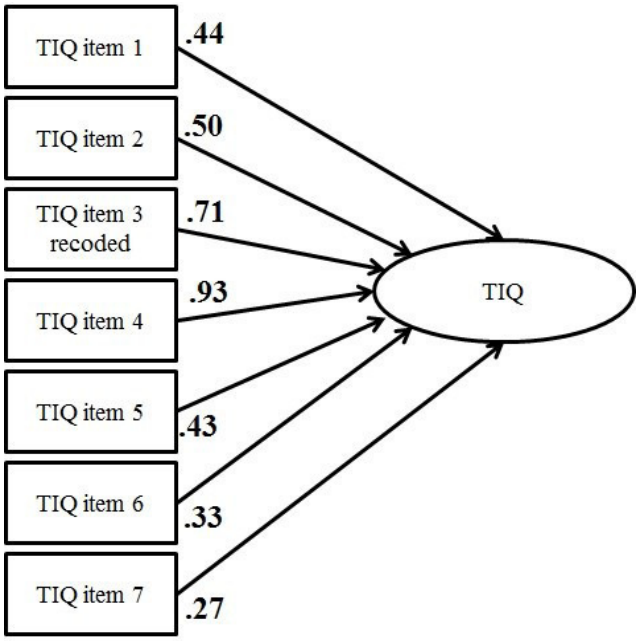

Figure 3. CFA of the Task Interdependence Questionnaire (standardized coefficients).

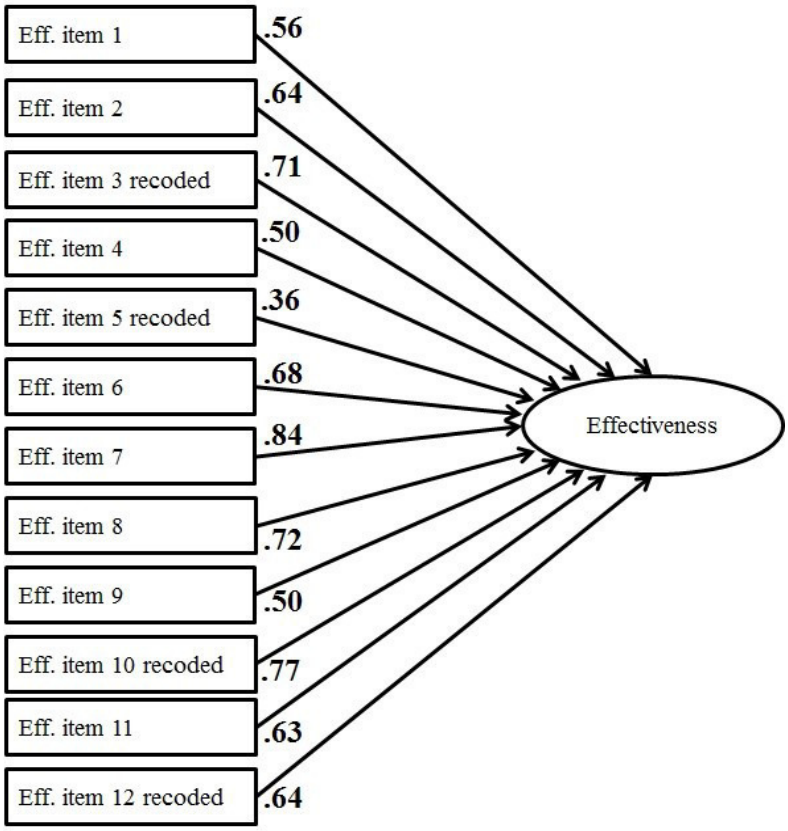

Figure 4. CFA of the Team Effectiveness measure (standardized coefficients).

4.5.2 Descriptive statistics

We calculated descriptive statistics of all constructs in the sample of 107 teams to check if variability was sufficient to proceed with the analysis. The results are given in Table 15. Furthermore, we checked if the two selected measures of task uncertainty differed substantially between the different job types represented in the sample. As the previous KS-tests and Levene's tests were insignificant, we performed an ANOVA with Tukey HSD post-hoc tests. We found that with respect to new situations, the groups did not differ significantly ($F(3,103) = 1.91$; $p = .13$). Regarding unclarity of goals, a significant difference was identified ($F(3,103) = 5.50$; $p < .01$), due to a difference between researcher teams and administration teams (see Table 16).

Table 15

Descriptive statistics of the measurement variables in the sample of 107 teams

	M	*SD*	Min	Max
Transformational leadership	3.69	0.57	1.82	5.00
Group Development	3.70	0.41	2.38	4.57
MITAG – Unclarity of goals	2.31	0.47	1.25	3.88
MITAG – New situations	3.23	0.45	2.25	4.67
Task Interdependence	3.29	0.38	2.22	4.22

Note. N = 107 teams

Table 16

Variation in task uncertainty across teams in different job categories

		Unclarity of goals		New situations	
	n	*M*	*SD*	*M*	*SD*
Research teams	91	2.36	0.46	3.28	0.46
Administration teams	8	1.75	0.26	2.88	0.28
Facility / workshops	5	2.03	0.44	3.22	0.28
IT- / PR-services	3	2.54	0.19	3.22	0.51

Note. N = 107 teams

4.5.3 Testing model 1

H_1 was confirmed. The preconditions of mediation (Baron & Kenny, 1986) were fulfilled, as transformational leadership predicted team effectiveness (H_{1a}) significantly by c = .78 (standardized coefficient; $p < .001$) when no mediator was present. With group development present as mediator, this relationship dropped to c' = .14 (H_{1d}), while a = .73 ($p < .001$; H_{1b}) and b = .87 ($p < .001$; H_{1c}). The total interaction effect of transformational

leadership on effectiveness was significant at $p < .01$ after BC-Bootstrapping (2-tailed).

H_3 was rejected, as unclarity of goals showed a low and statistically insignificant relationship to team effectiveness (H_{3b}). Transformational leadership was negatively related to unclarity of goals ($p < .001$; H_{3a}).

Allowing for the residuals of group development and unclarity of goals to covary, as recommended by Preacher and Hayes (2008), did not alter the reported results: changes in standardized parameters were less or equal .01.

The model including the latent interaction variable for testing H_2 would not converge, due to discrepancies between product indicators. Therefore, we abandoned H_2 and tested the alternative model 2.

4.5.4 Testing model 2

$H_{4a\text{-}c}$ were confirmed: with new situations present as a sole mediator, the effect of transformational leadership on team effectiveness dropped to c' = .66 ($p < .05$; H_{4c}), while a = -.50 ($p < .05$; H_{4a}) and b = -.29 ($p < .05$; H_{4b}). With GD and unclarity of goals present (model 2 in Table 14), the positive relationships were still significant ($p < .05$). The total interaction effect of transformational leadership on effectiveness was significant ($p < .05$) after BC-Bootstrapping (2-tailed). However, adding new situations as a third mediator did not further decrease the direct effect of transformational leadership on team effectiveness.

H_{4d} was confirmed in the SEM with the estimate for the effect of the latent interaction variable on team effectiveness at .13 ($p < .05$): when task interdependence was high, the negative relationship between new situations and team effectiveness was weaker. Task interdependence was not a predictor of team effectiveness (b = .04, $p > .05$).

Comparing this model 2 to model 1 (Table 14) is difficult, as it contains two additional variables (new situations and task interdependence). However, with respect to χ^2/df and RMSEA, the loss of fit is minimal. Thus, model 2 can be accepted. Figure 5 summarizes the identified relationships.

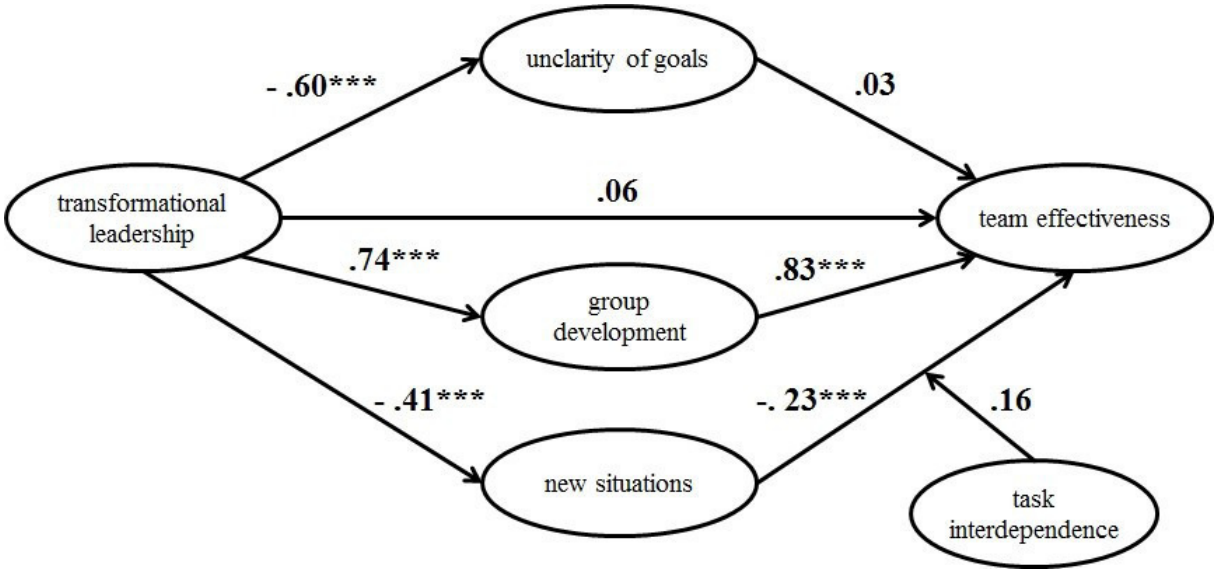

Figure 5. Structural equation model 2 with standardized estimates. ***$p < .001$.

4.5.5 Assessment of common method bias

Harman's single factor test identified a factor that accounted for 36.8 % of the entire variance of the variables: unclarity of goals, new situations, group development, team effectiveness, and transformational leadership. The regression analysis conducted with the sample of 54 teams that contained leader data confirmed the indirect effect of group development, with the 95% CI between 0.19 and 0.56. As a consequence, the identified relationships would remain relevant after correcting for a possible common method bias. The moderation effect of task interdependence could not be confirmed in a hierarchical regression analysis using team effectiveness measures from leaders. In Table 17, we provide the Pearson-correlation coefficients between the mean scores of the variables in the model.

4.6 Discussion

4.6.1 Main findings

This work made three main contributions to the state of the art in leadership research: (1) it was, as far as we know, the first to investigate the role of leadership in the context of

knowledge work, taking task characteristics (i.e. uncertainty and interdependence) into account; (2) with group development and task interdependence, it considered both interpersonal and structural coordination mechanisms; and (3) it addressed methodological limitations of previous research, such as unspecific measurements of uncertainty, issues related to the construct of group cohesion, and the restriction to very homogeneous samples.

Table 17

Pearson correlations of mean scores

		1	2	3	4	5	6
1	Transf. leadership	(.93)					
2	GD	.64**	(.87)				
3	MITAG (new sit.)	-.50**	-.51**	(.68)			
4	MITAG (unclar. goals)	-.32**	-.33**	.65**	(.78)		
5	Task interdependence	.72**	.86**	-.57**	-.50**	(.76)	
6	Team effectiveness	.37**	.47**	-.23*	-.03	.40**	(.89)

Note. N = 107 teams. ** indicates significance at $p < .01$. * indicates significance at $p < .05$. The main diagonal contains Cronbach's α.

The main finding is that group development mediates the positive relationship between transformational leadership and team effectiveness. Transformational leaders do not just create cohesion, some sort of social attraction, in the team. They achieve higher acceptance of and identification with group goals through visionary leadership, and their team members develop better interpersonal relationships among one another, which leads to improved sharing of resources and better coordination. This is why individual consideration and intellectual stimulation pay off beyond performance improvements at the individual follower level.

The results also show that task uncertainty (i.e. new situations) is indeed a relevant phenomenon, as it affected all groups of participants, to a greater extent than expected. New situations, the task uncertainty factor relating to unstable environmental conditions or unpredictably changing outside demands, is per se detrimental to team effectiveness, as the team's efforts to adjust consume additional resources. Teams led by transformational leaders report to suffer less from such unstable conditions and in turn show higher effectiveness. This mediation-effect of the factor of new situations does not explain any additional variance compared to the mediator group development. Thus, the data shows that it is by fostering teamwork (i.e. developing the team better) and creating emergence among team members, that transformational leaders achieve better team performance. The reduced task uncertainty with respect to new situations is rather a byproduct of this effect.

Furthermore, the data indicates that the structural coordination mechanism of task interdependence may help teams become less affected by such unstable environmental conditions: the negative effect of unstable environments on team effectiveness was lower when task interdependence was high. This means that beyond the improved sharing of resources among team members, which results from improved group development, the way work is organized can have an additional effect. Presumably, teams adapt more easily to new situations if cooperation mechanisms are well-defined.

Despite these mediating effects and contrary to what some authors have suggested, we did not find any evidence of task uncertainty (i.e. new situations) moderating the influence of transformational leadership on team effectiveness. Also, the mediating role of the task uncertainty factor of unclarity of goals was not confirmed. The data shows that transformational leaders, expected by definition to motivate team members with a vision, reduce unclarity of goals in their teams. Nevertheless, this did not positively affect team effectiveness. In research and development, unclear objectives may diminish efficiency but they also allow for innovation. This is in line with other findings. Eisenbeiß (2009), for

example, reported that although transformational leadership had a positive effect on follower creativity, it also increased the followers' dependence on the leader, which in turn had a negative impact on creativity.

4.6.2 Theoretical implications

Apart from the described findings, this research has further theoretical implications. We did not identify any moderating effect of task uncertainty, as we had assumed based on previous literature (Bass & Riggio, 2006; Frost et al., 2010). Some research questions came up: (1) subsequent studies could investigate whether another aspect of task uncertainty not represented here fits the described role as a moderator; (2) researching the role of the team members' appraisal of uncertainty may provide helpful insights; and (3) studies to be conducted in other cultures could test the generalizability of the results, for example across different levels of uncertainty avoidance. Of particular interest to researchers may be the finding that different types of task uncertainty, such as new situations and unclarity of goals, may play different roles in teams of knowledge workers. This is a first step towards refining existing models that include effects of uncertainty, and towards specifying uncertainty aspects more precisely in future studies, for example in research on team adaptation (see Maynard et al., 2015).

4.6.3 Practical implications

The results indicate that organizations should foster transformational leadership and remove barriers that may hinder group development. Task interdependence among team members, which is sometimes avoided as a possible source of problems, may also have positive effects on how the team deals with uncertainty. Many teams in non-research jobs reported task uncertainty to be higher than we had expected. For practitioners, this highlights the importance of group development and transformational leadership across a broad spectrum of jobs.

4.6.4 Limitations and implications for research

This study has several limitations. First, it was cross-sectional and nonexperimental. Thus, our design does not allow for causal interpretation. Following an experimental design was impossible, as we could not manipulate transformational leadership long enough for groups to develop significantly. If transformational leadership and group development are more stable over time than team effectiveness, then the indirect effect may have been overestimated (Maxwell & Cole, 2007). However, the causal effect of transformational leadership on team effectiveness has already been demonstrated experimentally (Avolio et al., 2009), and was replicated here. Assuming a reciprocal relationship between transformational leadership and group development seems difficult to justify on a theoretical level, such as a reciprocal relationship between transformational leadership and team effectiveness. However, Mullen and Copper (1994) argued that the relationship between cohesion and team effectiveness is reciprocal, with a stronger causal effect of group process on outcomes. Recent research confirmed their statement (Mathieu, Kukenberger, D'Innocenzo, & Reilly, 2015). The same may apply to the relationship between team effectiveness and group development: team success could, for example, foster identification with the team.

Second, our sample contained few responses from teams with low task interdependence or low task uncertainty. This may, in addition to the identified mediation effects, have obscured potential moderation effects of task uncertainty. The findings thus represent R&D teams with rather high task uncertainty.

Third, for reasons of model complexity, it was not possible to take into account to what extent the team members worked on projects together with their teammates or in virtual teams outside the official team structure. To overcome this limitation, we recommend researching the extent to which resources provided by the core team can be carried over into the work on virtual teams, or limiting future studies to a context in which team members are not participating in virtual teams.

Fourth, while the identified mediation effects were maintained when checking for common method bias, the moderation effect of task interdependence was not. Thus, this result has to be interpreted with caution. For future work, we recommend collecting external outcome indicators, such as financial figures, to reduce potential single source bias.

Fifth, the sample was imbalanced towards researchers and male participants, which was due to the true distribution of genders (34% were women) and jobs (55% were researchers) in the organization (based on HR data from the year 2014). Our data correctly represent today's R&D sector with its limited gender diversity. Additionally, our sample was collected in only one organization and only in Germany; therefore, possible cultural influences, such as effects caused by the level of uncertainty avoidance, may lead to different results in other cultures.

With respect to future research, we also recommend exploring possible suppressor-effects on the relationship between unclarity of goals and team effectiveness. Data should be collected from samples with greater variability in task uncertainty and task interdependence. The findings may also be relevant for cross-cultural psychology: different types of task uncertainty have a different impact within the model. Researching the effects of uncertainty avoidance may thus require measuring the type of uncertainty faced by the participants.

We recommend the GD instrument for research, as well as for practical application in organizations; although caution is advised when comparing regression coefficients across studies, the strength of the identified relationships justifies this choice.

4.6.5 Summary

In summary, task uncertainty affects a broad range of jobs in modern organizations, beyond the area of R&D. Transformational leadership fosters group development and thus leads to greater team effectiveness. This goes along with turbulent situations being perceived as less uncertain by team members. Task interdependence further buffers the negative effect of turbulent situations on team effectiveness.

Chapter 5

General discussion

The work presented here continued the UB's research line dedicated to the HSA. To our knowledge, it was the first to investigate the relationships between all the following constructs from the HSA: transformational leadership, group development, team effectiveness, and task uncertainty, the last of which was represented by the variables of uncertainty of goals and new situations. With task interdependence, we considered yet another construct mentioned in the HSA. We did so to control for possible confounding effects. Investigating these relationships all together advanced our knowledge, as previous research had only connected transformational leadership to team effectiveness (e.g., Avolio et al., 2009), and GD to team effectiveness (Navarro et al., 2015).

5.1 Objectives of this research

We completed the research presented here in order to find out what makes teams of knowledge workers effective and to provide tools for measuring such key factors. Testing models of the relationships between transformational leadership, group development, team effectiveness, task uncertainty, and task interdependence was the main objective of this research project. To test such models in a German sample, it was necessary to set up two additional objectives. They consisted in validating two instruments in a German sample: the GD questionnaire for measuring group development and the MITAG questionnaire to measure task uncertainty. All three objectives arose from the vision of empowering organizations to be more innovative.

5.2 Key outcomes of the research project

The project produced insights that are valuable with respect to the aforementioned vision. We learned that both group development and task uncertainty are relevant constructs when describing the positive effects of transformational leadership on team effectiveness in teams focused on innovating. While the construct of group development (GD) was equally applicable across the different cultures it was tested in, we found evidence of a cultural dependence regarding task uncertainty (MITAG). The research project presented here provided validated measurements of group development and task uncertainty for use in German samples, even though MITAG may be improved based on the recommendations given above.

We found strong evidence indicating that, regardless of the measured task characteristics, transformational leadership unfolds its positive effects on team effectiveness through improved group development. We also saw that different types of task uncertainty play different roles: whilst (reduced) uncertainty created outside the team ("new situations") does mediate the positive effect of transformational leadership on team effectiveness, uncertainty regarding the team's objectives does not do so. For organizations focused on innovation, this means that they should focus on fostering transformational leadership. Leaders, in turn, should focus on developing the team, rather than on detailing team objectives way beyond an orienting vision. Teamwork builds confidence among team members and helps buffer the negative impact of turbulent environmental conditions.

5.3 Strengths and limitations of this research

5.3.1 Strengths

The first strength of this research is that it addressed a relevant topic and built a bridge between different research disciplines. With uncertainty playing an increasing role in today's working environments (Navarro et al., 2011), researching the role of task uncertainty with respect to other variables is an imperative of organizational psychology. The findings are

likely to be relevant for other research disciplines, and by operationalizing a key characteristic of knowledge work through different aspects of task uncertainty, we created a link to other disciplines, such as innovation research and technology management. Thus, our results could, for example, help enhance existing models of innovation (e.g., the innovation excellence model as in Spath, Linder et al., 2011).

The second strength is the size of the samples; it allowed for the employing of structural equation modeling, which has the benefit of correcting for measurement error (Preacher & Hayes, 2008). We furthermore collected the data from a big organization that plays an important role as an innovator in German industry. Thus, the results are representative in a key area of practical application. Collecting data from two sources, team members and team leaders, allowed us to test for common source bias and demonstrate the robustness of the results (see 5.3.2 for details).

The third strength of this research is that its three subordinate studies addressed the previously described variety of research gaps and that we based these studies on a coherent measurement framework of organizational behavior: the HSA (Navarro et al., 2011). This provides a solid theoretical foundation for the interpretation of the results. With respect to the main study (chapter 4), the HSA allowed for the consideration of interpersonal and structural coordination mechanisms at the same time. As far as we know, previous research (Eisenbeiß, 2009; Paulsen et al., 2009; Reuveni & Vashdi, 2015) did not include structural coordination mechanisms in the research models, or at least, they did not clarify how these are related to processes other than outcomes (De Jong & Den Hartog, 2007).

Finally, this research also has practical relevance. It addressed key questions that needed to be answered in order to strengthen knowledge work in today's organizations. We compared knowledge workers to other job types and thereby addressed the limitations of former research, which was restricted to samples of certain types of knowledge workers (e.g., Eisenbeiß, 2009; Paulsen et al., 2009; Reuveni & Vashdi, 2015).

5.3.2 Limitations

Some limitations apply to all three studies. First, all samples consisted of voluntary participants. This implies that self-selection effects may have introduced some bias into the data (Bethlehem, 2010). We do not know of any literature on self-selection biases that would allow conclusions about the type of bias most likely to have affected our samples. As voluntary participation is a requirement of the ethical principles of psychologists and code of conduct by the American Psychological Association's (APA, 2003), this limitation affects all studies that adhere to this ethical guideline, and consequently most published research. However, if a self-selection effect is present in our data, it at least did not cause any ceiling effects: while the variance in task uncertainty was lower than expected, there was considerable variation in the variables of leadership style, team effectiveness, and group development.

The second limitation, which also affects all three studies, refers to the fact that all participants belonged to the same organization and thus to a single sector. This may have limited the external validity of the identified results. However, participants worked at different divisions of the organization, and the researchers even worked in different scientific areas.

The third limitation, which specifically affects the validation of the MITAG, results from gender distribution. When we confirmed the new factor structure of the MITAG in a CFA using the sample of German team members, the resulting parameters were not invariant for male and female participants. As this sample contained more male participants, this may have had an influence on the validation of the MITAG, such as the identified correlations, as well as on the main study testing the model (chapter 4). With respect to job type, other grouping variables that we did not regard here may have had an additional undetected influence. For example, such job variables could refer to jobs in sales, marketing, or manufacturing. In our opinion, the low AVE of the GD questionnaire is not a limitation, as

argued in section 2.4.2. With respect to the external validity of the main study, the overrepresentation of male participants in both samples does not pose a threat to the external validity of the results, as this correctly represents the current proportion of male researchers in the organization. In Germany, ca. 40% (Statistisches Bundesamt, 2017) of all researchers are currently female. Therefore, the results correctly represent the current situation, even at national level.

In both validation studies, we collected the measurement data of the instruments to validate and of the criterion variables from the same sample, using questionnaires. Data from other sources were not available due to the permissions granted by the participating organization. This may have led to an over-estimation of the identified relationships between the validated measurement and the other scales. Podsakoff et al. (2003, p. 880) summarized previous studies on the topic by stating that "on average, the amount of variance accounted for when common method variance was present was approximately 35% versus approximately 11% when it was not present." However, the strength and direction of the bias are variable. "Method variance can either inflate or deflate observed relationships between constructs" (Podsakoff et al., 2003, p. 880). In the validation studies, we were less interested in the absolute correlation coefficients but rather in the differences between these coefficients. As, by definition, such a bias would affect all variables, it would not alter the findings of which instrument correlated more strongly or weakly with the questionnaire to validate. Therefore, we did not consider this limitation critical in the validation studies. For the model test of the third study, however, common source bias posed a more serious threat. Thus, we checked for such a bias in the third study (section 4.5.5). Using Harman's single factor test, we identified a factor that accounted for 36.8 % of the entire variance. This is the upper limit of such a bias, which we considered acceptable. By replacing member data by leader data, we found that the obtained results were robust against common method bias, except for the moderating role of task interdependence regarding the relationship between new situations

and team effectiveness. Thus, one should consider this latter effect rather an exploratory finding, whilst the other results are safe to interpret.

Another limitation regarding the validation studies lies in the fact that neither MITAG nor GD questionnaire fulfilled all set validity criteria at item level. However, as noted above (2.4.2), the fact that the GD missed the defined threshold for AVE did not seem problematic to us. With respect to the MITAG, the factors of new situations and non-routine also missed the cut-off values for CR and AVE. We did not consider this a threat to the tool's validity in general either. However, this finding supports our claim that the items may benefit from the re-phrasing proposed in section 3.4.3.

Since we collected the data for both validation studies from the same sample, we needed to shorten the survey as much as possible in order to assure an acceptable return rate. Therefore, we had to select items from established questionnaires instead of administering the instruments at their full lengths. This was not an issue in the case of the JDS, where the manual clearly stated that using only selected subscales was permitted (Schmidt et al., 1985). However, such information was not available from the validation studies or manuals of the other instruments (F-A-T short, SABKWSE, TCL, and AfA). The SABKWSE is a one-factorial instrument, which means that selecting some items would affect reliability rather than validity. In the case of F-A-T short, TCL, and AfA, we entirely excluded at least one of each instrument's subscales. Thus, regarding these three instruments, we cannot exclude validity issues with the selected items. However, as the relationships between the selected item sets and the respective questionnaire to validate (either GD or MITAG) resulted as expected, it appears that we did incur such validity issues.

A limitation that applies to the validation of the MITAG and the main study is the fact that we found lower than expected variance regarding task uncertainty between the different job types. We compared researchers to staff from administration, mechanical workshops, and other occupations based on the idea that researchers would report much higher levels of task

uncertainty, compared to their colleagues involved in, presumably, more routine jobs. Thus, if our members sample had contained more participants with jobs characterized by low uncertainty, we might have found different results. However, this limitation also suggests that uncertainty is a relevant topic in a broad spectrum of jobs, contrary to our initial assumption that non-researchers would score much lower on task uncertainty. This confirms the statement by Navarro et al. (2011) that task uncertainty is becoming increasingly important in the modern working world.

Two additional limitations apply to the main study. One is its cross-sectional and nonexperimental character, due to which causal interpretation requires caution. In a previous laboratory experiment, group development did not change significantly for as long as we could manipulate leadership style. This is why we finally applied a cross-sectional research design. Based on previous experimental evidence (Avolio et al., 2009), one may safely assume that transformational leadership causes an increase in team effectiveness. With respect to the relationship between group development and team effectiveness, we assumed, based on Mullen and Copper (1994) and Mathieu et al. (2015), that the relationship is bidirectional, with the influence of group processes being larger than the contrary effect. Therefore, we included GD as a mediator in our model. Due to the lack of longitudinal data, we were not able to provide a deeper understanding of these relationships. The cross-sectional character of the study may also have led to overestimating the indirect effect of transformational leadership on team effectiveness via the mediator group development, if one assumes that team effectiveness is the least stable variable of those three (Maxwell & Cole, 2007). According to Maxwell and Cole (2007), the direct effect could have been overestimated by 0.48.

Another limitation derives from the fact that we did not know a lot about the different teams' tasks, particularly regarding content, thematic fields, and amount of teamwork done within the respective participating teams. This is a logical consequence of our research

approach. In previous research, restricted to rather homogeneous samples, it was relatively easy to describe what activities the teams undertake when working together. Our study followed a different approach, by comparing across many different teams. Thus, while we addressed the limitation of previous research that consisted in the use of homogeneous samples, we automatically incurred the limitation of sampling teams with diverse and not well-known tasks. The consequence of this limitation is that we cannot break our results down from their abstract level of description to lower level processes or team activities. Now we know that group development goes along with high team effectiveness. However, only future studies could discover more details about the specific activities that well-developed teams do better and that result in increased effectiveness. Such activities could include the exchange of knowledge, the development of shared mental models, and mutual feedback on individual work results.

Chapter 6

Conclusions

Chapters 2 to 4 contain detailed discussions of the results obtained in each of the single studies. This chapter serves to summarize these results and to embed the conclusions drawn from these into a greater context, without being too repetitive.

6.1 Main findings

6.1.1 Study 1

The main objective of the first study, reported in chapter 2, consisted in providing a validated continuous measure of group development for use in German-speaking samples. The research gap behind this objective consisted in the fact that such a measure was missing, since the available instruments had the following limitations. Group development measurements based on stage models (e.g., Tuckman & Jensen, 1977) might not be able to measure relevant differences of groups at a similar stage. Due to its problematic operationalization (Hogg, 1993), the continuous measure of group cohesion did not appear to be a good alternative. By validating the GD instrument, we wanted to provide such an alternative instrument. Another objective was to find out how the construct of group development correlated to other established instruments in the German language, and whether it was applicable across cultures. The fact that such evidence was missing from Germany was another research gap. We reached the objective and thus successfully closed the respective gaps, as the following summary of the research results confirms.

The evidence collected in the German samples of team members and team leaders indicates that the translated GD questionnaire fulfils high validity standards, including excellent reliability. The one-factorial structure of the instrument was confirmed in both samples. Additionally, the members sample produced the following findings: mean and

standard deviation were similar to those in previous studies (Navarro et al., 2015), and correlations to other measurements resulted as expected. We also found the GD instrument to be invariant across genders and the represented job types. We identified only one issue: at .48, AVE was marginally below the criterion value (.5). Presumably, this resulted from the fact that the items of the GD questionnaire represent four characteristics of well-developed groups and thus do not constitute parallel items. We also tested and discarded alternative models (e.g., with four factors). Considering all findings together, we do not consider the low AVE as a threat to the tool's validity. The results prove that the construct of GD is applicable in Germany, as it is in the cultures in which the previous validation studies had been conducted: Spain, Venezuela, and Brazil. We therefore reached the research objective of providing a continuous measurement of group development for German samples, and the GD became available for use in the study detailed in chapter 4. The GD overcomes the research gap named above.

6.1.2 Study 2

Analogous to the aforementioned, the main objective of the validation study described in chapter 3 was to provide a measurement instrument in the German language that distinguishes between different types of task uncertainty, such as the variety of uncertainty aspects described by Navarro et al. (2008). The corresponding research gap consisted in the lack of such an instrument. In German, only the AfA (Schmidt & Hollmann, 1998) was available. We did not consider it a useful alternative to the MITAG, since the AfA focuses on social roles instead of tasks, and since it features only two factors of ambiguity: one refers to work methods and schedule, the other to performance criteria. For the sake of the main study, depicted in chapter 4, we required an instrument that distinguished between more aspects of uncertainty, in order to resolve the inconsistencies in previous literature regarding the effects of uncertainty with respect to leadership and teamwork (see sections 4.2.4 to 4.2.7).

We assumed that these inconsistencies resulted from a lack of knowledge concerning

the dimensionality of task uncertainty, and this was the second research gap we addressed. As summarized in sections 4.2.4 to 4.2.7, we found theoretical support for a mediating as well as for a moderating role of task uncertainty regarding the variables in our model, and we argued that such roles would depend on the specific aspect or subordinate construct of task uncertainty that is operationalized. As argued in section 3.1, previous research (e.g., Gardner et al., 2012) has operationalized task uncertainty without specifying such subordinate constructs. Even when instruments were created using items from older instruments (e.g., Withey et al., 1983), instead of building a sound theoretical framework, the operationalizations are not comparable. Despite the existence of some previous research on sub-types of task uncertainty (Perrow, 1967; Ven & Ferry, 1980; Withey et al., 1983), there was a lack of theoretical insight about the dimensionality of task uncertainty, also across cultures. This was the second research gap we addressed in this study. By validating the MITAG in a German sample, we aimed at creating new knowledge about the cross-cultural applicability of the respective sub-types of task uncertainty. This could counteract the practice of using incompatible measurements across studies and disciplines. The results, summarized in the following paragraph, represent a valuable contribution with respect to the main objective of this study and the closing of the two respective research gaps.

The original factor structure of the Spanish MITAG questionnaire did not fit in the CFA we performed with the sample of German team members. In an EFA in the leaders sample, we identified three new factors in the German sample: unclarity of goals, new situations, and non-routine. The fit of this new model was also acceptable in the sample of team members. The difference regarding the new factors is substantial, even though they resemble the ones named by Navarro et al. (2008) – clarity, diversity, novelty, and conflict – and even though Navarro and colleagues also identified cross-loadings, for example between clarity and conflict, which in the German sample led to joining items from the respective factors. We deleted nine out of 18 initial items in the process. Although the study produced a

valid and reliable instrument for use in German samples, the results can help improve this instrument. We described such improvement potentials in section 3.4.3. Based on the identified pattern of differences between the German and the Spanish factor structure, we assume that it is the culture and the way uncertainty is perceived and dealt with that caused the differences in the factor structures rather than issues with the translation, which we tackled using a back-translation process (ITC, 2017).

The new factor structure in the German sample represents the source of task uncertainty rather than the type of uncertainty that characterizes the results found by Navarro et al. (2008) in their Spanish samples. Power distance (Hofstede et al., 2010) may explain the differences identified in the factor structure: Germans at lower levels of hierarchy show less acceptance of hierarchical differences (Hofstede et al., 2010). Thus, we assumed that compared to Spanish employees, German employees would see their leader as a colleague with a different role rather than as an unquestionable superior. Consequently, they would likely feel more entitled to demand good leadership from their superiors, including a precise definition of objectives. This could explain why Germans rather judge uncertainty by its source. The newly identified dimensions of the MITAG correlated as expected to measures of other task characteristics.

We completed the main objective, since we made a measurement of three uncertainty dimensions available for use in German samples. We used this tool in the study described in chapter 4. Consequently, we have successfully addressed the respective research gaps, even though we do not consider them fully closed. While we produced a useful measurement of task uncertainty in German, the identified issues indicate that the tool can be improved. Our findings are likely to be useful in further studies, which could produce a new measurement instrument with greater cross-cultural applicability. Likewise, although the findings add to our understanding of how task uncertainty is perceived in different cultures, more research is required to produce a theoretical model and operationalization that can replace previous

measurements.

6.1.3 Study 3

The objective of the main study was to research the relationships between transformational leadership, group development, task uncertainty, task interdependence, and team effectiveness. We thereby addressed the following gaps found in the current literature.

First, while the effects of transformational leadership on team creativity and team innovation had already been researched, the question of whether the effects of transformational leadership differ depending on the level of task uncertainty had not yet been answered. The theory led one to assume that transformational leadership could be more effective in teams with high task uncertainty (Frost et al., 2010), analogous to its increased effectiveness under uncertain environmental conditions (Felfe, 2006). Likewise, it had been argued that teamwork is the preferable method to deal with uncertain work or innovation work (Kozlowski & Bell, 2003; Navarro et al., 2011). We tested these assumptions to close the two respective research gaps. Another limitation of previous research that we addressed was that, in most studies, group cohesion had usually served as a mediator of the relationship between transformational leadership and team effectiveness (Bass et al., 2003; Jung & Sosik, 2002). We replaced group cohesion with group development (Navarro et al., 2015), to account for the shortcomings of the operationalizations of group cohesion, as referenced in the introduction and in section 2.1. Besides group development as an interpersonal coordination mechanism, we also took task interdependence as a structural coordination mechanism into account. The main reason we did this was that we suspected task interdependence to confound the results by creating a high need for group development even when task uncertainty was low (Mullen & Copper, 1994). In an indirect manner, this also corresponds to the research gap concerning possible triggers and influence factors of team adaptation (Maynard et al., 2015), here represented by task uncertainty and task interdependence. Finally, to address the limitations of IPO models mentioned by Ilgen et al.

(2005), we tested an IMO model. This was the more conservative approach, even though we considered group development an emergent process (Navarro et al., 2015).

We found in the members sample that group development mediates the positive relationship between transformational leadership and team effectiveness. This means that transformational leaders achieve a greater development of their team, and so the team becomes more effective. Thus, the results justified our choice of group development, an interpersonal coordination mechanism in the shape of a process, as a mediator variable. The results also showed the following: members of teams with a transformational leader feel less affected by unpredictably changing demands from outside the team (new situations) that in turn diminish team effectiveness; and it is their increased level of group development that protects them from such negative effects. Task interdependence decreases the negative effects of new situations even more. The results indicate that structuring work towards cooperation and interaction between team members will help the team adapt to the unexpected: with higher task interdependence, which represents the respective structural coordination mechanism, the negative influence of new situations on team effectiveness decreases.

The data did not confirm the alternative hypothesis that teams highly affected by new situations would benefit particularly from group development, and thus from transformational leadership. So, while environmental uncertainty moderates the effect of transformational leadership on team effectiveness (Felfe, 2006), we did not find the same phenomenon with respect to new situations, which is the corresponding task characteristic. Finally, we found that although transformational leaders define team goals better than other leaders, this is not how they contribute to increasing team effectiveness of research teams.

Therefore, this research has contributed to closing the research gaps named above. We tested the hypothesis that transformational leadership is more effective in uncertain tasks, based on two aspects of task uncertainty. We also showed that group development is important for teams to deal with the task uncertainty factor of new situations. With respect to

the question of how different aspects of task uncertainty affect the relationships between transformational leadership, group development, and task uncertainty, the research presented here does not provide a complete answer; other aspects than the ones tested may have an influence. We discuss this further down in the section on theoretical implications and future research (6.2.3).

6.2 Implications for theory and future research

In summary, the findings imply that GD and MITAG are both relevant for research, and the identified relationships between the variables in the model tested in chapter 4 allow for theoretical conclusions and the planning of future research. These conclusions particularly relate to the mechanisms that make transformational leadership effective.

6.2.1 Relevance of the GD construct

Our results show that the GD is a valid construct, not only in Spain, Venezuela, and Brazil but also in Germany. Consequently, the findings described above underline the importance of the GD for future research. In particular, the findings of chapter 2 provide additional support to the theory built by Meneses et al. (2008) and likewise to the theoretical implications named by Meneses (2015), which are not repeated in detail here. In summary, the GD combines and continues the research lines on three other constructs that describe the characteristics of groups: groupness, entitativity, and groupality. The proposal of GD as a continuous measurement implies abandoning the construct of groups as a dichotomy: group or non-group (McGrath, 1984). At theoretical level, the GD addresses the limitations of the stage models of group development: stage models assume linear development and do not provide insights into what happens after a team has reached the final stage (Miller, 2003). Their attempt to define the group's stage by its outputs can be regarded as a tautology that obscures the relevant processes that make a team effective (Meneses, 2015, p. 157).

Based on the evidence collected in chapters 2 and 4, the GD instrument is a valid alternative to stage or life cycle models, as well as to measurements of cohesion. We

recommend using it in future research, and consequently, its relevance in research models across several areas of organizational psychology may increase. The benefits that the GD offers to future studies result from the limitations of other established instruments that it addresses: the GD allows for the measuring of team processes that are relevant with respect to team effectiveness, independently of the team's current developmental stage (Meneses, 2015). The study in chapter 4 has also confirmed its importance as a correlate of team effectiveness. Unlike the models described by Tuckman and Jensen (1977), Wheelan (1994), Gersick (1988), Moreland and Levine (1982), and Morgan et al. (2010), the GD is a continuous measure and hence does not reduce variance between groups to produce ordinal data. Thus, the GD is less likely to cause ceiling effects or to disguise relevant covariance. Additionally, the GD does not imply linear development, as stage models do (Miller, 2003), and it may thus be particularly recommendable for longitudinal studies.

The GD also offers a benefit for theory development when we compare it to the supposedly most used continuous measurement of the characteristics of a group that predict its effectiveness: group cohesiveness. The different operationalizations of group cohesiveness mainly revolve around the mean extent to which the different members feel attracted to the group. The predominant interpretation of cohesiveness is the extent to which group members like each other (Hogg, 1993; Mullen & Copper, 1994). In comparison, the GD defines more characteristics of well-developed groups than cohesiveness does. It thus allows us to link a team's outputs to processes (i.e. sharing resources) or shared cognitions (i.e. common objectives) in the team.

The following are just two examples of the currently available research questions, which we mention in order to emphasize the potential of the GD in future research:

1) Leadership research could attempt to find out if other leadership styles do also foster GD. For example, Drescher, Korsgaard, Welpe, Picot, and Wigand (2014) have shown that shared leadership fosters trust among team members,

which in turn relates to performance improvements. From the validation study, we know that GD relates to mutual trust. Thus, one could investigate whether GD offers incremental validity in this context.

2) In diversity research, GD might help explain how diverse teams benefit from diverse knowledge, abilities, or viewpoints. According to Edmondson and Harvey (2017), "studies of team diversity have not explored the process through which a group of diverse individuals develop into a team ready to solve a new complex problem" (p.5). The GD might be a helpful instrument with which to analyze the processes involved.

We recommend the GD for studying these questions since it would require a validated continuous measurement of group development, which accounts, in comparison to other constructs such as group cohesion, for apparently relevant group-level processes and thus benefits theory development. In the second case, the intercultural applicability of the GD could be an additional advantage, as it would allow for the testing of diversity in teams composed of members from different cultures.

In addition to the above-named recommendations to use the GD in team research, we propose researching the GD itself further. This questionnaire and the construct it measures proved to be applicable not only in Spain and in Latin America but also in Germany, as chapter 3 showed. This makes a strong case for the general applicability of the model. Nevertheless, one could check for measurement invariance across cultures. It would also be advisable to broaden the evidence base by validating the GD in other cultures, for instance in Asian samples characterized by a higher degree of collectivism compared to Europe (Hofstede et al., 2010). Finally, one could also collect longitudinal data to check if the GD predicts group development over time, or one could compare recently formed groups to groups that have existed for a longer time.

6.2.2 Relevance of the MITAG's task uncertainty dimensions

Based on the evidence gathered in chapter 4, we consider task uncertainty a relevant variable for future research on knowledge work: the factors that resulted from the validation study in chapter 3, based on the team members sample, correlated significantly with relevant variables of the model that we tested in the sample of German teams in chapter 4. In other words, different aspects of task uncertainty can play different roles with respect to factors that influence team effectiveness, i.e. transformational leadership and group development. This could also apply to other variables that are researched in conjunction with task uncertainty, such as team autonomy (e.g., Cordery, Morrison, Wright, & Wall, 2010) or leadership style (e.g., Krabberød, 2014).

Furthermore, we found in chapter 4, based on the sample of teams, that task uncertainty affected not just researchers but also workers with other job descriptions. Thus, task uncertainty is apparently not only gaining importance as a key characteristic of knowledge work (Spath & Hofmann, 2009; Willke, 1998) but also as a general characteristic of modern working contexts. This is why we recommend including such task uncertainty measures into future research.

Today, only a small part of the literature on teams and leadership considers task uncertainty (see section 4.2.4). Often, uncertainty is operationalized without regard to the specific aspect being measured, or without relying on validated instruments based on a comprehensive theoretical framework (Gardner et al., 2012; Nidumolu, 1995; Tatikonda & Rosenthal, 2000). This is critical, as our results from chapter 4 show: different aspects of task uncertainty have different roles in the model. From now on, researchers should specify the aspect of task uncertainty that they measure, based on a validated instrument, instead of grouping items from one or several instruments. Research that focuses on uncertainty in general (e.g., Gardner et al., 2012; Nidumolu, 1995; Tatikonda & Rosenthal, 2000) might benefit from such specification, instead of relying on unspecific measurements or definitions

of task uncertainty. The MITAG could play an important part in this context, serving as a well-grounded and validated instrument to measure different aspects of uncertainty. As argued in section 6.1.2, appropriate alternatives to the MITAG are missing.

Consequently, the main implication for future research resulting from the validation study described in chapter 3 is to redesign the MITAG based on the recommendations made in section 3.4.3. Building on the theoretical basis presented by Navarro et al. (2008), a more universal operationalization could possibly be created. Thus, the main contribution to theoretical research provided by the validation of the MITAG is the identification of a new factor structure and the definition of improvement potentials to the questionnaire. Our results imply that measuring task uncertainty requires referencing both type and source of task uncertainty. We assumed that in Germany, due to the lower power distance compared to Spain, employees are more prone to expect their leaders to define group objectives well, which may result in answering the questionnaire rather based on who is responsible for the uncertainty experienced than based on the type of uncertainty. For researchers, this implies that exploring the effects of task uncertainty requires considering possible impacts caused by the local culture. As discussed in section 3.4.3, future research could adapt the MITAG's items to reflect such a distinction between type and source of uncertainty better.

Taking the results from the study in chapter 4 into account, it seems reasonable to define the measurement dimensions based on the theoretical foundations of Navarro et al. (2008), yet also considering what can be done to remedy the uncertainty. This way, the MITAG broadened our viewpoint on task characteristics, highlighting the source of uncertainty as a relevant aspect. In the revision of its items, one can thus either focus on the resources or actions required to overcome the uncertainty, as reflected in items 1, 4, 7, and 16; or, one can describe them as general difficulties encountered, such as the ones represented in items 2, 12, or 18. Adding the perspective of task uncertainty as demands could allow one to link it to resources of teams or individuals, and thus make task uncertainty measurements

available for research on occupational stress, as reflected in the job-demands-resources model (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001). Depending on the source of uncertainty or the resources available to deal with them, some aspects of task uncertainty may possibly affect worker health. Adapting the MITAG could therefore not only be beneficial to research on organizational effectiveness but also to research on psychological health. Future studies could investigate whether, for example, the source of uncertainty determines work-related strain, and thus integrate the respective aspects of task uncertainty into a model such as the one presented by Demerouti et al. (2001). Likewise, the representation of task uncertainty as demands linked to resources might be beneficial to team adaptation research (e.g., Maynard et al., 2015), in the sense that it allows for the investigation of which adaptation is required by the team and how it is achieved.

Despite the need for further such improvement of the MITAG, this research took us a step ahead towards defining a measurement instrument that can serve across job types and across cultures to measure different types of uncertainty. This will increase the interpretability and comparability of future research in this area. The MITAG already overcomes limitations of other instruments, as it excludes operationalizations of difficulty, which refers principally to individual characteristics, such as skills. Furthermore, it already distinguishes well between some job types (section 3.3.2), which other measures have failed to do in the past (Withey et al., 1983).

In summary, our recommendation for future research is to apply the proposed changes to the set of items and to revalidate the MITAG in Spain and Germany, or even another culture. This may provide the necessary evidence to accept or discard the interpretation presented here of the differences identified in the factor structure.

6.2.3 Mechanisms of transformational leadership

As mentioned above (section 4.6.1), the model test described in chapter 4 (based on the sample of teams) made three main contributions to the theoretical advancement in this

research area: (1) it addressed transformational leadership, group processes, and task uncertainty altogether in an integrative manner – as the first study that we know of; (2) it took interpersonal and structural coordination mechanisms into account; and (3) it addressed some methodological limitations of previous research.

The respective evidence has implications with respect to leadership research: it allows for a look into the black box of transformational leadership. More precisely, it assists in drawing conclusions about the mechanisms that help teams of transformational leaders deal with uncertain tasks. While a lot of research has corroborated the positive effects of transformational leadership on work groups (Avolio et al., 2009), we still know little about the way these effects are created. Based on the results described above, we know that in knowledge worker teams, a transformational or visionary leader is not required to reduce unclarity of goals. Instead, transformational leadership renders its positive effects through the fostering of group development as an interpersonal coordination mechanism, which also aids in reducing the negative effects of unstable outside demands that require the team to adapt. A possible implication for future leadership studies could be to investigate the relationships between transformational leadership and single processes at group level that would foster group development. Such hypothetical processes could be the ones mentioned in section 4.2.3: coordination of the team members' activities, acceptance of group goals, reduction of interpersonal conflicts through individualized consideration, and increasing self-efficacy.

Unlike what could be expected based on the literature (Felfe, 2006; Frost et al., 2010), the aspects of task uncertainty that we measured did not moderate the relationship between transformational leadership and team effectiveness. Other aspects of task uncertainty that we did not analyze, such as the AfA's (Schmidt & Hollmann, 1998) factor related to unclear work schedules, might still produce such a moderation effect. Therefore, we do not yet consider this research question to be fully answered. For future research, we recommend testing a model similar to ours but including other aspects of task uncertainty. Nevertheless,

we addressed the limitations of previous research (e.g., De Jong & Den Hartog, 2007; Eisenbeiß, 2009; Reuveni & Vashdi, 2015) and provided initial evidence on this question. The finding that transformational leadership is apparently more effective in uncertain environments, but not when tasks are uncertain, requires theoretical explanations that are not yet available.

6.2.4 Task characteristics in teamwork models

The finding from chapter 4 that new situations mediated the effect of transformational leadership on team effectiveness in the team sample is also relevant for research on team adaptation (e.g., Maynard et al., 2015) and consequently an implication for theory development in team research. Subsequent studies should take into account that the team members' appraisal of new situations might depend on psychosocial processes in the team, including leadership style. This subjectivity of adaptation triggers has not been considered in past literature (Maynard et al., 2015).

Furthermore, the results presented in chapter 4 support the claim by Meneses (2015) that in future research on team development, task characteristics should be taken into account. Task characteristics have been represented, for example in the model by Burke, Stagl, Salas, Pierce, and Kendall (2006), at a general level. However, to our knowledge, elaborate models including the subordinate aspects of task uncertainty, such as unclarity of goals, new situations (see chapter 3), novelty (Navarro et al., 2011), task variety (Withey et al., 1983), and analyzability (Withey et al., 1983) are still missing. The evidence of chapter 4 could be integrated into existing models, such as the one presented by West (2002).

6.2.5 The interaction between coordination mechanisms

We considered task interdependence and group development together, which – to our knowledge – was also unprecedented in the literature. The moderation effect of task interdependence on the negative relationship between new situations and team effectiveness identified in the sample of teams in chapter 4 has to be interpreted with caution, as it was not

repeated in the reduced sample of teams containing leader data. However, the data clearly shows that both coordination mechanisms play different roles. This moderation effect deserves further research. We assume that task interdependence could even be manipulated in experimental settings, thus allowing one to research possible causal effects of this mechanism regarding the way team members collaborate and adapt to outside demands.

Future studies could also investigate how exactly task interdependence fosters team adaptation. The effect might merely be due to increased contact between team members. However, it is also possible that task interdependence fosters some processes or mechanisms of team adaptation. Based on the summary of team adaptation frameworks presented by Baard, Rench, and Kozlowski (2013), we propose investigating the roles of cognitive mechanisms, such as shared mental models and transactive memory systems, regarding the described effect of task interdependence. The finding that new situations has no incremental validity after considering GD in the model implies that research on team adaptation could benefit from the GD as a possible source of adaptation potential – and could link adaptation processes to the GD's processes.

6.2.6 The relevance of the HSA

An implication that results from all three studies refers to their common foundation: they all operationalized structures and processes based on the HSA measurement framework of organizational behavior. This was the first time that a complete set of processes within the HSA framework was analyzed in a research study. The results show that its components are relevant and that despite the existence of more complex frameworks for operationalizing knowledge work, the HSA covers relevant aspects and provides valid and reliable measurements. Future research can build on this and extend the framework.

The HSA serves to evaluate how work is done in organizations and our findings show that the variables included in the framework are relevant. It was created to build a bridge between research in organizational psychology and practical application in organizations. It

has three components: a theoretical model, a battery of measurement instruments, and a system of management tools to apply it in organizations (Quijano et al., 2008). As an integrated systemic model, the HSA is constantly challenged empirically (Quijano et al., 2008), and each empirical study can only address a selection of aspects represented in the model. Chapters 2 and 3 address the component of instruments, thus increasing the international application range of the HSA. The study described in chapter 4 was the first to investigate the relationships between a combination of HSA variables highlighted by Navarro et al. (2011). The results can serve as a basis for theory development by providing information on how such variables are interrelated. In particular, the finding that transformational leadership style, group development, and some aspect of task uncertainty have an influence on results can enable future studies to link the HSA's enablers, such as HR development (Quijano et al., 2008), i.e. leader training, to these psychosocial processes.

6.2.7 Possible follow-up research

Additionally, future research could also address the limitations of this work. Subsequent studies should attempt to collect longitudinal data in order to address the issue of supposedly reciprocal relationships between GD and team effectiveness. Another limitation of this work was the collection of information from the same source. Collecting external outcome indicators would presumably remedy this issue in future studies.

By contrasting tasks across different types of teams, this research has followed a different approach than previous investigations. It may be advisable to re-use this approach in order to study, for example, the impact of other leadership variables, such as participative leadership or shared leadership.

6.3 Practical implications

The HSA is not restricted to academic use: it is also a toolbox for practitioners to evaluate key aspects of teamwork in organizations. Consequently, the findings underline the relevance of the constructs of transformational leadership, group development, task

uncertainty, task interdependence, and team effectiveness in the context of fostering organizational effectiveness.

To practitioners in the area of Human Resources, the findings are relevant as they are helpful in the evaluation and intervention in knowledge worker teams. Group Development has shown itself to be a key predictor of team effectiveness, and transformational leadership has a substantial influence on Group Development. With the short scale of transformational leadership from the HSA (HSA-TFL short, Berger et al., 2012) and the GD questionnaire, these constructs can be measured together with high efficiency, which is a necessary requirement for effective intervention, such as administering leadership trainings, leader recruitment, or additional measures to foster team development.

Similarly, the findings provide guidance to team leaders, particularly to leaders of knowledge worker teams. While there is nothing new to the recommendation of applying the four "i's" of transformational leadership (idealized influence, inspirational motivation, intellectual stimulation and individualized consideration), the findings still provide new insights into what they serve for and how teams can benefit from this leadership style. Although transformational leadership fosters team development, leaders should pay attention to the characteristics that make a well-developed team and take advantage of the connections between leadership and Group Development. Leaders should aim at improving the interpersonal relationships among group members, at defining group goals, at fostering the identification with the team, and at ensuring team coordination. With respect to the interpersonal relationships, leaders should be aware that individualized consideration may not only be relevant for each member's personal well-being and individual performance. It may also reduce conflict among team members and foster identification, as team members realize that their personal needs are respected. In addition to this, leaders could apply other team-building methods. Leaders should also define team goals instead of individual goals. Communicating a general vision of a desirable future or outcome may foster motivation and

identification with the team. However, the findings in chapter 4 clearly indicate that, particularly in knowledge work, team objectives should not be over-specified, as this does not contribute to team effectiveness. Uncertainty of objectives is a characteristic of knowledge work and a too-dominant transformational leader may actually block team creativity. Leaders should therefore not impose too-detailed objectives; rather, they should encourage the team members, individually and as a group, to find their own solutions. Knowledge work is characterized by unstable environmental conditions. It seems that organizing the work in a way that enhances task interdependence among team members can reduce the negative effects of such unstable conditions on team outcomes. Consequently, team leaders can define project roles and responsibilities, or let team members define such roles by themselves. To foster the members' identification with the team, leaders should, for example, provide feedback on team performance, support boundary reinforcement, and safeguard the team's interests within and outside the organization. Finally, to achieve a high level of coordination, leaders should grant access to relevant information and establish intra-team feedback loops. All this information can be useful for the creation of training concepts and their application.

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Annex

Publications

We submitted the work presented in this doctoral thesis for publication to scientific journals, separated into three articles, which coincide with chapters 2 to 4. To date, only chapter 4 has been accepted and published.

- Leuteritz, J.-P., & Berger, R. (2017). *Validation of the German Group Development (GD) questionnaire*. Manuscript in preparation.
- Leuteritz, J.-P., Navarro, J., & Berger, R. (2017). *Validation of the German version of the Group Tasks Uncertainty Model (MITAG)*. Manuscript submitted for publication.
- Leuteritz, J.-P., Navarro, J., & Berger, R. (2017). How knowledge worker teams deal effectively with task uncertainty: The impact of transformational leadership and group development. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.01339

The following pages contain the first pages of these articles.

Validation of the Spanish Group Development (GD) questionnaire in a German sample

4705 words

This research did not receive any funding.

The authors do not have any financial interest from the direct applications of this research.

Abstract

Teamwork is highly important in modern organizations, and Group Development (GD) is a key variable in researching and evaluating what makes teams successful. We therefore analyzed the psychometric characteristics of the Spanish GD questionnaire in a German sample. 605 participants (501 team members and 104 team leaders), aged between 18 and 65 years, from a German research organization provided data by answering an online survey. They answered the GD questionnaire and items related to other group processes (democracy, mutual trust, team spirit, and interest in the team's tasks). The data confirmed the unidimensional factor structure of the Spanish original for the German GD instrument. The instrument showed good internal consistency, as well as convergent and discriminant validity. The GD correlated as expected to constructs measured with other established instruments, and it showed concurrent validity with respect to the *team members' motivation and interest in team tasks* ($r = .79$, $p < .01$). We recommend using the GD in German samples to measure team processes that are highly relevant for team effectiveness.

Keywords: validation, questionnaire, team, workgroup, group development, confirmatory factor analysis.

Validation of the German Group Development (GD) questionnaire

Organizations rely increasingly on teams to confront today's challenges (Unsworth & West, 2000). Assessing group development is thus regarded as a vital aspect of human resource development (London & Sessa, 2007).

Group development models such as those described by Tuckman & Jensen (1977), Wheelan (1994), or Morgan, Salas, and Glickman (1993) focus on a group's life cycle or developmental stages. Their limitations include the assumption of linear development (Miller, 2003), and consequently the lack of insight they provide into what happens after a team has reached the final stage. This could cause ceiling effects or eliminate variance in not-recently formed teams. Sometimes, researchers require a continuous measurement of a group's capability of creating emergence or working as a team. In the past, they have frequently measured group cohesion for this purpose. As a direct predictor of group performance, cohesion has thus gained a prominent role, for example leadership research, (Jung & Sosik, 2002), or diversity research (Webber & Donahue, 2001). However, the concept of group cohesiveness and the way it is measured has been criticized (Hogg, 1993). The main issue lies in its different operationalizations: cohesion can be restricted to commitment to the team task (Carron, 1982), it may additionally include interpersonal attraction and group pride (Mullen & Copper, 1994), or it can primarily represent team structure (Lickel, Hamilton, Leqis, Sherman & Wieczorkowska, 2000). Valid alternative instruments to for use in diverse cultural contexts are missing. To resolve these issues and to provide an instrument for the continuous measurement of group development, Meneses, Ortega, Navarro, and Quijano (2008) developed the GD questionnaire.

Validation of the Group Tasks Uncertainty Model (MITAG) in a German sample

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Author Note

This research did not receive any funding.

The authors do not have any financial interest from the direct applications of this research.

The research was conducted at Universitat de Barcelona.

Validation of the Group Tasks Uncertainty Model (MITAG) in a German sample

Abstract

Task uncertainty is a key factor in teamwork research. This study analyzed the psychometric characteristics of the Spanish group tasks uncertainty model (MITAG) in two German samples. The participants (501 team members and 104 team leaders from a German research organization) answered the MITAG together with selected items from the German Job Diagnostic Survey (JDS) and the instrument Ambiguitätsfacetten der Arbeit (AfA). Confirmatory factor analysis did not reproduce the original 4-factor structure in the German sample, although the 3 newly identified factors unclarity of goals, new situations, and non-routine resemble the original factors. Results showed sound internal consistency and confirmed the convergent and discriminant validity of the new factors. The MITAG offers a concept-based short scale for researchers and practitioners.

Keywords: task uncertainty, group tasks uncertainty model, confirmatory factor analysis, validation.

Validation of the Group Tasks Uncertainty Model (MITAG) in a German sample

Modern working contexts are increasingly affected by task uncertainty. Unclear objectives, time pressure, and polyvalence are rising across different job types (Navarro, Quijano, Berger & Meneses, 2011). Research is required to find out how individuals and teams deal effectively with uncertain tasks and this requires measuring task uncertainty.

Task uncertainty is of particular interest in team research, as it may have a direct or indirect (i.e. moderating) influence team performance. Some have argued that uncertainty was detrimental to performance (Weiss & Hoegl, 2016), as adapting to task uncertainty requires the team to spend extra resources on planning and decision-making, thus decreasing efficiency. Others showed that task uncertainty could moderate the relationship between group processes and team performance, such as boundary reinforcement (Faraj & Yan, 2009) or relational resources among team members (Gardner, Gino & Staats, 2012). Sicotte and Bourgault (2008) identified both, direct effects and moderating effects on team performance. These contradictions largely remain unresolved, since the operationalizations of task uncertainty differ and since too little attention has been paid to the multidimensionality of this construct. The same contradictions extend to project uncertainty (Um & Kim, 2018), some aspects of which may be closely related to task uncertainty.

Several measurements of task uncertainty were created in the past decades, and they have methodological weaknesses and lack conceptual foundations. For example, Perrow (1967) defined task uncertainty by *task variety* (or *number of exceptions*) and *task analyzability*. Other researchers took this work up. Van de Ven and Ferry (1980), for instance, created a questionnaire based on the dimensions *task variability* and *difficulty*. Combining measures of difficulty and uncertainty may however not be advisable, as task difficulty refers to the worker's knowledge, skills, and abilities, whereas task uncertainty may instead rather depend on external factors. However, the idea that difficulty is a defining aspect of task uncertainty is still propagated in research, e.g. by Dingsøyr et al. (2018), referencing the work by Van de Ven, Delbeq and Koenig (1976). Withey, Daft, and Cooper (1983) compared 12 task uncertainty measurement instruments, targeting *task variety* or *variability*, *difficulty*, *analyzability*, and

frontiers in Psychology

ORIGINAL RESEARCH
published: 15 August 2017
doi: 10.3389/fpsyg.2017.01339

How Knowledge Worker Teams Deal Effectively with Task Uncertainty: The Impact of Transformational Leadership and Group Development

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The purpose of this paper is to clarify how leadership is able to improve team effectiveness, by means of its influence on group processes (i.e., increasing group development) and on the group task (i.e., decreasing task uncertainty). Four hundred and eight members of 107 teams in a German research and development (R&D) organization completed a web-based survey; they provided measures of transformational leadership, group development, 2 aspects of task uncertainty, task interdependence, and team effectiveness. In 54 of these teams, the leaders answered a web-based survey on team effectiveness. We tested the model with the data from team members, using structural equations modeling. Group development and a task uncertainty measurement that refers to unstable demands from outside the team partially mediate the effect of transformational leadership on team effectiveness in R&D organizations ($p < 0.05$). Although transformational leaders reduce unclarity of goals ($p < 0.05$), this seems not to contribute to team effectiveness. The data provided by the leaders was used to assess common source bias, which did not affect the interpretability of the results. Limitations include cross-sectional data and a lower than expected variance of task uncertainty across different job types. This paper contributes to understanding how knowledge worker teams deal effectively with task uncertainty and confirms the importance of group development in this context. This is the first study to examine the effects of transformational leadership and team processes on team effectiveness considering the task characteristics uncertainty and interdependence.

Keywords: transformational leadership, group development, task uncertainty, knowledge work, team effectiveness

OPEN ACCESS

Edited by:
Radha R. Sharma, Hero Moto Corp Chair Professor & Professor, OB & HRD, Management Development Institute (MDI), India

Reviewed by:
Stefano Livi, Sapienza Università di Roma, Italy
Jenell Lynn-Senter Wittmer, University of Toledo, United States

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Specialty section:
This article was submitted to Organizational Psychology, a section of the journal Frontiers in Psychology

Received: *20 February 2017*
Accepted: *20 July 2017*
Published: *15 August 2017*

Citation:
Leuteritz J-P, Navarro J and Berger R (2017) How Knowledge Worker Teams Deal Effectively with Task Uncertainty: The Impact of Transformational Leadership and Group Development. Front. Psychol. 8:1339. doi: 10.3389/fpsyg.2017.01339

INTRODUCTION

Uncertainty is growing in modern working contexts. Polyvalence, time pressure, unpredictable environmental conditions, and the relevance of knowledge and distributed skills drive this development (Navarro et al., 2011). Knowledge workers are particularly exposed to uncertain tasks and the relevance of knowledge work is rising in the developed economies (Spath and Hofmann, 2009): today's organizations need to constantly innovate (Reuveni and Vashdi, 2015), and they increasingly rely on teams for this purpose (Edmondson and Nembhard, 2009). Consequently,