Received 30 November 2015
Revised 27 May 2016
5 August 2016
Accepted 5 August 2016

Measuring employee innovation

A review of existing scales and the development of the innovative behavior and innovation support inventories across cultures

Martin Lukes
Department of Entrepreneurship, University of Economics, Prague, Czech Republic, and
Ute Stephan
Economics, Finance and Entrepreneurship Group, Aston Business School, Aston University, Birmingham, UK

Abstract

Purpose – The purpose of this paper is to develop a model of employee innovative behavior conceptualizing it as distinct from innovation outputs and as a multi-faceted behavior rather than a simple count of "innovative acts" by employees. It understands individual employee innovative behaviors as a micro-foundation of firm intrapreneurship that is embedded in and influenced by contextual factors such as managerial, organizational and cultural support for innovation. Building from a review of existing employee innovative behavior scales and theoretical considerations the authors develop and validate the Innovative Behavior Inventory (IBI) and the Innovation Support Inventory (ISI).

Design/methodology/approach – Two pilot studies, a third validation study in the Czech Republic and a fourth cross-cultural validation study using population representative samples from Switzerland, Germany, Italy and the Czech Republic ($n = 2{,}812$ employees and 450 entrepreneurs) were conducted.

Findings – Both inventories were reliable and showed factorial, criterion, convergent and discriminant validity as well as cross-cultural equivalence. Employee innovative behavior was supported as comprising of idea generation, idea search, idea communication, implementation starting activities, involving others and overcoming obstacles. Managerial support was the most proximal contextual influence on innovative behavior and mediated the effect of organizational support and national culture.

Originality/value – The paper advances the understanding of employee innovative behavior as a multi-faceted phenomenon and the contextual factors influencing it. Where past research typically focuses on convenience samples within a particular country, the authors offer first robust evidence that the model of employee innovative behavior generalizes across cultures and types of samples. The model and the IBI and ISI inventories enable researchers to build a deeper understanding of the important micro-foundation underpinning intrapreneurial behavior in organizations and allow practitioners to identify their organizations' strengths and weaknesses related to intrapreneurship.

Keywords Innovative work behaviour, Cross-cultural, Inventory, Intrapreneurship, Innovation support, Validation

Paper type Research paper

1. Introduction

Innovation and intrapreneurship are key drivers underlying the competitive advantage of organizations. The flourishing literature on intrapreneurship seeks to leverage entrepreneurial and innovative spirit for larger organizations (Hornsby *et al.*, 1999; Parker, 2011; Park *et al.*, 2014). Employee individual innovative behavior constitutes a micro-foundation (Felin *et al.*, 2015) of organizational innovation and intrapreneurship. Yet, it is less well established how such individual employee intrapreneurial, innovative behavior should be measured (Adams *et al.*, 2006). Studies typically consider either simplistic overall measures, or single out particular aspects of employee innovative

This study was supported by the European Commission, project CID – Culture and Innovation Dynamics: Explaining the Uneven Distribution of Human Knowledge (No. FP6-043345). The authors would like to thank the cooperators in Germany, Switzerland and Italy.

International Journal of Entrepreneurial Behavior & Research
Vol. 23 No. 1, 2017
pp. 136-158

1355-2554
DOI 10.1108/IJEBR-11-2015-0262

behavior. They are typically conducted in one country, often in one particular organization, considering a convenience sample of a particular type of employees such as R&D professionals (for an exception Patterson *et al.*, 2005).

In this paper, we provide a brief review of existing measures of employee innovative behavior. Very few studies measure employee innovative behavior as a multidimensional construct (e.g. de Jong and den Hartog, 2010) but none examine cross-cultural validity and go beyond selective samples. Hence it is unclear whether these measures are valid in other countries and samples. Existing measures also often mix aspects of innovative behavior with outcomes or ignore essential features of innovative behavior such as idea search.

Another stream of literature explores the contextual factors facilitating individual employee innovative behavior. For instance, research on organizational climate for innovation and creativity has been summarized in meta-analyses (Amabile *et al.*, 1996; Hunter *et al.*, 2007), as has research on leadership and innovation (Hammond *et al.*, 2011; Rosing *et al.*, 2011). Yet the results are often less clear than expected (Rosing *et al.*, 2011), and a lack of differentiation of the dependent variable, i.e. individual employee innovative behavior appears to be a contributing factor. Finally, although related research at the country level confirms a relationship of culture with innovation and entrepreneurship (Shane, 1992; Stephan and Uhlaner, 2010), perceptions of cultural support for innovation are largely ignored in studies of employee innovative behaviors.

The literature might benefit from an integrative measure that captures employee innovative behavior in a nuanced manner whilst being sufficiently efficient (i.e. consisting of valid and reliable short scales) and applicable to different types of employees and across various cultural contexts. This study employs an integrative scale building approach, i.e. incorporating existing scales when possible, to develop and validate the Innovative Behavior Inventory (IBI) and the Innovation Support Inventory (ISI). Our core contribution is methodological in nature. By integrating theoretical considerations and existing scales, we offer validated multi-facetted and cross-culturally equivalent measures of employee innovate behavior and its immediate contextual determinants. We validate scales in representative samples and different sample types (employees vs entrepreneurs) across the working population in four different countries. This is a significant step forward from past research, where scales are often narrow and only validated for specific samples in particular countries.

2. An integrative model of employee innovative behavior and its support

Intrapreneurship, i.e. entrepreneurship within existing organizations or corporate entrepreneurship, is attracting increasing attention in the management and entrepreneurship literatures (e.g. Hornsby *et al.*, 1999; Parker, 2011), especially at the organizational level (de Jong and Wennekers, 2008; Rauch *et al.*, 2009).

This paper focuses on the individual level as it is individuals or groups of individuals who act in the intrapreneurship process. Most scholars consider individual innovative behavior – such as creatively recombining resources to exploit opportunities – to be an integral part of entrepreneurship (Shane, 2012). Despite some differences, intrapreneurship and employee innovation both entail innovative activities, overcoming barriers and have business consequences (de Jong and Wennekers, 2008). Indeed individual-level employee innovative behavior can be seen as underlying intrapreneurship, a construct that is typically located at the firm level. Thus, employee innovative behavior is a micro-foundation (Felin *et al.*, 2015) of organizational intrapreneurship. We define employee innovative behavior in this paper as behaviors through which employees generate or adopt new ideas and make subsequent efforts to implement them.

Innovative behavior has multiple facets that unfold over time. Typically, idea generation and subsequent idea implementation are differentiated as the main building blocks of innovation (Krause, 2004; Bledow *et al.*, 2009). Innovation is also social in nature, such as when

others need to be influenced and convinced about the value of an idea or their help needs to be mobilized to implement novel ideas. Past research on employee innovative behavior and intrapreneurship tends to focus on simplified models of employee innovative behavior (Zhou and George, 2001; Janssen, 2000; Krause, 2004). We propose a complementary, more fine-grained model of employee innovative behavior that captures main facets of individual employee behaviors involved in innovation, which we discuss next.

2.1 Employee innovative behavior

When reviewing past research and scales measuring employee innovative behavior we found that the understanding of employee innovative behavior can range from being viewed as one homogenous concept (e.g. Scott and Bruce, 1994) to detailed lists of up to 16 facets (de Jong and Wennekers, 2008). The more comprehensive lists, however, intermixed qualitative different constructs including personality traits (such as risk taking), specific behaviors (such as internal coalition building) and clusters of behaviors (such as championing). Across our review of relevant scales and literature, we could most consistently identify six key facets of innovative behavior that should lead to innovation outputs. We disregarded personality traits and focused on the specific behaviors that make up broader concepts such as championing.

Traditionally, researchers considered individual creativity (e.g. Amabile *et al.*, 1996; Hunter *et al.*, 2007) to be the basis of innovation in organizations. Idea generation as a behavioral aspect of creativity is thus present in all studies of employee innovative behavior (de Jong, and den Hartog, 2010; Tierney *et al.*, 1999; Scott and Bruce, 1994; Zhou and George, 2001; Janssen, 2000). Rather than generating ideas, innovative activity may also be triggered by individuals searching for new ideas in their environment. The idea search perspective is consistent with findings that entrepreneurial and innovative activities may be based on searches of existing knowledge sources (e.g. Tang *et al.*, 2012). However, it is largely underresearched (Park *et al.*, 2014), even though both idea generation and search are seen as valid paths into entrepreneurship (Davidsson, 2015).

Successful innovation requires that novel ideas are acted upon and implemented (e.g. de Jong and Wennekers, 2008; Bledow *et al.*, 2009). Employees in organizations are rarely able to implement ideas on their own and often have to receive permission from their managers. Thus, an important aspect of innovative behavior is to communicate the idea to colleagues and managers to receive their feedback (Binnewies *et al.*, 2007). In existing research, this facet of innovative behavior is often "hidden," either as a part of a broadly defined creativity construct (Zhou and George, 2001; Baer and Oldham, 2006), or it is equated with idea championing (de Jong and den Hartog, 2010). Even though championing refers to a cluster of different activities of particular champions (Howell *et al.*, 2005). Once an idea is approved, further resources such as time, money and people are allocated to start the implementation process.

Idea implementation typically involves the nomination of an innovation champion – a key individual who takes responsibility to implement the idea (Howell *et al.*, 2005; Lukes, 2012). The innovation champion starts implementation activities by preparing plans for implementation. This entails anticipating problems and proactively developing contingency plans (Crant, 2000), as well as acquiring funds and resources (e.g. Scott and Bruce, 1994). He/she involves other people in the implementation, communicates a vision of what the innovation entails, and displays enthusiasm and confidence about it (Howell *et al.*, 2005). A key challenge in the implementation stage is to overcome obstacles, barriers and resistance (Howell *et al.*, 2005). This is achieved by adapting the idea or implementation plans until a product, service or process has been improved and is used in the organization and, thus, innovation outputs have been achieved. Notably innovation outputs have been inconsistently defined in the literature, and are sometimes confounded with implementation activities (de Jong and den Hartog, 2010). We define outputs as reports of achieved changes, i.e., implemented novel ideas that changed products, services or processes in an organization.

2.2 Innovation support

Individual employee innovative behavior can be facilitated or hampered by contextual factors. There is a wealth of research on contextual factors facilitating individual employee innovative behavior. Conceptually it is useful to think of individuals as being embedded in increasingly distal layers of context (e.g. Leung *et al.*, 2005). Layers of context more proximal to an individual, such as the immediate manager and the organization, will exert a greater influence on that individuals' innovative behavior than more distal layers of context, such as national culture. At the same time, lower layers of context are necessarily part of and are influenced by more distal layers. For instance, leadership styles and organizational cultures are shaped by wider national cultures (House *et al.*, 2004). Contexts that signal clearly that innovative behavior is desired and supported, i.e., that legitimize such behaviors, in turn encourage individual employees to not hold back and generate, search for, communicate and implement ideas. Past research has identified three important contextual influences for innovating employees: their managers, features of the organization they work in, and wider national culture.

With regard to the role of managers, past research has explored the effects of a range of different leadership styles – with mixed findings (e.g. see the meta-analyses by Hammond *et al.*, 2011; Rosing *et al.*, 2011). One aspect that receives consistent support is leader/manager support for employee innovation (Hunter *et al.*, 2007 meta-analysis). Managerial support can be described as a perception that an employee's supervisor is supportive of new and innovative ideas (Oldham and Cummings, 1996).

With regard to the organizational level, research has focused on organizational support. This includes the organization making resources available for the implementation of new ideas and the encouragement of innovation including top management support and use of rewards (e.g. Hunter *et al.*, 2007). From the employees' perspective, the perception that such organizational support for innovation is available is important and encourages them to engage in innovative behavior (e.g. Amabile *et al.*, 1996; Patterson *et al.*, 2005).

Compared to managerial and organizational support for innovation, research on employee innovative behavior has largely ignored the influences of national culture. Yet related research at the country level confirms a relationship of culture with innovation and entrepreneurship (Shane, 1992; Stephan and Uhlaner, 2010). National culture is assumed to influence organizational culture since organizations are embedded in national cultures (e.g. House *et al.*, 2004). House *et al.* (2004) in the study of 61 societies present supporting evidence. Moreover, they showed that effective leadership styles are influenced by both organizational culture and national culture reflecting the fact that deep-seated sociocultural assumptions shape managers' and employees' behavior.

We focus our model and measures specifically on innovation-related managerial, organizational and cultural support. Innovation will benefit from being explicitly legitimized by innovation-supportive managers, organizations and national culture. Moreover, our review of the leadership and organizational literature suggests that specific innovation-related measures are more likely to yield consistent findings.

Building on and extending past research, we suggest a theoretical model consisting of employee innovative behavior (seen as a multi-faceted construct that reflects key aspects of innovation – idea generation, idea search, idea communication, implementation starting activities, involving others and overcoming obstacles), innovation outputs (results achieved by engaging in innovative behavior) and key contextual influences on employee innovative behavior. We propose that managerial support is the most proximal contextual influence on employee innovative behavior, which in turn is influenced by organizational support (as managers are embedded within organizations), and that organizational support will be influenced by national culture support for innovation.

3. A review of existing measures of creativity, employee innovative behavior and innovation support

In the following text, we provide a review of existing measures of innovative behavior and innovation support (Table I) that we built on and integrated in our measurement instrument. Our review also allowed us to identify those aspects of innovative behavior that have not been sufficiently operationally defined in past research.

Existing innovation measures can be grouped into six categories (Table I): measures of creativity and innovativeness as a personality trait; unidimensional measures of innovative behavior at work; measures of innovation champion behavior; multidimensional measures of innovative activity, including innovation outputs; measures of organizational innovation support; and measures of managerial innovation support.

First, measures of personal creativity and innovativeness are closely related to the idea generation facet in our model. However, none of the existing measures is directly applicable for measuring idea generation with a focus on behavior. Rather, existing measures capture personality (Kirton, 1976; Jackson, 1994) or supervisor-rated creativity (Tierney *et al.*, 1999). For our measure, we adapted items from Jackson (1994) that focus on work-related activities.

Second, unidimensional measures of innovative behavior at work are well-established (Scott and Bruce, 1994; Zhou and George, 2001) and usually include a mix of items capturing idea generation as well as idea implementation aspects. Baer and Oldham (2006) later used four items from Zhou and George (2001) as an overall measure for creativity, which mixes aspects of idea generation and idea communication. Janssen (2000) first differentiated between idea generation, idea promotion and idea realization, but because of high intercorrelations between the three scales concluded that they measure one construct of employee innovative behavior. A similar conclusion was reached by Kleysen and Street (2001). However, differentiating the constituting facets of employee innovative behavior is important to aid further theory building, for instance, to understand what types of innovative behaviors are most effective in which situations. We integrated items in our measure that are frequently used (e.g. Scott and Bruce, 1994) whilst paying attention to differentiating innovation facets.

Third, some measures focus solely on the behavior of innovation champion (e.g. Shane *et al.*, 1995) and thus capture only the implementation stage. Howell *et al.* (2005) developed and validated a champion behavior measure capturing three different aspects of championing behavior that is, despite its initial focus on product innovation champions, applicable to a broader range of employees. We incorporated their items for measuring the distinct aspects of implementation of innovation.

Fourth, multidimensional measures of employee innovative behavior include various aspects on innovative behavior as well as the measurement of innovation outputs (Hornsby *et al.*, 1999; Krause, 2004; Dorenbosch *et al.*, 2005; Lau *et al.*, 2012 – see Table I for details). The best developed measure is by de Jong and den Hartog (2010) who created a multidimensional scale with four distinct innovative behaviors (idea generation, exploration, championing and implementation) and an independent measure of innovation outputs. But even in this case, several shortcomings exist. Two subscales were measured by two items only, which means that these scales cannot be used in cross-cultural comparison as measurement equivalence cannot be established through the common structural equation modeling tests (Vandenberg and Lance, 2000). The distinct aspects of implementation were captured in a summary fashion by three rather general items only. Nevertheless, their work is a valuable contribution and several items overlap with our measure[1].

Fifth, other measures are focused on factors supporting innovation. This topic received more attention in previous research (Hunter *et al.*, 2007 for a meta-analytic review of climate for creativity), thus we report in Table I only the six studies that align with our intent to capture core aspects of managerial and organizational support.

Table I.
A review of existing measures of creativity, innovative work behavior and innovation support

Study	Countries	Sample size and composition	Scales and (number of items)	Comments to items
Personal creativity and innovativeness				
Kirton (1976)	UK	532 + 276 various individuals	Originality (13), efficiency (7), group conforming (12)	Focused on personality rather than on work-related behavior
Jackson (1994)	USA	na – not used for innovative work behavior research	Innovativeness (8)	Focused on personality, not on work-related behavior; part of Jackson Personality Inventory
Tierney *et al.* (1999)	USA	191 R&D employees	Creativity performance (9)	Supervisor ratings of employee creativity
Work-related innovative behavior – unidimensional				
Scott and Bruce (1994)	USA	172 R&D professionals (+26 managers' ratings)	Innovative behavior (6)	One general factor involving both generation and implementation of ideas; items well proved in subsequent studies, but no differentiation in various aspects of innovative behavior
Zhou and George (2001)	USA	149 employees (+ their supervisor's ratings)	Creativity (13)	Despite the name, the scale includes three implementation focused items, these are adopted from Scott and Bruce (1994), 4 of them used also by Baer and Oldham (2006)
Janssen (2000)	The Netherlands	170 employees (+110 supervisors' ratings)	Idea generation (3), idea promotion (3), idea realization (3)	Items partially based on Scott and Bruce (1994), created to measure three basic steps in the innovation process, due to high intercorrelations viewed as an overall scale of innovative work behavior; more distinct aspects of employee innovative behavior not taken into account
Kleysen and Street (2001)	Canada	225 employees	Innovative work behavior (14)	Originally intended as opportunity exploration, generativity, formative investigation, championing and application factors, however the multidimensional model did not work, thus only one overall scale presented
Championing behavior				
Shane *et al.* (1995)	30 countries, none from Central Europe	1,228 employees from 4 organizations	Autonomy from norms (8), cross-functional appeal (4), locus of support (3)	Items focused on preferences of rather senior level organizational members for championing behaviors, i.e. not innovative behavior *per se*

(*continued*)

Table I.

Study	Countries	Sample size and composition	Scales and (number of items)	Comments to items
Howell *et al.* (2005)	USA	47 innovation champion (+ their division managers' and 216 team members' ratings)	Expressing enthusiasm and confidence about innovation success (6), persisting under adversity (6), getting the right people involved (3)	Good for measuring innovative behavior in the later stages of innovation process; can be used for various occupations
Work-related innovative behavior – multidimensional				
Hornsby *et al.* (1999)	USA, Canada	174 US managers, 353 Canadian managers	Specific entrepreneurial behaviors (6 open ended questions, out of which 2 measuring outcomes – ideas implemented)	Mixing measures of outputs (e.g. implemented ideas) and process (e.g. time spent on thinking about new ideas); trying to be exact in capturing numerical outcomes, but difficult to answer correctly for many employees
Krause (2004)	Germany	399 managers	Generation and testing the ideas (5) and implementation (3)	Measures different aspects of innovative behavior (e.g. involves risk taking) in (one) process of innovation; implementation scale measures the results of the innovation process
Dorenbosch *et al.* (2005)	The Netherlands	132 non-managerial employees	Creativity oriented work behavior (10), implementation oriented work behavior (6), innovative behavior toward the use of computer technology (3), innovative behavior toward the use of financial resources (2)	EFA only, some cross-loadings, not fully established scale, some items not conceptually close, e.g., keeping oneself informed with department's financial situation
de Jong and den Hartog (2010)	The Netherlands	703 dyads of knowledge workers and their supervisors	Idea exploration (2), idea generation (3), idea championing (2), idea implementation (3) + innovative output (6)	Well-developed scale with innovative work behavior as second-order factor; high intercorrelations; two scales with two items only; subscales focus mainly on the initial phases (and do no differentiate between idea generation and idea search), only rough overall measure of idea implementation, innovative output measure includes making suggestions, producing ideas and acquiring knowledge, i.e. not measuring "final" outputs
Lau *et al.* (2012)	Hong Kong	131 managers in postgraduate courses	Innovativeness (3), risk taking (3), change orientation (3), opportunism (3)	Innovative approach concerning scenario-based items, questionable rating of response options

(*continued*)

Table I.

Study	Countries	Sample size and composition	Scales and (number of items)	Comments to items
Organizational climate supporting innovation				
Scott and Bruce (1994)	USA	172 R&D professionals (+26 managers' ratings)	Resource supply (6), (organizational) support for innovation (16)	Covering in detail different aspects of organizational support for innovative behavior
Amabile *et al.* (1996)	USA	Overall sample of 12.525 respondents coming from different sources	Organizational encouragement (for creativity) (15)	Covering in detail organizational culture encouraging creativity through constructive feedback, reward, mechanisms for developing new ideas and shared vision
Zhou and George (2001)	USA	149 employees (+ their supervisor's ratings)	Perceived organizational support for creativity (4 items)	Items covering several aspects of organizational support
Patterson *et al.* (2005)	UK	6,869 employees	Innovation and flexibility scale (6)	One of 17 scales for organizational climate; besides innovation and flexibility scale also reflexivity scale predicted subsequent innovation outcomes
Managerial support				
Baer and Oldham (2006)	USA	170 employees (+10 supervisors' ratings)	Support for creativity by managers and coworkers (10)	Managerial and coworker support for creativity is mixed, individual items not provided, modified from Madjar *et al.* (2002) who listed 3 items for managerial support
Tierney and Farmer (2004)	USA	140 R&D employees	Supervisor creativity-supportive behavior (16), employee view of creativity expectations (3)	Used as one scale due to high intercorrelations of three factors (one of them creativity encouragement, the other two more general task support and team facilitation) in the supervisor creativity-supportive behavior

Organizational climate for innovation measures capture employee perceptions of resource supply and (organizational) support for innovation (Scott and Bruce, 1994), constructive feedback, reward, mechanisms for developing new ideas and shared vision on the organizational level (Amabile *et al.*, 1996). Zhou and George (2001) provided a shorter four-item measure covering several aspects of perceived organizational support for creativity. The most comprehensive study of organizational climate (Patterson *et al.*, 2005) used an innovation and flexibility scale as one of 17 scales measuring organizational climate and demonstrated its predictive validity for innovation outcomes. From these existing scales, we found the measure by Scott and Bruce (1994) the most useful as it focuses directly and in a sufficient detail on organizational support for innovation.

Sixth, specific measures of managerial support for innovation include Baer and Oldham's (2006) support for creativity (by managers and coworkers) who captured managerial support and team climate toward innovation; and Tierney and Farmer's (2004) measure of creativity encouragement, task support and team facilitation. Other measures of supervisor support (e.g. in KEYS, Amabile *et al.*, 1996) are not specifically focused on the innovative behavior of subordinates.

To sum up, some aspects of innovative behavior such as idea search or implementation starting activities have not received much attention in previous research. Past research also does not differentiate facets of idea communication such as communication of the initial idea vs involving others in the implementation stage. Concerning supporting contextual factors, we identified no measure for cultural support for innovation. Past research has focused on single countries, mainly the USA, the Netherlands and the UK (e.g. Patterson *et al.*, 2005; de Jong and den Hartog, 2010), and often samples consistent of a few hundred employees. Thus, there is merit in integrating and extending existing measures to underresearched aspects of employee innovative behavior, and to validate such an integrative measure across multiple samples and countries.

4. Scale development

4.1 Study 1: construction of item pool

We created an item pool based on existing scales, and where facets of innovation were not well covered we developed items in line with our theoretical model. The item pool was derived based on repeated discussions and consensus among four experts with academic and innovation consulting experience. We used or modified items from previous research that corresponded to innovation facets in our model and were easy to understand for a broad audience beyond R&D professionals. For instance, we avoided the word "innovation" and rather used "new idea" (Table II for examples). For idea generation three items from Jackson (1994) were used and five items newly developed. For other facets, the use of items was as follows: idea search (one item from Scott and Bruce, 1994, three new items), idea communication (one item from Howell *et al.*, 2005, nine new items), implementation starting activities (two items from Scott and Bruce, 1994, one new item), involving others (three items from Howell *et al.*, 2005, two new items), overcoming obstacles (four items from Howell *et al.*, 2005, two new items), innovation outputs (five new items), managerial support (one item from Shane *et al.*, 1995, one item from Madjar *et al.*, 2002, eight new items), organizational support (eight items from Scott and Bruce, 1994, three new items) and cultural support (three items from Stephan, 2008, two new items). The item inventory was developed in Czech and English. Respondents answered all items on Likert-type scale ranging from 1 – fully disagree to 5 – fully agree, i.e., higher value represents more innovation. The pilot study samples were 96 graduate students from a Czech University, that were employed full-time or part-time in the last 12 months. After statistical analyses (correlation analysis, exploratory factor analysis, scale reliabilities) which are available upon request, we reformulated five items, added two items and cut the total number to 54 items in ten scales.

Item	Factor loading
Innovative Behavior Inventory	
Idea generation	
I try new ways of doing things at work	0.686
I prefer work that requires original thinking[a]	0.648
When something does not function well at work, I try to find new solution	0.612
Idea search	
I try to get new ideas from colleagues or business partners	0.776
I am interested in how things are done elsewhere in order to use acquired ideas in my own work	0.771
I search for new ideas of other people in order to try to implement the best ones	0.758
Idea communication	
When I have a new idea, I try to persuade my colleagues of it	0.665
When I have a new idea, I try to get support for it from management	0.727
I try to show my colleagues positive sides of new ideas	0.701
When I have a new idea, I try to involve people who are able to collaborate on it	0.46
Implementation starting activities	
I develop suitable plans and schedules for the implementation of new ideas[b]	0.592
I look for and secure funds needed for the implementation of new ideas[b]	0.505
For the implementation of new ideas I search for new technologies, processes or procedures[b]	0.707
Involving others	
When problems occur during implementation, I get them into the hands of those who can solve them[c]	0.351
I try to involve key decision makers in the implementation of an idea[c]	0.403
When I have a new idea, I look for people who are able to push it through	0.696
Overcoming obstacles	
I am able to persistently overcome obstacles when implementing an idea[c]	0.778
I do not give up even when others say it cannot be done[c]	0.807
I usually do not finish until I accomplish the goal[c]	0.812
During idea implementation, I am able to persist even when work is not going well at the moment	0.818
Innovation outputs	
I was often successful at work in implementing my ideas and putting them in practice	0.707
Many things I came up with are used in our organization	0.667
Whenever I worked somewhere, I improved something there	0.653
Innovation Support Inventory	
Managerial support	
My manager motivates me to come to him/her with new ideas	0.738
My manager always financially rewards good ideas	0.546
My manager supports me in implementing good ideas as soon as possible	0.871
My manager is tolerant of mistakes and errors during the implementation of something new	0.542
My manager is able to obtain support for my proposal also outside our department	0.712
Organizational support	
The way of remuneration in our organization motivates employees to suggest new things and procedures	0.775
Our organization has set aside sufficient resources to support the implementation of new ideas	0.796
Our organization provides employees time for putting ideas and innovations into practice	0.609
Cultural support	
Most people in (country name) come up with new, original ideas at work	0.756
Most people in (country name) are able to really implement new ideas at work	0.823
Most people in (country name) look for new challenges at work	0.708
Most people in (country name) are able to improvise easily when unexpected changes happen at work	0.404

Sources: [a]Item from Jackson (1994); [b]modified item based on Scott and Bruce (1994); [c]modified item based on Howell *et al.* (2005)

Table II.
Items of Innovative Behavior Inventory and Innovation Support Inventory (factor loadings based on confirmatory factor analysis – Study 3)

4.2 Study 2: pilot study on criterion validity

The revised version of the inventories was translated from English to Italian, German and French by experienced translators and then back-translated by independent translators. We piloted the inventory on university student samples in Germany, Italy and Switzerland ($n = 157$) to ensure that the inventories were applicable across cultures. To ensure that items were meaningful in a work context, $n = 172$ employees of a large Czech automotive company rated the same version. Through exploratory factor analyses and analyzing scale reliabilities the inventories were shortened to 35 items (see Table II), e.g., dropping cross-loading items and items with low loadings (Tabachnick and Fidell, 2007).

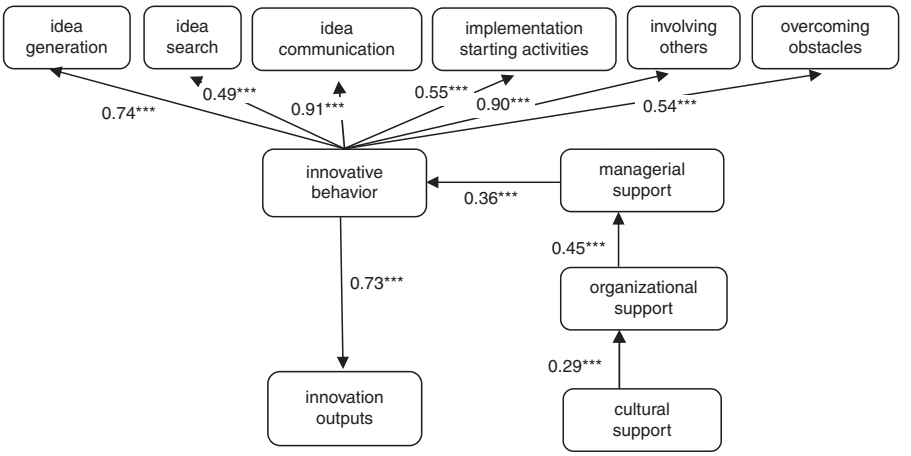
After Studies 1 and 2, the IBI consists of 23 work-related innovative behavior items in six scales and the ISI is composed of 12 items in three scales (Table II for details).

Criterion validity. We validated our measure with the objective data received from the above mentioned automotive company. As a part of their continuous improvement system the company tracks the number of suggested and successfully implemented ideas. This information regarding the last year was separately available for managers vs non-managers. Managers suggested significantly more ideas per capita than non-managers ($\chi^2 = 77.3$, df = 1, $p < 0.001$) and had more successfully implemented ideas ($\chi^2 = 65.7$, df = 1, $p < 0.001$). The most closely corresponding scales in IBI are idea generation and idea communication (corresponding to ideas suggested) and innovation outputs (corresponding to ideas successfully implemented). An analysis of variance based on managerial status revealed that managers reported generating more ideas than non-managers ($F = 11.12$, df = 1, $p < 0.005$, $\eta^2 = 0.071$), communicating ideas more ($F = 6.45$, df = 1, $p < 0.05$, $\eta^2 = 0.042$) and higher innovation outputs ($F = 8.47$, df = 1, $p < 0.005$, $\eta^2 = 0.054$). Therefore, the results based on the IBI and the company system corresponded. We interpret this as an evidence for the criterion validity of three IBI scales. We did not validate the implementation starting activities, involving others and overcoming obstacles scales, because the items used were based on previously validated measures (Scott and Bruce, 1994; Howell *et al.*, 2005).

4.3 Study 3: factorial, convergent and discriminant validity

Sample. The sample consisted of $n = 267$ employees from diverse industry branches (72 percent manufacturing, 11 percent trade, 10 percent ICT, 7 percent business services) working for international firms in the Czech Republic. All employees are or were involved in implementing ideas in their current organization in the last year. In total, 60 percent of the employees worked in companies with 250 or more employees, 69 percent were male, 54 percent had university education, and 61 percent were 25-34 years old. Moreover, 10 percent were blue collar employees, 52 percent white collar employees and the 38 percent managers.

Factorial validity. Using structural equation modeling (AMOS 17, Arbuckle, 2008) we tested our model in which innovation outputs are determined by employee innovative behaviors, and in turn contextual factors as described in the theoretical model (Figure 1). The model fitted the data well with root-mean-square error of approximation (RMSEA) = 0.045, 90 percent CI = 0.039-0.051, comparative fit index (CFI) = 0.913, Tucker-Lewis index (TLI) = 0.905, and $\chi^2 = 842.02$, df = 544. It supported the factorial validity of the IBI and ISI. All items loaded significantly and substantially on their corresponding factor. The factor loadings (standardized regression weights in CFA) are displayed in Table II. Moreover, innovative behavior was substantiated as a second-order factor consisting of six first-order factors (Figure 1). Cronbach's αs ranged from 0.60 to 0.88 (Table III) for all scales, which is satisfactory for this stage of research (DeVellis, 1991) and considering the low number of items per scale (Cortina, 1993). Following the suggestion of a reviewer, we added additional paths from cultural and organizational support to innovative behavior and from cultural, organizational and managerial support



Note: ***$p<0.001$

Figure 1.
Structural equation results, confirmation of a theoretical model (Study 3)

to innovation outputs. The analyses primarily supported our model as shown in Figure 1. Detailed analyses are available upon request.

Convergent and discriminant validity. We sought to establish evidence for convergent and discriminant validity for the IBI and ISI. We selected existing scales that capture similar constructs to the scales included in IBI and ISI to establish convergent validity (Table IV). For instance, the leader-member exchange scale (Graen and Uhl-Bien, 1995) should overlap with managerial support. Discriminant validity is examined by scale correlations to loosely related or unrelated constructs, e.g., comparing the same leader-member exchange scale with idea generation and idea search. We describe the key results for convergent validity and then for discriminant validity.

First, we checked unidimensionality of all the scales used for establishing convergent and discriminant validity. All scales showed unidimensionality in exploratory factor analyses and were normally distributed. Cronbach's αs are reported in Table IV.

For convergent validity, we used eight items of the creative behavior scale developed by Zhou and George (2001; further adapted by Baer and Oldham, 2006) that specifically reflect idea generation (e.g. I often have a fresh approach to problem) and idea communication (e.g. I suggest new ways of performing work tasks). As expected this scale correlated strongly with the IBI idea generation and communication scales ($r = 0.69$, $p < 0.001$ and $r = 0.55$, $p < 0.001$, respectively) while correlations with other IBI facet scales were lower (Table IV). Unexpectedly, the creative behavior scale correlated substantially with the IBI innovation output scale ($r = 0.53$, $p < 0.001$). This may be due to the fact that it captures two innovative behaviors important for achieving innovation outputs.

We expected our idea search scale to strongly correlate with four items from scanning and search scale (Tang *et al.*, 2012) (e.g. I have frequent interactions with others to acquire new information). As expected it correlated strongly with idea search ($r = 0.58$, $p < 0.001$) more so than with all other IBI scales, with which correlations were moderately strong (Table IV).

We used Hornsby *et al.* (1999) entrepreneurial behavior scale covering innovation indicators (see Table I). All items were skewed and correspondingly log-transformed and z-standardized to make the different response scales comparable (e.g. counts of ideas suggested and time estimates). We expected and found the highest correlation of the Hornsby *et al.*'s scale with the IBI innovation outputs scale ($r = 0.35$, $p < 0.001$). Correlations with the remaining innovative behavior scales were lower (Table IV).

Table III.
Intercorrelation table, IBI and ISI scales, scale reliabilities based on Study 3

	M	SD	1	2	3	4	5	6	7	8	9	10
1. Idea generation	4.02	0.60	(0.67)									
2. Idea search	4.07	0.72	0.34***	(0.81)								
3. Idea communication	4.05	0.59	0.51***	0.38***	(0.72)							
4. Implementation starting activities	3.19	0.82	0.28***	0.20***	0.31***	(0.61)						
5. Involving others	3.91	0.67	0.32***	0.36***	0.57***	0.23***	(0.60)					
6. Overcoming obstacles	3.67	0.77	0.37***	0.20***	0.41***	0.25***	0.27***	(0.88)				
7. Innovation output	3.43	0.85	0.39***	0.13*	0.44***	0.41***	0.29***	0.37***	(0.78)			
8. Managerial support	3.53	0.81	0.13*	0.18**	0.27***	0.19**	0.25***	0.18**	0.21***	(0.82)		
9. Organizational support	2.99	0.88	0.00	0.07	0.16**	0.07	0.10	0.08	0.14	0.45***	(0.79)	
10. Cultural support	3.03	0.65	0.08	0.01	0.07	0.04	0.02	0.21***	0.23***	0.10	0.23***	(0.77)

Notes: $n = 267$. Cronbach's α are on the diagonal in parentheses. *$p < 0.05$; **$p < 0.005$; ***$p < 0.001$

Table IV.
Convergent and discriminant validity: correlations of IBI and ISI scales with other measures (Study 3)

	α	1	2	3	4	5	6	7	8	9	10
Creative behavior[a]	0.89	*0.69****	0.32***	0.55***	0.40***	0.34***	0.41***	0.53***	0.14*	0.03	0.03
Scanning and search[a]	0.75	0.46***	*0.58****	0.43***	0.23***	0.42***	0.32***	0.24***	0.09	0.02	−0.01
Innovation indicators[b]	0.75	−0.30***	−0.18**	−0.22***	−0.25***	−0.08	−0.19**	*−0.35****	−0.06	0.01	−0.15*
Leader-member exchange[a]	0.85	−0.03	−0.07	−0.16**	−0.04	−0.10	−0.11	−0.10	*−0.70****	−0.34***	−0.02
Organizational support for creativity[a]	0.84	0.00	0.07	0.25***	0.01	0.14*	0.08	0.17**	0.44***	*0.79****	0.20***
Cultural openness to opportunities[a]	0.72	0.06	0.07	0.00	0.02	0.09	0.10	0.15*	0.12*	0.14*	*0.62****

Notes: 1 = idea generation, 2 = idea search, 3 = idea communication, 4 = implementation starting activities, 5 = involving others, 6 = overcoming obstacles, 7 = innovation output, 8 = managerial support, 9 = organizational support, 10 = cultural support. Pearson correlations, two-tailed significance; [a]$n = 260$; [b]due to missing data $n = 218$. The highest correlation in italics. *$p < 0.05$; **$p < 0.005$; ***$p < 0.001$

As expected, discriminant validity correlations of the scanning and search, creative behavior and innovation indicators scales with contextual factors (managerial, organizational and cultural support) were small, mostly non-significant and lower than correlations with other IBI scales (Table IV). This supported discriminant validity of the IBI.

Concerning contextual factors, we employed the leader-member exchange scale (Graen and Uhl-Bien, 1995, seven items), organizational support for creativity scale (Zhou and George, 2001, four items) and the entrepreneurial opportunities scale from Stephan (2008, three items) to compute convergent validity correlations for the managerial, organizational and cultural support scales, respectively. As hypothesized the managerial support scale correlated highly and most strongly with leader-member exchange, the organizational support scale with organizational support for creativity, and the cultural support scale with cultural entrepreneurial opportunities, respectively (Table IV). Also as expected discriminant validity correlations of the leader-member exchange, organizational support for creativity, and cultural entrepreneurial opportunities scales with the IBI scales were mostly small and lower than correlations with the innovation support scales (Table IV). The exceptions were significant correlations with idea communication that may be due to the fact that communicating ideas to others is easier when it is supported by a manager and organization.

4.4 Study 4: cross-cultural validation on representative samples of adult population in four European cultures

There is a lack of cross-cultural studies of employee innovative behavior and innovation support (Table I for the countries in which previous studies were conducted). To provide support for the applicability of the IBI and ISI in different countries and occupations, we conducted a cross-cultural validation study on representative samples of the adult population in four countries. Switzerland occupies consistently the top position of innovation leader in official innovation rankings (e.g. Global Innovation Index, 2016), Germany represents the strongest European economy and the Czech Republic and Italy constitute examples of Eastern (and post-communist) and Southern European economies. Although all cultures are European, they reflect considerable cultural diversity and diversity in terms of their innovation performance[2].

Sample. Data were gathered between May and July 2008 using computer assisted telephone interviewing. The data were collected by professional survey vendors using random digit dialing on mobile phone numbers. The initial sample included 4,795 working-age adults from Germany ($n = 1{,}285$), Italy ($n = 1{,}256$), Switzerland ($n = 1{,}250$) and the Czech Republic ($n = 1{,}004$). The response rate varied between 26.5 percent in the Czech Republic, 29.6 percent in Italy, 47.7 percent in Switzerland to 50.1 percent in Germany[3]. We checked the representativeness of national samples for each country concerning age, gender, education level, size of residence and region by comparing them with a country's census data (conducting χ^2 tests). All samples were representative, the only exception was Switzerland where our sample included older respondents than the population. Since we focus on innovative behavior at work, we removed from the sample individuals that were retired, unemployed, students or homemakers ($n = 1{,}498$), 36 individuals who were multivariate outliers (tested via Mahalanobis distance[4]) and as well as 450 individuals who were entrepreneurs (but see below for additional analysis including entrepreneurs), resulting in a sample of 2,812 employees for our analysis of the IBI and ISI instruments. The samples by countries were 584 Czech Republic, 844 Germany, 587 Italy and 797 Switzerland.

A small number of missing values existed, which were estimated using the estimation maximization procedure (Tabachnick and Fidell, 2007). Analyses with missing cases deleted were highly similar.

Replicating the factor structure. Before establishing cross-cultural equivalence, we successfully replicated the factor structure (as shown in Figure 1) in the combined sample of Study 4. The model showed good fit. RMSEA = 0.039 90, percent CI = 0.038-0.041, CFI = 0.940, TLI = 0.930 and χ^2 = 2,937.98, df = 544. As with Study 3, we explored whether additional direct paths from the contextual factors on innovative behavior and innovation output (that were not specified in model) would improve model fit. This was not the case.

Evidence for cross-cultural equivalence of IBI and ISI. Relationships and means can only be validly compared across countries if measurement invariance exists. We tested measurement invariance with multi-group confirmatory factor analysis (e.g. Kline, 2005; Steenkamp and Baumgartner, 1998) based on maximum likelihood estimation and conducted with AMOS 17 (Arbuckle, 2008). We tested whether the factor structures of our scales were replicable with the same number of factors (configural equivalence), whether item loadings were comparable (metric equivalence), and whether item intercepts were comparable (scalar equivalence) across cultures. We also tested whether the full theoretical model, i.e. assuming influences from context factors on innovative behavior and in turn on innovation outputs was replicable across cultures. Equivalence of item and factor error variances was not tested as measurement errors are partialled out in confirmatory factor analyses when estimating parameters (Kline, 2005; Vandenberg and Lance, 2000).

Overall model fit was evaluated using the following fit indices (Kline, 2005; Vandenberg and Lance, 2000): RMSEA with values < 0.06 indicating good model fit, CFI, TLI. For CFI and TLI values > 0.90 indicate sufficient model fit and > 0.95 good fit. Measurement equivalence tests imply comparisons of nested models, i.e., models that are "versions" of each other and apply increasingly stringent constraints of equality across samples. For instance, the metric invariance model assumes that in addition to equal factor structures the factor loadings are also the same across samples, in other words the factor loadings are "constraint" to be the same in the multi-group model. Equivalence is supported when the constraint model does not fit the data worse than the model it is derived from. To determine whether a model fit was worse we follow Cheung and Renswold (2002) and examine changes in CFI as well as report changes in TLI, as model fit is often best judged based on multiple parameters (Steenkamp and Baumgartner, 1998; Vandenberg and Lance, 2000). A decrement of CFI by 0.01 or less indicates good measurement invariance, a decrement by more than 0.02 indicates non-negligible differences between models (Cheung and Renswold, 2002; Vandenberg and Lance, 2000). We do not rely on χ^2 to determine model fit but merely report it for completeness, because χ^2 false rejects valid models when sample sizes are large, as is the case here (Steenkamp and Baumgartner, 1998). In addition to overall model fit, Modification indices (MI) and expected parameter changes (EPC) were inspected to ascertain "local" fit of parameters. A high MI and EPC for a parameter that is constraint equal across cultures points to measurement invariance of that specific parameter; indicating that this parameter should vary freely across cultures (e.g. Kline, 2005).

Full metric and full scalar equivalence are rarely achieved in cross-cultural data (Byrne *et al.*, 1989; Steenkamp and Baumgartner, 1998), and we present also tests of partial metric and scalar equivalence. Partial metric and partial scalar equivalence exists when at least two items per factor show equivalent loadings and intercepts, respectively. This is sufficient to conduct valid mean comparisons across cultures (Byrne *et al.*, 1989; Steenkamp and Baumgartner, 1998).

Following van de Vijver and Leung (1997), we conduct invariance tests by comparing each country sample against the pancultural sample as a comparison sample with the country being tested for equivalence being removed from the pancultural sample. Table V summarizes the equivalence test.

Model and type of equivalence	Comparison	RMSEA	CFI	ΔCFI	TLI	ΔTLI	χ^2 (df)	$\Delta\chi^2$ (Δdf)
Czech								
1. Configural	–	0.029	0.940	–	0.933	–	3,493.43 (1,080)	–
2. Full metric: 1st-order factor loadings	1 vs 2	0.029	0.938	−0.002	0.933	0.000	3,597.66 (1,105)	104.23 (25)
3. Full scalar: item intercepts	2 vs 3	0.032	0.920	−0.018	0.915	−0.018	4,343.46 (1,130)	745.90 (25)
3.1. Partial scalar (3 items not constrained)	2 vs 3.1	0.030	0.930	−0.008	0.926	−0.007	3,930.60 (1,127)	332.95 (22)
4. Full metric: 2nd-order factor loadings	3.1 vs 4	0.030	0.930	−0.000	0.926	−0.000	3,946.33 (1,132)	15.73 (5)
5. Full scalar: 1st-order factors intercepts	4 vs 5	0.031	0.928	−0.002	0.924	−0.002	4,020.28 (1,137)	73.95 (5)
6. Structural model	5 vs 6	0.031	0.928	−0.000	0.925	0.001	4,029.13 (1,141)	8.85 (4)
German								
1. Configural	–	0.030	0.933	–	0.927	–	3,739.67 (1,080)	–
2. Full metric: 1st-order factor loadings	1 vs 2	0.030	0.932	−0.001	0.927	−0.000	3,815.53 (1,105)	75.86 (25)
3. Full scalar: item intercepts	2 vs 3	0.032	0.924	−0.008	0.920	−0.007	4,166.61 (1,130)	351.07 (25)
4. Full metric: 2nd-order factor loadings	3 vs 4	0.032	0.924	−0.000	0.920	−0.000	4,185.68 (1,135)	19.07 (5)
5. Full scalar: 1st-order factors intercepts	4 vs 5	0.032	0.923	−0.001	0.920	−0.000	4,204.41 (1,140)	18.73 (5)
6. Structural model	5 vs 6	0.032	0.923	−0.000	0.920	−0.000	4,215.03 (1,144)	10.61 (4)
Italian								
1. Configural	–	0.031	0.929	–	0.921	–	3,961.24 (1,080)	–
2. Full metric: 1st-order factor loadings	1 vs 2	0.031	0.927	−0.002	0.922	0.001	4,036.92 (1,105)	75.680 (25)
3. Full scalar: item intercepts	2 vs 3	0.033	0.920	−0.007	0.915	−0.007	4,374.52 (1,130)	337.61 (25)
4. Full metric: 2nd-order factor loadings	3 vs 4	0.033	0.919	−0.001	0.915	−0.000	4,391.47 (1,135)	16.95 (5)
5. Full scalar: 1st-order factors intercepts	4 vs 5	0.033	0.916	−0.003	0.912	−0.003	4,540.58 (1,140)	149.11 (5)
6. Structural model	5 vs 6	0.033	0.916	−0.000	0.912	−0.000	4,550.42 (1,144)	9.84 (4)
Swiss								
1. Configural	–	0.030	0.934	–	0.928	–	3,685.83 (1,080)	–
2. Full metric: 1st-order factor loadings	1 vs 2	0.030	0.933	−0.001	0.928	−0.000	3,743.69 (1,105)	57.87 (25)
3. Full scalar: item intercepts	2 vs 3	0.031	0.928	−0.005	0.924	−0.004	4,000.78 (1,130)	257.09 (25)
4. Full metric: 2nd-order factor loadings	3 vs 4	0.031	0.927	−0.001	0.924	−0.000	4,018.72 (1,135)	17.93 (5)
5. Full scalar: 1st-order factors intercepts	4 vs 5	0.031	0.927	−0.009	0.924	−0.000	4,033.19 (1,140)	14.47 (5)
6. Structural model	5 vs 6	0.031	0.927	−0.000	0.924	−0.000	4,042.57 (1,144)	9.38 (4)

Note: $n = 2{,}812$

Table V.
Test of measurement invariance (Models 1-5) and theoretical model (Model 6 "structural model" as shown in Figure 1) in Czech, German, Italian and Swiss representative samples, Study 4

The analyses support configural, full metric and full scalar invariance of both the first and the second-order factors (Models 1-5) in the German, Italian and Swiss samples. For the Czech sample the intercepts of three items (H2, J5, M5) were not equivalent, hence partial scalar equivalence was achieved for the Czech sample along with configural and full metric

invariance. We fully replicated the theoretical model, i.e. the structural relationships among the latent constructs in all cultures (Models 6 in Table V).

IBI across sample types: comparing the innovative behavior of employees and entrepreneurs. Entrepreneurship is often associated with innovative behavior, following the view that entrepreneurs and their firms introduce novelty into the market place (Rauch *et al.*, 2009). One way of validating whether the IBI captures relevant aspects of innovative behavior is to compare employees with entrepreneurs. If we were to find measurement equivalence of the IBI measure across samples of employees and entrepreneurs, then this would provide further support for the generalizability of the inventory. Furthermore, we would expect mean differences favoring entrepreneurs. We use Study 4 representative samples and compare the 2,812 employees with 450 entrepreneurs. We focus our comparison on the IBI as two of the three context measures (managerial and organizational support) are not meaningful for entrepreneurs. For the same reason we exclude the idea communication subscale. Employees and entrepreneurs differed systematically in age, gender and education; we thus include these variables as covariates in our analyses.

We followed the same procedure of equivalence testing across samples as outlined above. Table VI displays the results. We find support for configural, metric and scalar measurement equivalence (Models 1-5 in Table VI) of the IBI in the employee compared to the entrepreneur sample. CFI did not deteriorate substantially in any of the nested models, thus indicating measurement equivalence. We also found support for the equivalence of the structural model, i.e. innovative behavior is predicting innovation outputs with similar strength in both samples.

We conducted a multivariate ANCOVA to test for mean differences between employees and entrepreneurs. We chose a multivariate procedure to account for the correlations among the innovative behavior scales. All analysis controlled for gender, education and age and due to missing values on these variables the sample was reduced to 2,762. We found a significant effect for sample type, i.e. employee vs entrepreneur (Pillai's Trace $F(6, 2{,}762) = 38.07$, $p < 0.001$, $\eta^2 = 0.077$). Employees differed from entrepreneurs most strongly in implementation starting activities ($F(1, 2{,}762) = 109.69$, $p < 0.001$, $\eta^2 = 0.038$) and overcoming obstacles ($F(1, 2{,}762) = 97.53$, $p < 0.001$, $\eta^2 = 0.034$). They also differed with regard to idea generation ($F(1, 2{,}762) = 55.76$, $p < 0.001$, $\eta^2 = 0.020$), idea search ($F(1, 2{,}762) = 15.32$, $p < 0.001$, $\eta^2 = 0.006$), but did not significantly differ with regard to involving others ($F(1, 2{,}762) = 0.426$, ns). Employees and entrepreneurs also differed significantly in innovation outputs ($F(1, 2{,}762) = 121.28$, $p < 0.001$, $\eta^2 = 0.042$). Figure 2 plots

Model and type of equivalence	Comparison	RMSEA	CFI	ΔCFI	TLI	ΔTLI	χ^2 (df)	$\Delta\chi^2$ (Δdf)
1. Configural	–	0.035	0.952	–	0.942	–	1,419.03 (284)	–
2. Full metric: 1st-order factor loadings	1 vs 2	0.034	0.952	0.000	0.945	0.003	1,440.50 (297)	21.46 (13)
3. Full scalar: item intercepts	2 vs 3	0.035	0.948	−0.004	0.942	−0.002	1,554.77 (310)	114.27 (13)
4. Full metric: 2nd-order factor loadings	3 vs 4	0.035	0.947	−0.001	0.942	−0.000	1,571.87 (314)	17.10 (4)
5. Full scalar: 1st-order factors intercepts	4 vs 5	0.036	0.943	−0.004	0.939	−0.003	1,670.94 (319)	99.10 (5)
6. Structural model	5 vs 6	0.036	0.940	−0.003	0.936	−0.003	1,735.70 (320)	64.75 (1)

Note: Idea communication and Innovation Support Inventory are excluded from this comparison as these scales are not suitable for entrepreneurs

Table VI. Test of measurement invariance (Models 1-5) and theoretical model (Model 6 "structural model" for innovative behavior and innovation outputs) across sample types employees ($n = 2{,}812$) vs entrepreneurs ($n = 450$), Study 4

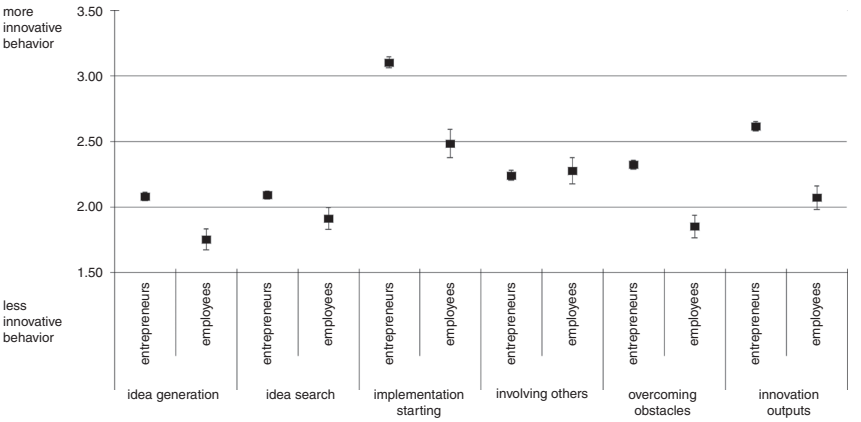


Figure 2.
Innovative behavior profiles employees vs entrepreneurs: adjusted mean differences and 95 percent confidence intervals (Study 4)

Notes: Mean comparison controlling for age, gender and education, due to missing values on the control varaibles $n = 2{,}406$ employees and $n = 356$ entrepreneurs

these mean differences along with the 95 percent confidence intervals. Overall, the pattern of mean differences on the IBI highlights entrepreneurs as more proactive and persistent than employees and somewhat more creative in terms of idea generation – although the two groups do not differ with regards to involving others in the innovation. The pattern of results is broadly consistent with evidence from research on personality characteristics of entrepreneurs, which highlights their proactivity, self-efficacy (which is closely related to persistence) and innovativeness and points to no differences with regard to relating to others (e.g. agreeableness, see Frese and Gielnik, 2014 for an overview).

5. Discussion

Over the course of four studies including diverse and population representative samples from four countries, this study developed the theoretically based IBI and ISI. Where past research focuses on convenience samples within a particular country, we offer first robust evidence that our model of employee innovative behavior generalizes across types of samples (including representative samples of employees vs entrepreneurs) and cultures (through examining cross-cultural equivalence). It is also the first study on employee innovative behavior conducted in the context of Central Europe. Our study consolidates and extends prior research on innovative behavior in the workplace by proposing an integrative model of individual employee innovative behavior. By integrating existing measures of innovative behavior, the IBI presents a multi-faceted model of individual employee innovative behavior whilst also drawing attention to the importance of contextual factors for supporting individual employee innovative behavior in organizations. The IBI and ISI together offer parsimonious measures that nevertheless capture the multi-facetted nature of individual employee innovation efforts in sufficient detail to enable future research to advance a more nuanced understanding of individual innovation at work – an important micro-foundation underpinning organizational-level intrapreneurship. For instance, different employee skills likely underlie specific innovative behaviors such as idea generation vs idea search or involving others.

Our study recognizes that employee innovative behavior is also influenced by the perceived work environment and support (Amabile *et al.*, 2004; Hunter *et al.*, 2007). We extend the contextual drivers to include perceived cultural support for innovation. Our findings support the influential role of contextual factors for innovation outputs and are

consistent with an "onion" model of contextual embeddedness of individual employee innovative behavior. Specifically, cultural norms influence organizational cultural support toward innovation, which in turn shapes how supportive leaders and managers are of employee innovative behavior (see House *et al.*, 2004).

We developed the IBI and ISI by building on and extending existing scales instead of developing a completely new measure. Such an integrative approach enables research to progress efficiently. At the same time, our large, multi-country population representative samples provide novel evidence on the robustness of some established scales; e.g., items for measuring implementation starting activities by Scott and Bruce (1994) and items for overcoming obstacles and involving others from Howell *et al.* (2005). We also developed and validated a new idea search scale. Idea search behavior has been largely neglected in previous innovation studies, even though entrepreneurship research highlights the importance of active search for opportunities (Tang *et al.*, 2012). Finally, we created new scales of idea generation, idea communication, innovation outputs, managerial support and organizational support. Although these facets have been covered in previous studies (e.g. Scott and Bruce, 1994; Jackson, 1994); the newly created items outperformed many of the existing items in our analyses.

The IBI and ISI showed good factorial validity, good internal reliability, equivalence across cultures as well as discriminant, convergent and criterion validity. An underlying six-factor structure of innovative behavior was established in pilot studies and confirmed by confirmatory factor analysis in an independent study. Both inventories constitute useful diagnostic tools to identify employee innovative behavior and its support for future research. Practitioners may use the IBI and ISI to diagnose the strengths and weaknesses of individuals, teams and divisions in an organization and across organizations to develop targeted interventions (e.g. creativity trainings, job redesign or changes in the reward systems for managers and employees).

The study has limitations. First, the cross-sectional research design limits the ability to determine causation, although such design is typical and appropriate for scale development studies. Future studies should include longitudinal studies. Second, although we draw on population representative samples, we focus on European countries. Future research should explore whether the IBI and ISI can be employed in non-European countries. Third, we relied mostly on self-report, which may bias relationships. However, we used also objective data to establish criterion validity in Study 2 and the analysis of mean differences between employees and entrepreneurs further confirms validity of the IBI. Future studies may include measures such as supervisory assessment of innovative behavior.

6. Conclusion

Overall, this paper adds to our understanding of the multi-faceted nature of employee innovative behavior and contextual factors supporting innovation. Using an integrative scale building approach, it offers reliable measures – IBI and ISI – with good factorial, criterion, convergent and discriminant validity. IBI and ISI offer a concise yet nuanced understanding of the multiple facets of employee innovative behavior. For researchers, the suggested theoretical model provides an understanding of employee innovative behavior that is measurable and widely applicable for different innovation types and employee groups. It offers, to our knowledge, the first innovative behavior scale that is tested for broad variety of occupations and is cross-culturally applicable. It may be useful for research that focuses on individual behavior as a micro-foundation of intrapreneurship. For managers and practitioners dealing with the topic of innovation, an informed understanding of innovative behaviors and innovation supporting factors may help them to build on innovation strengths, reduce weaknesses and manage their innovation more efficiently.

Notes

1. Their scale was published after we collected our data. Thus, we could not incorporate their items and scales in our measure.
2. Germany is ranked 12th, the Czech Republic 24th and Italy 31st out of 141 economies worldwide in the Global Innovation Index.
3. Details on the sampling strategy are available from the authors.
4. The outlier pattern indicates careless or biased responding.

References

Adams, R., Bessant, J. and Phelps, R. (2006), "Innovation management measurement: a review", *International Journal of Management Reviews*, Vol. 8 No. 1, pp. 21-47.

Amabile, T.M., Schatzel, E.A., Moneta, G.B. and Kramer, S.J. (2004), "Leader behaviors and the work environment for creativity: perceived leader support", *Leadership Quarterly*, Vol. 15 No. 1, pp. 5-32.

Amabile, T.M., Conti, R., Coon, H., Lazenby, J. and Herron, M. (1996), "Assessing the work environment for creativity", *Academy of Management Journal*, Vol. 39 No. 5, pp. 1154-1184.

Arbuckle, J.L. (2008), *AMOS 17 User's Guide*, SPSS Inc., Chicago, IL.

Baer, M. and Oldham, G.R. (2006), "The curvilinear relation between experienced creative time pressure and creativity: moderating effects of openness to experience and support for creativity", *Journal of Applied Psychology*, Vol. 91 No. 4, pp. 963-970.

Binnewies, C., Ohly, S. and Sonnentag, S. (2007), "Taking personal initiative and communicating about ideas: what is important for the creative process and for idea creativity?", *European Journal of Work and Organizational Psychology*, Vol. 16 No. 4, pp. 432-455.

Bledow, R., Frese, M., Anderson, N., Erez, M. and Farr, J. (2009), "A dialectic perspective on innovation: conflicting demands, multiple pathways, and ambidexterity", *Industrial and Organizational Psychology: Perspectives on Science and Practice*, Vol. 2 No. 3, pp. 305-337.

Byrne, B.M., Shavelson, R.J. and Muthén, B. (1989), "Testing for the equivalence of factor covariance and mean structures: the issue of partial measurement invariance", *Psychological Bulletin*, Vol. 105 No. 3, pp. 456-466.

Cheung, G.W. and Renswold, R.B. (2002), "Evaluating goodness-of-fit indexes for testing measurement invariance", *Structural Equation Modeling*, Vol. 9 No. 2, pp. 233-255.

Cortina, J.M. (1993), "What is coefficient alpha? An examination of theory and applications", *Journal of Applied Psychology*, Vol. 78 No. 1, pp. 98-104.

Crant, M. (2000), "Proactive behavior in organizations", *Journal of Management*, Vol. 26 No. 3, pp. 435-462.

Davidsson, P. (2015), "Entrepreneurial opportunities and the entrepreneurship nexus: a re-conceptualization", *Journal of Business Venturing*, Vol. 30 No. 5, pp. 674-695.

de Jong, J. and den Hartog, D. (2010), "Measuring innovative work behavior", *Creativity and Innovation Management*, Vol. 19 No. 1, pp. 23-36.

de Jong, J. and Wennekers, S. (2008), "Intrapreneurship; conceptualizing entrepreneurial employee behavior", Scientific Analysis of Entrepreneurship and SMEs (SCALES), EIM, Zoetermeer.

DeVellis, R.F. (1991), *Scale Development: Theory and Applications*, Sage, Newbury Park, CA.

Dorenbosch, L., van Engen, M. and Vergangen, M. (2005), "On-the-job innovation: the impact of job design and human resource management through production ownership", *Creativity and Innovation Management*, Vol. 14 No. 2, pp. 129-141.

Felin, T., Foss, N.J. and Ployhart, R.E. (2015), "The microfoundations movement in strategy and organization theory", *Academy of Management Annals*, Vol. 9 No. 1, pp. 575-632.

Frese, M. and Gielnik, M. (2014), "The psychology of entrepreneurship", *Annual Review of Organizational Psychology & Organizational Behavior*, Vol. 1, pp. 413-438.

Global Innovation Index (2016), available at: www.globalinnovationindex.org/content/page/analysis-indicator (accessed May 5, 2016).

Graen, G.B. and Uhl-Bien, M. (1995), "Relationship-based approach to leadership: development of leader-member exchange (LMX) theory of leadership over 25 years: applying a multi-level multi-domain perspective", *Leadership Quarterly*, Vol. 6 No. 2, pp. 219-247.

Hammond, M.M., Neff, N.L., Farr, J.L., Schwall, A.R. and Zhao, X. (2011), "Predictors of individual-level innovation at work: a meta-analysis", *Psychology of Aesthetics, Creativity, and the Arts*, Vol. 5 No. 1, pp. 90-105.

Hornsby, J.S., Kuratko, D.F. and Montagno (1999), "Perception of internal factors for corporate entrepreneurship: a comparison of Canadian and U.S. managers", *Entrepreneurship Theory and Practice*, Vol. 24 No. 2, pp. 9-24.

House, R.J., Hanges, P.J., Javidan, M., Dorfman, P.W. and Gupta, V. (2004), *Culture, Leadership and Organizations: The GLOBE Study of 62 Societies*, Sage, Thousand Oaks, CA.

Howell, J.M., Shea, C.M. and Higgins, C.A. (2005), "Champions of product innovations: defining, developing, and validating a measure of champion behavior", *Journal of Business Venturing*, Vol. 20 No. 5, pp. 641-661.

Hunter, S.T., Bedell, K.E. and Mumford, M.D. (2007), "Climate for creativity: a quantitative review", *Creativity Research Journal*, Vol. 19 No. 1, pp. 69-90.

Jackson, D.N. (1994), *Jackson Personality Inventory – Revised Manual*, Sigma Assessment Systems, Port Heron, MI.

Janssen, O. (2000), "Job demands, perceptions of effort-reward fairness, and innovative work behavior", *Journal of Occupational and Organizational Psychology*, Vol. 73 No. 3, pp. 287-302.

Kirton, M.J. (1976), "Adaptors and innovators: a description and measure", *Journal of Applied Psychology*, Vol. 61 No. 5, pp. 759-762.

Kline, R.B. (2005), *Principles and Practice of Structural Equation Modeling*, 2nd ed., Guilford, New York, NY.

Kleysen, R.F. and Street, C.T. (2001), "Towards a multi-dimensional measure of individual innovative behavior", *Journal of Intellectual Capital*, Vol. 2 No. 3, pp. 284-296.

Krause, D.E. (2004), "Influence-based leadership as a determinant of the inclination to innovate and of innovation-related behaviors: an empirical investigation", *Leadership Quarterly*, Vol. 15 No. 1, pp. 79-102.

Lau, T.L.M., Shaffer, M.A., Chan, K.F. and Man, T.W.Y. (2012), "The entrepreneurial behavior inventory: a simulated incident method to assess corporate entrepreneurship", *International Journal of Entrepreneurial Behavior and Research*, Vol. 18 No. 6, pp. 673-696.

Leung, K., Bhagat, R.S., Buchan, N.R., Erez, M. and Gibson, C.B. (2005), "Culture and international business: recent advances and their implications for future research", *Journal of International Business Studies*, Vol. 36 No. 4, pp. 357-378.

Lukes, M. (2012), "Supporting entrepreneurial behavior and innovation in organizations", *Central European Business Review*, Vol. 1 No. 2, pp. 29-36.

Madjar, N., Oldham, G.R. and Pratt, M.G. (2002), "There's no place like home? The contributions of work and nonwork creativity support to employees' creative performance", *Academy of Management Journal*, Vol. 45 No. 4, pp. 757-767.

Oldham, G.R. and Cummings, A. (1996), "Employee creativity: personal and contextual factors at work", *Academy of Management Journal*, Vol. 39 No. 3, pp. 607-634.

Park, S.H., Kim, J.N. and Krishna, A. (2014), "Bottom-up building of an innovative organization: motivating employee intrapreneurship and scouting and their strategic value", *Management Communication Quarterly*, Vol. 28 No. 4, pp. 531-560.

Parker, S.C. (2011), "Intrapreneurship or entrepreneurship?", *Journal of Business Venturing*, Vol. 26 No. 1, pp. 19-34.

Patterson, M.G., West, M.A., Shackleton, V.J., Dawson, J.F., Lawthom, R., Maitlis, S., Robinson, D.L. and Wallace, A.M. (2005), "Validating the organizational climate measure: links to managerial practices, productivity and innovation", *Journal of Organizational Behavior*, Vol. 26 No. 4, pp. 379-408.

Rauch, A., Wiklund, J., Lumpkin, G.T. and Frese, M. (2009), "Entrepreneurial orientation and business performance: cumulative empirical evidence", *Entrepreneurship Theory and Practice*, Vol. 33 No. 3, pp. 761-788.

Rosing, K., Frese, M. and Bausch, A. (2011), "Explaining the heterogeneity of the leadership-innovation relationship: ambidextrous leadership", *Leadership Quarterly*, Vol. 22 No. 5, pp. 956-974.

Scott, S.G. and Bruce, R.A. (1994), "Determinants of innovative behavior: a path model of individual innovation in the workplace", *Academy of Management Journal*, Vol. 37 No. 3, pp. 580-607.

Shane, S. (2012), "Reflections on the 2010 AMR decade award: delivering on the promise of entrepreneurship as a field of research", *Academy of Management Review*, Vol. 37 No. 1, pp. 10-20.

Shane, S., Venkataraman, S. and MacMillan, I. (1995), "Cultural differences in innovation championing strategies", *Journal of Management*, Vol. 21 No. 5, pp. 931-952.

Shane, S.A. (1992), "Why do some societies invent more than others?", *Journal of Business Venturing*, Vol. 7 No. 1, pp. 29-46.

Steenkamp, J.B.E.M. and Baumgartner, H. (1998), "Assessing measurement invariance in cross-national consumer research", *Journal of Consumer Research*, Vol. 25 No. 1, pp. 78-107.

Stephan, U. (2008), "Culture of entrepreneurship (C-ENT)", doctoral dissertation, Philipps University of Marburg, Marburg.

Stephan, U. and Uhlaner, L.M. (2010), "Performance-based vs socially supportive culture: a cross-national study of descriptive norms and entrepreneurship", *Journal of International Business Studies*, Vol. 41 No. 8, pp. 1347-1364.

Tabachnick, B.G. and Fidell, L.S. (2007), *Using Multivariate Statistics*, Allyn and Bacon, Boston, MA.

Tang, J., Kacmar, K.M. and Busenitz, L. (2012), "Entrepreneurial alertness in the pursuit of new opportunities", *Journal of Business Venturing*, Vol. 27 No. 1, pp. 77-94.

Tierney, P. and Farmer, S.M. (2004), "The Pygmalion process and employee creativity", *Journal of Management*, Vol. 30 No. 3, pp. 413-432.

Tierney, P., Farmer, S.M. and Graen, G.B. (1999), "An examination of leadership and employee creativity: the relevance of traits and relationships", *Personnel Psychology*, Vol. 52 No. 3, pp. 591-620.

Vandenberg, R.J. and Lance, C.E. (2000), "A review and synthesis of the measurement invariance literature", *Organizational Research Methods*, Vol. 3 No. 1, pp. 4-70.

van de Vijver, F.J.R. and Leung, K. (1997), *Methods and Data Analysis for Cross-cultural Research*, Sage, Thousand Oaks, CA.

Zhou, J. and George, J.M. (2001), "When job dissatisfaction leads to creativity: encouraging the expression of voice", *Academy of Management Journal*, Vol. 44 No. 4, pp. 682-696.

Corresponding author
Martin Lukes can be contacted at: martin.lukes@vse.cz