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Predictors of Individual-Level Innovation at Work: A Meta-Analysis

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Abstract

Numerous narrative reviews related to innovation in work organizations have been published, yet very few quantitative reviews have been conducted. The present meta-analysis investigates the relationships between four predictor types (individual differences, motivation, job characteristics, and contextual influences) and individual-level workplace innovation. Results indicated that individual factors, characteristics of the job, and factors of the environment were moderately associated with phases of the innovation process. Implications for future research opportunities are discussed.

Keywords:

Innovation, meta-analysis, personality, climate, motivation, leadership

Predictors of Individual-Level Innovation at Work: A Meta-Analysis

The importance of innovation for organizational success has been increasingly noted in the conceptual and empirical literature of the organizational sciences (e.g., Agars, Kaufman, & Locke, 2008; Anderson, De Dreu, & Nijstad, 2004; West, 2002). In response to the emergence of innovation as a critical factor in creating and maintaining organizational competitiveness, a wide array of individual, job, and environmental factors have been examined in relation to employee innovation. Although numerous narrative reviews of work-related innovation have been published (e.g., Egan, 2005; Mumford, 2003; Patterson, 2002; Shalley & Gilson, 2004; Shalley, Zhou, & Oldham, 2004; Zhou & Shalley, 2003), little attention has been given to quantitative reviews. Baas, DeDreu, and Nijstad (2008) conducted a meta-analysis on mood and creativity; however, the majority of the included studies were laboratory experiments with student participants. With the exception of one meta-analysis of organizational level innovation (Damanpour, 1991), a second examining personality and creativity for artists and scientists (Feist, 1999), and another examining climate for creativity (Hunter, Bedell, & Mumford, 2007), no studies have quantitatively reviewed individual-level employee creativity or innovation, despite calls for meta-analyses in this area (e.g., Anderson & King, 1993; Anderson et al., 2004).

A particular gap in the published literature is quantitative assessment of the predictors of employee or individual-level innovation. Specifically, meta-analytic data in this domain may advance innovation research by identifying the relative contributions of various predictors that allow more definite conclusions to be drawn (Anderson et al., 2004). Meta-analyses permit statistical corrections to account for distortions created by measurement error, sampling error, and other artifacts inherent in individual research studies (Schmidt & Hunter, 2004). This is particularly advantageous for research on innovation, in which there are a number of studies using relatively small sample sizes (Anderson et al., 2004). As such, conclusions drawn from meta-analyses tend to be much more accurate than conclusions drawn from narrative reviews. Further, meta-analyses may help clarify inconsistent results that are so often found in research (Rosenthal & DiMatteo, 2001). It may also be important to conduct meta-analyses in this area because there has been confusion with regard to the definition and measurement of both creativity and innovation.

The purpose of the present study is to test the relationships between various predictor types (individual differences, motivation, job characteristics, and contextual influences) and individual-level innovation using meta-analysis. In addition to providing a quantitative review of relevant predictors, this meta-analysis seeks to advance the study of innovation in three additional ways. First, we shed light on the debate regarding the nature of the possible elements of the innovative process (particularly the distinction between creativity and implementation) by contrasting the effects of various predictors on these outcomes. Additionally, we provide a comparison of multiple sources of judgments about the level of innovative processes, such as innovation rated by oneself or by one's supervisor. Finally, we provide direction for future research by highlighting under-researched areas of this domain.

Distinguishing Creativity and Innovation

Although there is not broad consensus with regard to the definition and dimensions of creativity, there is reasonable agreement regarding the definitional differences between creativity and innovation in applied settings, such as workplaces. For example, Unsworth (2001) and Anderson et al. (2004) both noted that, although creativity focuses on the generation of novel ideas, innovation in work organizations is concerned with the generation of possible alternatives, selection from among those alternatives, and implementation of the chosen alternative(s). As such, workplace innovation can be understood as a broader process that includes idea generation (creativity), but also the implementation of ideas within the work setting. Additionally, definitions of creativity typically focus on "absolute novelty," whereas definitions of innovation focus on a "relative novelty." Creativity describes the creation of something new; however, innovation may also include the application of a product, procedure, or process already in use elsewhere, provided that it is a new application within a particular role, work group, or organization (Anderson et al., 2004).

Parallel with the evolving distinction between creativity and innovation, several models of the components of the innovation process have been proposed (Patterson, 2002). Although there are differences in terminology, Patterson has noted that generally the models propose an initial "creativity" or ideation stage in which the task or problem is identified and further specified with alternative approaches or ideas developed, and then an "implementation" stage in which alternatives are assessed with regard to the situational context and selected alternative(s) are implemented. An example of such a model is that of Farr, Sin, and Tesluk (2003) who suggested that the innovative process could be described as two broad stages (Creativity and Innovation Implementation), each of which is comprised of two phases (one more preparatory or planful in focus and one more action-focused) . The Creativity stage includes a preparatory phase during which issue interpretation and problem identification take place and then an action phase in which alternative ideas and solutions are generated. Within the Innovation Implementation stage, the preparatory phase includes evaluation and selection of ideas and then an action stage that involves the actual implementation and application of the chosen solution(s) in the work situation. In the present paper, we suggest that innovation includes both an ideation and an implementation stage. We use the term "ideation" to suggest that this stage includes not only the generation of new ideas (as in creativity), but also the generation of solutions that apply existing systems to new situations (as in innovation). As suggested by Farr et al. (2003), various individual, job, and environmental factors may play more or less important roles throughout the innovation process, particularly with regard to generating ideas and implementing them.

Predictors of Innovation

Drawing from a wide variety of theories and narrative reviews of empirical work on individual creativity and innovation (Amabile, 1996; Patterson, 2002; Zhou & Shalley, 2003), we identified four areas of particular importance for innovative performance (individual differences, motivation, job characteristics, and contextual influences). A visual representation of these domains can be seen in Figure 1. We elaborate on each below.

Individual differences

Personality dimensions. Early empirical investigations of creativity were based on the premise that individuals vary with regard to their potential to be creative (see Barron & Harrington, 1981; Feist, 1999 for reviews). Based on the theory that creativity was primarily determined by stable traits, researchers developed and validated scales to assess creativity-relevant personality traits, often by designing lists of adjectives common to exceptionally creative individuals (e.g., Creative Personality Scale, Gough, 1979). Examples of these adjectives include clever, confident, individualistic, insightful, inventive, original, and unconventional. Applications of the Creative Personality Scale to the workplace have obtained evidence of a significant relationship between creative personality and some dimensions of innovative performance (Oldham & Cummings, 1996; Zhou & Oldham, 2001).

Hypothesis 1: Creative personality is positively correlated with innovative performance.

In addition to creative-specific personality, researchers have also suggested individuals with more general personality traits (e.g., Five-Factor Model) may be better suited for engaging in innovative work. Of the Big Five factors, openness to experience is most clearly linked with innovative behavior and has been the most frequently examined personality factor. Individuals high on openness have high intellectual curiosity, imagination, independence, and sensitivity to the arts (McCrae, 1987) and, as such, are less likely to shy away from new experiences and change which are part and parcel of innovation. Further, individuals higher on openness may be more likely to engage in divergent thinking (McCrae, 1987), which may be a precursor to some sorts of creativity and innovation. Although there may be links between additional personality dimensions and innovative behavior, there have been few such examinations in work settings, with the possible exception of Taggar (2002). Thus, we were unable to examine them in the meta-analysis.

Hypothesis 2: Openness to experience is positively correlated with innovative performance.

Demographic Variables. In addition to personality, the individual difference variables of tenure and education may influence innovative performance. These factors are frequently included as control variables in innovation studies. Most studies argue that education and tenure may reflect task domain knowledge through formal training or experience on the job (e.g., Tierney & Farmer, 2004, Kark & Carmeli, in press; Oldham & Cummings, 1996). If any rationale is given for their inclusion, authors frequently cite Amabile's (1988) componential model of creativity to suggest this relationship. As individuals gain knowledge and experience, they build a larger and more integrated repository of response possibilities, which include ideas, facts, and cognitive scripts, from which to draw creative ideas to problems (Amabile, 1983). Although these variables are often included as controls because of their potential to influence innovation, little attention is actually given to them. A meta-analysis presents a unique opportunity to examine the claims of this relationship, particularly because they are included in a large number of studies.

Hypothesis 3a: Educational level is positively correlated with innovative performance.

Hypothesis 3b: Tenure is positively correlated with innovative performance.

Motivation

Motivational components are present in nearly all theories of creativity and innovation (e.g., Amabile, 1983, 1996; Ford, 1996). Intrinsic motivation refers to motivation stemming from the individual's engagement in the task, whereas extrinsic motivation refers to motivation stemming from factors outside the task, such as rewards or compensation (Amabile, 1996). Previous research has shown positive relationships between both intrinsic and extrinsic motivation and innovation (George & Zhou, 2002; Taggar, 2002). Additionally, if submitting suggestions or implementing innovative work processes is rewarded by the organization through monetary or other extrinsic means, individuals may be more motivated to be actively involved in such processes (Eisenberger & Rhoades, 2001). This refers to learned industriousness theory (Eisenberger, 1992), in which individuals learn which performance dimensions (e.g., innovation) lead to rewards and are motivated to perform them accordingly. Alternatively, some researchers have posited a 'paradox of rewards' in which extrinsic motivation may undermine intrinsic motivation over time, particularly for children and adolescents (Deci, Koestner, & Ryan, 1999). Empirical studies have produce mixed results in this regard. Although we expect both intrinsic and extrinsic motivation to exhibit a positive relationship with innovative behavior, we believe that intrinsic motivation will have a stronger and more consistent relationship with innovation. Amabile (1979, 1985) proposed that some extrinsic factors may constrain attention to the existing conception and interpretation of the task as originally defined, whereas intrinsic motivation is more conducive to the processing of divergent information, allowing the individual to explore different solutions to the problem or different approaches to the task.

Hypothesis 4a: Intrinsic motivation is positively correlated with innovative performance.

Hypothesis 4b: Extrinsic motivation is positively correlated with innovative performance.

Self-efficacy can also be conceptualized as a variable that influences the motivation to engage in particular behaviors (Bandura, 1977, 1997). However, when examining this relationship one should distinguish between *job self-efficacy*, which refers to beliefs about one's competence with regard to task performance, and *creative self-efficacy*, which refers to beliefs about one's competence with regard to creative performance. Tierney and Farmer (2002) introduced the concept of creative self-efficacy, which positively predicted creative performance above and beyond job self-efficacy. Both job and creative self-efficacy have exhibited positive relationships with creative and innovative outcomes (Axtell et al., 2000; Carmeli & Schaubroeck, 2007; Frese et al., 1999).

Hypothesis 5a: Job-related self-efficacy is positively correlated with individual innovative performance.

Hypothesis 5b: Creative self-efficacy is positively correlated with individual innovative performance.

Job Characteristics

In addition to the individual factors discussed above, several job and environmental factors may also relate to individual innovation. Job characteristics most frequently studied as predictors of innovation include job complexity, autonomy, time pressure, and role requirements. First, complex jobs are less routine and more challenging, which may promote idea generation (Amabile, 1988). Furthermore, jobs that are more complex may demand more innovation in their very nature by allowing individuals to simultaneously focus on multiple aspects of their work (Oldham & Cummings, 1996). Studies that include job complexity typically measure it by use of Dictionary of Occupational Title ratings (e.g. Tierney & Farmer, 2002) or using Hackman and Oldham's (1980) Job Diagnostic Survey (e.g. Farmer, Tierney, & Kung, 2003; Oldham & Cummings, 1996).

Hypothesis 6a: Job complexity is positively correlated with innovative performance.

Autonomy has been found to relate to both creative and innovative behaviors. Autonomy was positively related both to the generation and testing of ideas (Krause, 2004) and innovation implementation (Axtell et al., 2000). Jobs with little discretion in how, when, or where work is accomplished may stifle an employee's ability to be innovative. Alternatively, providing employees with freedom and independence to determine which procedures should be used to carry out a task may increase the likelihood that they will be willing to implement them within their job.

Hypothesis 6b: Autonomy is positively correlated with innovative performance.

Finally, perceptions of role obligations to be innovative should also relate to innovative behavior. If individuals believe that they are expected to engage in innovative behaviors, they may be more likely to invest time and energy in these behaviors. Previous research has found positive relationships between one's perceptions of expectations or requirements regarding innovation and individual innovative behavior (Carmeli & Schaubroeck, 2007; Scott & Bruce, 1994; Unsworth, Wall, & Carter, 2005). Tierney and Farmer (2004) extended this research by suggesting expectations for creativity influence creative performance through an application of the 'Pygmalion Effect.' They suggest that supervisors who expect their employees to be creative provide more creative-relevant support, which is internalized by employees, and, in turn, enhances employees' creative self-efficacy. Although support was found by Tierney and Farmer for the mediated model, due to few studies measuring the complete sequence of intervening variables, we will only address the direct effect.

Hypothesis 6c: Role expectations regarding creativity and innovation requirements are positively correlated with innovative performance.

Context

Finally, contextual factors may play a role in creativity and innovation. Shalley et al. (2004) suggested that contextual factors may influence innovative performance through an effect on the employees' intrinsic motivation to perform the task. We expect positive relationships between innovation with support for creativity or innovation, organizational climate (e.g. participative, open, and safe climate), availability of resources, supervisory support, leader-member exchange, and transformational leadership.

Empirical studies at the organizational and group level have provided evidence that support for innovation is positively related to innovative outcomes (Scott & Bruce, 1994). However, there is less research at the individual level. This issue has been recently addressed by examining perceptions of both support for creativity and innovation (Farmer, Tierney, & Kung-McIntyre, 2003; Madjar, Oldham, & Pratt, 2002; West & Wallace, 1991). Scott and Bruce (1994) characterized support for innovation as a psychological climate variable. Another set of climate variables that are examined in the current meta-analysis can be differentiated from support for creativity or innovation, because these other climate variables are non-creativity specific. We have termed this set of variables "positive climate" because these constructs all focus on perceptions of a positive, open, and supportive work environment. We included measures such as psychological safety (Baer & Frese, 2003), participative safety climate (Axtell et al., 2000), socio-political support (Spreitzer, 1995a), Team-Member Exchange (TMX; Scott & Bruce, 1994), and open group climate (Choi, 2004b).

Hypothesis 7a: Organizational climate for creativity/innovation is positively correlated with individual creative and innovative performance.

Hypothesis 7b: Positive work climate is positively correlated with individual creative and innovative performance.

In addition to positive climate, authors have examined the impact of resources and supplies on innovative outcomes. Organizational resources, e.g., information (Spreitzer, 1995a, 1995b), technical support (Choi, 2004a), and instrumental support (Madjar, 2008), may provide the employee with needed assistance and resources, thereby facilitating innovation. Although these types of resources may have differential impact on innovation, we combined them into a single variable, as did Scott and Bruce (1994). Most of the resource measures include some aspect of information (e.g., in training, Choi, 2004; access to information, Spreitzer, 1995), but may also include financial resources or technical support.

Hypothesis 8: Organizational resources are positively correlated with individual creative and innovative performance.

Additionally, factors about one's leader or supervisor have also been examined as predictors of creative behavior. Beeler, Shipman, and Mumford (this issue) outline the role leaders play in facilitating innovation throughout the innovation process through their guidance, initiating structure, support, motivating tactics, and championing behaviors. Supervisor support should increase creative behavior by increasing employee's interest at work (Oldham & Cummings, 1996). Additionally, supervisor support might increase creative behavior by increasing an employee's intrinsic motivation (Harackiewicz, 1979; Oldham & Cummings, 1996). Similarly, Leader-Member Exchange (LMX) should also be positively related to creative behavior. According to LMX theory, as the relationship between leaders and subordinates develops, they move from a formal relationship to a higher quality relationship characterized by mutual trust and respect. In addition, in a high quality LMX relationship the subordinate should have more autonomy and decision-making latitude (Graen & Uhl-Bien, 1995), which are positively related to creativity and innovation. In line with these arguments, previous research has supported this link between LMX and creative behavior (Basu & Green, 1997; Jaussi & Dionne, 2003; Scott & Bruce, 1994).

Transformational and charismatic leadership were examined together in the present study. Charismatic leadership should increase creativity and innovation because, when leaders articulate a vision to their followers, they encourage their followers to be unconventional (Strickland & Towler, 2010). Additionally, charismatic leaders can increase intrinsic motivation and self-efficacy of their followers, which should also lead to higher levels of creativity and innovation (Tierney & Farmer, 2002). Transformational leadership should also increase creative and innovative behavior because it enhances motivation along with social and idea support (Jaussi & Dionne, 2003). Although not all studies have found a significant relationship between transformational leadership and innovation (Basu & Green, 1997; Jaussi & Dionne, 2003), we still predict an overall positive relationship between transformational leader behaviors and creativity and innovation.

Hypothesis 9a: Perceived supervisory support is positively correlated with individual creative and innovative performance.

Hypothesis 9b: The quality of leader-member exchange (LMX) is positively correlated with employee creative and innovative performance.

Hypothesis 9c: Transformational leadership level is positively correlated with employee creative and innovative performance.

Interactionist Perspective

As reviewed above, a variety of individual difference, motivational, and contextual factors affect one's involvement in innovative behavior. Woodman and Schoenfeldt (1990) presented a model of creative behavior that suggests these factors do not predict creativity in isolation, but rather interact with one another to either facilitate or inhibit creativity. Specially, the interactionist model purports that creative behavior is a function of antecedents (biographical variables and past reinforcements of creativity), personality, cognitive factors (abilities, styles, knowledge, and preferences), intrinsic motivation, social influences (support and rewards), and contextual influences (physical environment and constraints). In sum, Woodman and Schoenfeldt (1990) argue that creativity is a complex interaction of person and situation. As innovation may include some of the same processes as creativity, it may be safe to suggest the same for innovation.

There have been a number of studies in the areas of creativity and innovation, which have considered interaction effects, with mixed results. Most frequently, personality and characteristics of supervision, such as feedback, support, and control, have been examined (e.g. Baer & Oldham, 2006; George & Zhou, 2001; Madjar et al., 2002; Oldham & Cummings, 1996; Zhou, 2003; Zhou & Oldham, 2001). For example, Oldham and Cummings (1996) found that employees high on creative personality, who also reported high job complexity and perceived their supervisors to be supportive and non-controlling, were the most creative. Additionally, George and Zhou (2001) found that individuals high on openness to experience were most creative when they received positive feedback and they had flexibility in their jobs.

Additionally, job and contextual factors may also interact in the prediction of innovation or may be interrelated themselves. For example, it is feasible that organizations that have high expectations for creativity may also reward such behavior, and such rewards may increase self-determination and intrinsic motivation (Eisenberger & Rhoades, 2001). Although there is theoretical grounding (Woodman & Schoenfeldt, 1990) and some empirical evidence (cited above) to suggest that characteristics of the supervisor may moderate the relationships between personality and innovation, too few studies have been conducted with common variables to allow for their inclusion in this meta-analytic investigation. Consequently, we focus only on main effects of the various predictors on innovation rather than interactions among them.

Moderators of the predictor-innovation relationship

Stage of the innovation process. Although we are unable to examine interactions among multiple predictor variables, we are able to investigate some moderators of the predictor-innovation relationship. As described earlier, we are interested in the entire process of innovation, from idea generation to implementation (adapted from Farr et al., 2003). Although Farr et al. distinguish creativity stages from implementation stages, we use the term 'ideation' rather than creativity. Within the ideation stage, we also include generating solutions involving the application of both "relative novelty" and "absolute novelty," thereby distinguishing it from creativity. See Figure 1 for a description.

The stage of the innovation process at which the measurement of innovative behavior occurs may influence their relationships with the predictor variables. Some studies' criterion measurement includes the entire process, most commonly supervisory ratings simultaneously capturing ideation and implementation (e.g., Scott & Bruce, 1994), whereas other studies may only assess idea generation or implementation. This distinction of the components of the creativity process is similar to the two-stage (initiation and implementation) conceptualization used in the Damanpour (1991) meta-analysis. As these stages may represent different psychological processes, we anticipate that relationships between predictors and outcomes may be specific to various stages of the innovation process. For example, Axtell et al. (2000) found that individual, group, and organizational factors differentially influenced creativity and implementation. Individual variables more strongly predicted the suggestion of ideas, whereas group and organizational factors influenced the implementation of ideas to a greater extent. Similarly, we suggest that personality might be more strongly tied with earlier stages.

Hypothesis 10a: The correlation between personality and ideation is stronger than the correlation between personality and implementation.

Because the implementation stage can be full of obstacles and challenges, such as resistance to change, persistence is necessary. Although intrinsic motivation has been found to be positively related with creativity, it may be even more important in implementation stages to maintain the necessary persistence to overcome obstacles (Farr et al., 2003).

Hypothesis 10b: The correlation between intrinsic motivation and implementation is stronger than the correlation between intrinsic motivation and ideation.

In most cases, in order for a creative idea to be successfully implemented, it must be first successfully 'sold' to other individuals and/or to a larger group(Bain & Tran, 2006). Additionally, Drazin, Glynn, & Kazanjian (1999) describe the process as inherently multi-level: "Individuals and groups participate in creative processes in an iterative fashion. Individuals develop ideas, present them to the group, learn from the group, work out issues in solitude, and then return to the group to further modify and enhance their ideas. The iterative, interactive nature of group creativity requires that individuals first choose to engage individual-level creativity." (p. 291). As such, it is likely that contextual factors become more important for successful implementation than for generation of creative ideas. Positive relationships with co-workers and supervisors may increase the ability of the individual to garner necessary support and foster successful implementation. Further, empirical evidence suggests that individual perceptions of group and organizational factors influenced the implementation of ideas to a greater extent than individual difference factors (Axtell et al., 2000).

Hypothesis 10c: The correlations between contextual factors (climate for innovation, positive climate, supervisor support, LMX, transformational leadership) and individual *implementation are stronger than the correlations between contextual factors and ideation.*

Rating Source. We predict that the relationship between various predictors and innovation may be dependent upon the rating source, such as self, supervisor, peer, or trained rater. In work organizations, creativity and innovation are often measured through scales rated by a supervisor, (e.g., George & Zhou, 2001, Scott & Bruce, 1994; Tierney, Farmer & Graen, 1999), peer (Taggar, 2002), customer (Madjar & Ortiz-Walters, 2008), or the participant (Carmeli & Schaubroeck, 2007).

Amabile's (1983) consensual assessment technique remains a frequently used approach in the measurement of creativity (Shalley, 1995; Zhou & Oldham, 2001). In this approach, two or more raters independently evaluate the overall creative performance of the participant and a composite score is computed, given adequate rater agreement. This technique is most commonly used for laboratory studies. Additionally, studies have also used more objective measure such as the number of patents, idea submitted, or technical papers (Oldham & Cummings, 1996; Scott & Bruce, 1994; Tierney et al., 1999). Ratings have been found to vary systematically by source in the performance appraisal literature, where self-ratings tend to be more lenient than supervisor and peer rating (Harris & Schaubroeck, 1988). However, there is little discussion of these differences with regard to creative or innovative performance. Given that most predictors are self-reported, we might expect stronger relationships for self-reported creativity and innovation due to common method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Therefore, we predict that self-ratings display stronger relationships than other-ratings, most likely due to common-method bias with the predictors.

Hypothesis 11: The correlations between all predictors and self-reported innovative performance are stronger than the correlations between the predictors and other-reported (supervisor, trained rater, coworker, customer) innovative performance.

Sample. Finally, we address distinctions between student and working participants as a moderator of predictors innovation. In general, most studies of creativity and innovation at work have been field studies (e.g., Van Dyne, Jehn, & Cummings, 2002), although some have investigated work-like projects in the classroom, such as extensive group projects (Choi, 2004b), or work simulations, such as an in-basket activity (Cooper et al., 1999). In field studies, innovation and creativity may be associated with certain risks and negative consequences, such as resistance to change (e.g., Van de Ven & Poole, 1995; Klein & Sorra, 1996) and strained relationship with co-workers or supervisors (Janssen, 2003). In a classroom setting, these negative consequences are less likely; thus, creativity may have stronger relationships with its predictors in classroom settings.

Hypothesis 12: The correlations between all predictors and innovative performance are stronger in studies using student populations in non-work settings than in studies using employees in work settings.

Method

Literature Search

To identify articles for inclusion in the meta-analysis we first searched PsychINFO and PSYCHArticles for studies on creativity and innovation published between 1980 and 2008. We conducted keyword searches for each of the predictor variables with ‘creativity’ or ‘innovation.’ These search procedures resulted in identifying 1,820 abstracts. We also reviewed references of four recent narrative review articles on creativity and innovation (Anderson et al., 2004; Egan, 2005; Madjar, 2005; Zhou & Shalley, 2003). Additionally, we included conference papers from the Society for Industrial and Organizational Psychology over the past ten years. After an initial review of abstracts and elimination of studies that were clearly not relevant, we reviewed the remaining 400 studies based on the following inclusion criteria. We excluded studies that a) did not measure relevant predictors, b) only presented qualitative data or a review of previous work, c) did not present *individual* level creativity or innovation measures (i.e., we excluded measures of creativity/innovation at the group or organizational levels), d) did not include a behaviorally-based measure of creativity or innovation (e.g., we excluded creative personality or innovative cognitive style as measures of creativity), and e) presented measures of association that could not be converted into correlations. Additionally, as we were interested in workplace creativity and innovation, we only included research that included a) field studies conducted in a workplace (e.g., Axtell et al., 200), b) working student samples surveyed about their work (e.g., Ettlie & O'Keefe, 1982), or c) lab studies based on work-relevant tasks (e.g., creativity in an in-box exercise, Cooper, Clasen, Silva-Jalonen, & Butler, 1999). Based on these exclusion criteria, 303 correlations from 88 independent samples in 80 articles were included in the meta-analysis. For studies that included correlations between multiple measures of creativity or innovation, we computed a single estimate by either composite correlation or average to avoid over-weighting any one sample (Hunter & Schmidt, 1990). If a study's multiple measurement included two different phases of the innovation process, we used both estimates, one in each subgroup meta-analysis. For example, if a study contained a measure of idea generation and implementation, we computed a single estimate for the overall meta-analysis, but then used each respective correlation when looking at criterion type. We excluded studies in which the sample data contained more than 50% overlap with other published sources (e.g., Axtell et al., 2006).

Classification Procedures

We coded articles for rating source (objective, self, supervisor, peer, trained rater, and subordinate) and for the stage of innovation process at which criterion measurement occurred (creativity and implementation). Table 1 provides the numbers of independent sample correlations for each combination of criterion measurement and type of predictor. Because of the noted confusion in definitions and frequent interchangeable use of some terminology, we coded the research studies based on actual measurement, not just on the basis of the terminology stated by the authors of the research document. Most studies used (or adapted) scales developed by a) Tierney et al. (1999), b) Scott & Bruce (1994), c) George & Zhou, 2001, d) Oldham and Cummings (1996), or e) Janssen (2001). If a measure of "creativity" (as described by the research authors) included both the generation of ideas and implementation, we categorized the study using this measurement as "innovation." In several cases, although the scales were labeled as measures of creativity, they included elements of implementation and, as such, were coded as "innovation." For example, the George and Zhou (2001) scale included the item "Develops adequate plans and schedules for the implementation of new ideas" and, therefore, the scale was coded as innovation rather than creativity.

Insert Table 1 about Here

Four coders, who were familiar with the creativity/innovation literature prior to coding, met for a training session in which all four jointly coded one example article. Then, the four coders independently coded a set of 30 articles and discussed them in two subsequent follow-up training sessions. All discrepancies were resolved through discussion to reach consensus. Additionally, to assess interrater agreement, 33 percent of the 80 total studies were coded by all four coders and the remaining studies were coded by at least two coders. Agreement ranged from 77% to 92% among the four coders.

Meta-analytic procedures

We used methods suggested by Hunter and Schmidt (2004) to conduct the meta-analysis. Several studies included multiple measures of innovation whether from multiple sources (e.g., Janssen, 2001) or multiple components of innovation (e.g., Axtell et al., 2000; Clegg et al., 2002). For the overall innovation meta-analysis, we computed a composite correlation, as recommended by Hunter and Schmidt (1990) in order to maintain the independence of the sample.

Each primary correlation was corrected for attenuation due to unreliability in both the predictor and the criterion using reliability estimates provided by the primary researchers. Objective measures in the predictor (e.g., education) and criterion (e.g., number of ideas generated) measures were assumed to have perfect reliability when not otherwise specified. Correlations were also corrected for bias associated with sample size. Next, the sample-weighted mean of these corrected correlations were computed (ρ), as well as the square root of the variance that was not attributed to the sampling error or unreliability in the predictor and criterion (SDρ).

An 80% credibility interval and a 95% confidence interval were computed around each corrected sample-weighted mean effect size to provide an estimate of the variability of the individual effect sizes across studies. Credibility intervals (CV) provide information regarding the range of the dispersion of individual study correlations, whereas confidence intervals (CI) provide information regarding the variability around the mean population estimate. An 80% credibility interval that does not include zero indicates that 90% of the individual effects in the meta-analysis are either positive or negative as indicated (for positive correlations, 10% are equal to or less than zero and 10% are at or beyond the upper bound of the interval). A wide credibility interval also suggests the presence of moderators. The confidence interval provides additional information concerning the confidence that the estimated mean accurately represents the true correlation in the population. A 95% confidence interval that does not include zero suggests that the average relationship between the predictor and outcome is likely non-zero. Finally, the percentage of observed variance accounted for in the three artifacts was computed and is listed in Table 2. Due to small cell sizes, no studies were eliminated due to outlying values. Extreme values may not be true outliers, but rather may occur because of large sampling error (Hunter & Schmidt, 2004). Therefore, we retained such values to prevent overcorrecting for sampling error. Additionally, we calculated a fail-safe N in order to calculate how many null studies would be required to reduce the correlation below a critical value. We chose .05 as the critical value, consistent with other meta-analyses (e.g., Eagly & Karau, 1991).

Results

Table 2 summarizes the results of each meta-analysis of the included correlates of innovation. As can be seen, corrected effect sizes range from small ($\rho = .05$) to moderately strong ($\rho = .44$). The majority of the effect sizes are moderate ($\rho > .20$). Further, the 95% confidence interval excludes zero for all predictors, except tenure, suggesting that the true effect on innovation is likely non-zero. Additionally, Table 2 highlights areas that have received the most research attention. The most frequently studied correlates include education, tenure, autonomy, and climate for innovation. Although the number of correlations included in each meta-analysis was small for some predictors, our fail-safe N analyses provided evidence of the confidence of our findings. For example, for the correlates displaying moderate effects ($\rho > .20$) between 22 and 110 additional null studies would be required to reduce the effect to .05.

Insert Table 2 about Here

Individual Differences. Contrary to early theories of creativity (Barron & Harrington, 1981), personality factors were not very strong correlates of innovative performance; however, both creative personality and openness held moderately strong positive estimated population correlations with innovative performance (ρ = .25 and .24, respectively). Although neither 95% confidence interval included zero, the credibility interval for creative personality included zero suggesting a wide dispersion of included effects. Overall some support was provided for both Hypotheses 1 and 2.

Demographic factors held positive, although relatively weak, relationships with innovation. As predicted in Hypothesis 3a, education was positively related to innovation (ρ = .15) and, as predicted in Hypothesis 3b, tenure was positively correlated with innovative performance (ρ = .05). However, although both relationships were in the expected direction, zero was included in the confidence interval for tenure and in the credibility intervals for both education and tenure. In consequence, Hypotheses 3a and 3b were not supported.

Motivation. As shown in Table 2, motivation demonstrated stronger relationships with individual innovation than did personality factors. In general, all motivation predictors exhibited moderately strong positive relationships as indicated by ρ's ranging from .14 to .33. Intrinsic motivation had a slightly stronger relationship with innovation than did extrinsic motivation (ρ = .24 and .14, respectively). Thus, Hypotheses 4a and 4b were supported. Contrary to 'the paradox of rewards' (Zhou & Shalley, 2003), we found a relatively consistent, but small positive relationship between extrinsic motivation and creativity. Notably, intrinsic motivation was examined in twice as many studies as extrinsic motivation. Job self-efficacy and creative self-efficacy both demonstrated moderately strong positive relationships (ρ = .26 and .33, respectively), supporting Hypotheses 5a and 5b. Thus, it appears that motivation, especially self-perceptions of efficacy, is positively related to individual innovative behavior.

Job Characteristics. Of all predictor categories, job characteristics demonstrated the strongest relationships with individual innovation. Job complexity held a relatively strong positive relationship (ρ = .32), as did autonomy (ρ = .32), and role expectations (ρ = .38), supporting Hypotheses 6a, 6b, and 6c. As predicted, it appears that structuring jobs (or at least enhancing perceptions of job characteristics) to provide a variety of skills and behaviors, granting individuals discretion in how and when they do their work, and creating an expectation of creativity enhances the innovative performance of employees.

Context. All climate and leadership factors displayed positive relationships with innovation. Regarding Hypothesis 7a, climate for innovation was moderately positively related to individual innovation (ρ = .18). Further, general positive climate was even more strongly related (ρ = .23) to innovation, supporting Hypothesis 7b. In addition to a supportive climate, the analysis indicated that the resources available to employees were also related to innovative performance (ρ = .27). It should be noted that there appeared to be a wide dispersion of included correlations for both positive climate and resources as the credibility intervals included zero.

Finally, we investigated the relationship between supervisors' behaviors and followers' innovative performance. Specifically, the relationship for supervisor support was consistent and positive (ρ = .21), supporting Hypothesis 9a. In support of Hypothesis 9b, leader-member exchange quality, showed a moderate relationship with innovative performance (ρ = .29). Hypothesis 9c, which predicted that transformational leadership would be positively related to individual innovative performance, exhibited a weaker, though still positive, relationship (ρ = .13) than the other contextual variables.

Moderators

We examined moderation effects in cells that held more than three correlations. Tables 3 – 5 present the results of the moderator analyses. In addition to examining for overlapping credibility and confidence intervals, a pairwise comparisons using Z-tests was calculated to determine whether the effects were statistically different from each other (as suggested by Quinones, Ford, & Teachout, 1995). As a caveat, results of moderating variables should be considered with caution as in many cases only a small number of studies were included (see Table 1). Further, we were unable to examine moderators for very many predictors. These results also highlight where future research is needed.

Stage of innovation process. Hypotheses 10a-c suggest that the relationship between various factors and innovation may vary by the stage of the process measured. In particular, we hypothesized that individual difference variables would be more strongly related to ideation than implementation, whereas job and contextual factors would be more strongly related to implementation than ideation. Table 4 summarizes the moderation analyses of the stage of the innovation process.

Hypothesis 10a suggested the correlation between personality and ideation is stronger than the correlation between personality and implementation. This hypothesis could only be tested in regards to openness to experience. Openness was more strongly related to ideation (ρ = .34) than innovation (ρ = .16). The Z-score between these was marginally significant ($Z = 1.63$, $p < .10$) providing some support for this hypothesis. This finding may be strengthened with more studies.

Regarding motivation, Hypothesis 10b predicted that the correlation between intrinsic motivation and implementation is stronger than the correlation between intrinsic motivation and ideation. Intrinsic motivation exhibited only a slightly stronger relationship with ideation (ρ =

.21) than with the entire innovation process (ρ = .18), so that this hypothesis could not be substantiated.

Contextual factors were examined in Hypothesis 10c, which predicted that the correlation between contextual factors (climate for creativity/innovation, positive climate, supervisor support, LMX, transformational leadership) and implementation is stronger than the correlation between contextual factors and ideation. Only supervisor support, climate for innovation, and positive climate were able to be examined, and their results were in the predicted direction. The most convincing evidence of this distinction is with regard to climate for creativity/innovation, in which we were able to compare ideation and implementation stages. As predicted, climate for creativity/innovation displayed a considerable stronger relationship with implementation (ρ = .37), than with ideation (ρ =.15). Neither the confidence interval nor the confidence intervals overlapped providing evidence of moderation; however, the Z-score difference was not significant.

Insert Table 3 about Here

Criterion rating source. Table 4 presents the results of the analysis of criterion rating source moderation. Self and supervisory ratings were the most common rating source for job and organization relevant predictors; whereas self and trained third party raters were most frequent for personality and intrinsic motivation predictors. Creative personality had a significantly larger effect on innovation as assessed by trained raters than by supervisors (Z = 1.97, $p < .05$). In general, as predicted, stronger relationships were found for self-ratings than supervisor ratings for organizationally relevant predictors. Climate for innovation had a marginally significantly larger effect on innovation when self- assessed than when assessed by supervisors ($Z = 1.31$, $p < .10$). Autonomy and positive climate had larger correlations with some criterion measures based on self-ratings than with innovation as rated by supervisors; however; they did not reach significance. With more studies these effects may likely reach significance.

Insert Table 4 about Here

Sample. Only two predictor variables, creative personality and intrinsic motivation, were able to be examined with the type of sample as a moderator. Because we focused the meta-analysis on work and work-related performance many laboratory studies of non-work relevant indicators of innovation (e.g., uses of a brick) were excluded. Table 5 summarizes our findings. As expected, the effects were stronger for student samples than a working population; however, the difference between the two groups was not significant for either predictor variable. As such, Hypothesis 12 was not supported.

Insert Table 5 about Here

Discussion

It is, ultimately, individuals who generate ideas and are responsible for turning those ideas into a reality. As such, organizations benefit by knowing who is most likely to suggest and implement new ideas and what conditions best foster these processes. To that end, this meta-analysis serves as one of the first comprehensive quantitative reviews of individual-level creativity and innovation in the workplace.

Summary of Findings

Personality played a small direct relationship in the prediction innovative performance. The fact that creative personality was not consistently related to innovative performance suggest that creativity and innovation is not solely trait-driven, as early researchers had hypothesized (Barron & Harrington, 1981). Further, many studies examining personality suggest that personality may not have a direct relationship with innovative performance, but rather interact with environmental factors (Zhou & Oldham, 2001; Zhou, 2003). Because of the small number of studies that have addressed these factors, we were not able to examine these interactions using meta-analysis.

Contrary to our expectations, education and tenure were not consistently related to creativity and performance. Education and tenure provide an individual with exposure to a variety of experiences, perspectives, and knowledge bases (Perkins, 1986), which in turn may manifest in creative and innovative performance. However, both education and tenure exhibited an inconsistent relationship with creativity and innovation. One reason for this inconsistency may be that the relationship between these factors and innovation may not be linear as creativity may develop and decline across the lifespan (Simonton, 2000).

The results of this analysis support the notion that individuals need some driving force to help them overcome challenges associated with creative and innovative work (George & Zhou, 2002; Taggar, 2002). Motivation factors demonstrated a consistent positive relationship with creative and innovative behavior. Job and creative self-efficacy were also important correlates, although the relationship was slightly stronger for creative self-efficacy than for job self-efficacy. In addition to these internal motivating factors, extrinsic motivation was also positively related to creativity, but with a smaller magnitude. Taken together, these findings support the notion that individual motivation is an important factor in predicting creative performance (Amabile, 1983).

Of all the predictor categories, job characteristics held the most consistent and strongest positive relationships with creativity and innovation. The results suggest that complex jobs may promote creativity and innovation as they include diverse activities and challenges (Amabile, 1988). In addition, autonomy may be an important factor in individual innovation as it provides an individual with freedom to decide how, when, and with whom to work (West & Farr, 1989). Finally, this analysis indicates that individuals respond to expectations or requirements that mandate innovative behavior. Overall, these findings suggest that jobs may be redesigned to facilitate creativity and innovation at work by increasing complexity and autonomy, as well as by clearly requiring (and encouraging) creativity and innovation on the job. Future research is needed to be able to investigate other moderators of this relationship.

Creativity and innovation can be difficult endeavors that involve risks that take people out of their comfort zones (Staw, 1995). Therefore, having support from the environment may facilitate an employee engaging in such behaviors. Positive relationships at work may foster innovation through its effect on psychological conditions and motivation. Specifically, individuals who feel care for them report greater psychological safety, meaningfulness, and availability and are in turn more likely engage in innovative behavior (Vinarski-Peretz & Carmeli, this issue). An environment that encourages individuals to be creative or innovative or an environment that is safe for risk taking is likely to enable an individual to take a risk in terms of suggesting a new idea or trying something new. Overall, our results supported this hypothesis as support for creativity/innovation, general support, and positive climate held positive relationships with such behavior. This finding is consistent with a recent meta-analysis of climate for creativity (Hunter et al., 2007).

Leaders are important shapers of the work environment and influence their follower's innovative behaviors in a number of ways. For example, leaders provide meaningful support during challenging times (Unsworth, Wall, & Carter, 2005), including shaping the emotional responses of followers (Zhou & George, 2003). They often have control over resources necessary for the innovation process and can be resources for their followers in terms of technical knowledge or social networking (Mumford & Licuanan, 2004). Additionally, they influence their followers' perceptions of job characteristics (Purvanova, Bono, & Dzieweczynski, 2006), which is an important correlate of innovation as discussed above. The pattern of results provides support for the leader's role in the employee's creative and innovative performance. Leadership, especially as measured through LMX quality, was positively related to creative and innovative behavior of followers. Although the magnitude of the relationship varied somewhat among measures of supervisory support, LMX, and transformational leadership, in general, leadership was positively related to creativity. Taken together, these results highlight the importance of contextual and leadership influences in the creativity process.

We found that both the stage of the innovation process and the rating source had some effect on the strength of relationships found between innovation and its correlates. Consistent with Axtell et al. (2000), we found some support for the idea that relationships between contextual factors and implementation was stronger than relationships between these factors and ideation. This was particularly pronounced for climate for creativity/innovation in which we were able to look at implementation directly. Again, few studies distinguished the implementation stage from the rest of the creativity process; therefore, more research is critical to be able to draw more specific conclusions.

Additionally, self-reported measurement of creativity tended to have larger effect sizes with predictors, but this could be a factor of common method bias since the majority of the predictors were also self-report measures (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). More primary research that distinguishes creativity and implementation is necessary to explore causes of variation in effect sizes concerning source of the criterion data and to draw more conclusive findings.

Limitations and Implications for Future Research

Before turning to the implication for future research, a number of limitations should be noted. The most notable limitation is the small number of studies. Because of this, we were unable to make conclusive statements about effect sizes for all potential predictors of individual innovation. Despite this limitation this study still makes several important contributions, for even small meta-analyses are less likely to lead to error than narrative reviews (Schmidt, Hunter, Pearlman, & Hirsh, 1985). Many relationships were distinguishable from zero and evidence exists suggesting that non-zero relationships will likely hold when more studies are included. Further, our Fail-Safe *N* analyses showed that many additional studies displaying null relationships would be required to reduce these findings to non-significance. Although meta-analyses with few studies may increase variability in effect sizes, they do not affect the mean estimates (Schmidt et al., 1985). One strength of the present study is that it highlights precisely where more research is needed. With more research, we will be able to make more conclusive remarks about effect sizes. Additionally, more studies will allow us to examine interaction effects.

This study was limited to direct effects of predictors on individual creativity and innovation, despite recent theoretical and empirical emphasis on the interaction of individual differences and situational factors on creativity. Following Woodman, Sawyer and Griffin’s (1993) interactionist perspective of organizational creativity, some research has been conducted examining the interaction of individual differences and contextual factors in the prediction of creativity and innovation. Although it is possible to use meta-analytic methods to examine the moderating effect of various situational factors on the relationship between individual differences and individual innovation using general linear modeling procedures (see Wright and Bonett, 2002, for an example), there has not yet been sufficient research conducted examining the same variables to be included as moderators.

Additionally, this study only examined individual level innovation. The need for meta-analytic reviews of predictors of team and organization level creativity and innovation still persists. Moreover, future work should continue to distinguish stages of the innovation process, especially in terms of idea generation and implementation across levels of analysis. For example, West (2002) suggests that external demands may inhibit team creativity but promote implementation. Meta-analytic testing of such a hypothesis is important, but can only be answered with continued research examining stages of the innovation process independently.

In addition to the general need for additional studies to provide better answers to research questions concerning individual and situational predictors of individual innovation, it is important to note more specific needs that seem especially critical to theoretical and practical advances related to this topic. We organize our suggestions into three topic areas: type of predictor, stages of the innovation process, and source of outcome measures.

Type of predictor. In terms of individual differences, there are few if any studies of individual innovation that examine compound personality traits as possible predictors, despite findings showing that compound traits are more valid predictors of other types of job behaviors than single personality traits, including those of the Five Factor Model (cf., Hough & Ones, 2001; Ones, Dilchert, Viswesvaran, & Judge, 2007). Also, studies of motivation factors other than intrinsic motivation are relatively few, especially in relation to self-regulatory factors shown to be related to goal-setting, persistence, and risk-taking in other performance domains.

Diefendorff and Lord (2008) and Vancouver and Day (2005), among others, provide useful discussions of current theoretical and empirical literature concerning self-regulation that can guide research related to the innovation process.

There are a considerable number of studies of organizational climate studies (see the meta-analysis by Hunter et al., 2007) and also large numbers of studies that have investigated the relation of autonomy and individual control to individual innovation, but other situational factors have received less attention. Leadership, job resources, and role expectations concerning innovation have shown promising results, but the small number of studies of each variable prevents more detailed understanding of their effects. Again, situational factors are typically investigated in a "one at a time" fashion that does not attempt to examine composites of situational features.

Stages of the innovation process. Although we recognize that innovation does not occur in organizations in the neat, linear fashion that is implied by most stage models, it is still useful heuristically to parse the overall innovation process into early and late phases that conceptually can be distinguished by their relative emphases on different activities. Yet we found that most studies of work-related individual innovation assessed only overall innovation outcomes, making it impossible to address questions about whether certain predictors had greater validity in early innovation process phases that emphasize creativity and ideation or in later phases that primarily focus on implementation of selected ideas. Additionally, we found very few studies specifically examining components of ideation or implementation, such as idea evaluation. We understand the difficulties of obtaining useful measures of innovation-related behaviors in the different phases, but these are needed in ordered to understand better the psychological processes that are strongly associated with each. A particular need is for more studies that examine how the focal problem or opportunity that drives the innovative process becomes salient. That is, we need to examine what leads to problem identification and recognition, opportunity recognition, environmental scanning, and the various other ways that a “need for innovation” becomes something that individual employees notice.

Source of outcome measures. Most studies of individual innovation that we found use either self- or supervisory-ratings as the outcome measure(s) of innovation. There is nothing “wrong” with such measures, but having more varied sources of outcome measures would provide a broader set of perspectives about the usefulness of innovation attempts and would also allow researchers to be more confident that our findings are not source-bound. In particular, it would be useful to have more evaluations of innovation provided by customers or end-users of the new product or procedure and to have more objective measures that could include sales, market penetration, adoption increase, and profitability data.

Practical Implications

In addition to providing effect size estimates of various predictors and highlighting future research needs, there are several practical implication of this comprehensive meta-analysis. First, having a better understanding of predictors and dimensions of creativity and innovation is important because creativity and innovation is so important in organizational success, particularly in gaining a competitive advantage (Agars et al., 2008). Zhou and Shalley (2003) outline five important areas in which creativity and innovation impact organizational success: performance appraisal, rewards and compensation, employee relations, recruitment and selection, and training. Our findings are applicable to these areas as well. For example, some differences were found in effect sizes across the rating source, as well as the stage of the creativity process. Therefore, when evaluating employee creativity as part of performance appraisals, supervisors and human resource practitioners need to consider both the rater and the stage of the creativity process they are measuring. We found that expectations for creative performance and extrinsic rewards do contribute to creative performance, suggesting benefits of strategically linking expectations of creative performance with acknowledgement or reward of such performance. Additionally, our findings regarding personality and ability suggest that selection tests may be designed to hire creative performers, although the relevant personality factors are different from those typically regarded as predictors of performance. When hiring creative employees, it may be important to consider factors such as creative personality and openness to experience. Similarly, as previously discussed, jobs can be designed to promote creativity. Finally, efforts to promote a supportive environment, even without specific reference to creativity or innovation, will likely be rewarded with enhanced innovative performance.

Conclusions

In sum, the results of this meta-analysis suggest that individual factors, as well as characteristics of the job and contextual factors, play roles in understanding creativity and innovation at work. Of equal importance, the results of the meta-analysis also highlight the gaps where research thus far has not provided an adequate knowledge base. Table 1 highlights where more research is needed in terms of criterion source and stage of the innovation process. In sum, the study of individual creativity and innovation at work has advanced to a considerable degree with a dramatic increase in the number of studies in the last few years, but there is still a need for more research to better understand these relationships and processes.

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Table 1.
Cell frequencies of correlations by moderator.

Predictor	Ideation	Measure Imple-mentation	Innova-tion	Sample Student	Working	Objective	Self Rating	Rating Source Super-visor Rating	Peer rating	Trained rater	Subor-dinate/ Customer
Openness	3	0	6	2	7	0	2	4	2	1	0
Creative Personality	7	0	2	5	4	2	3	5	2	4	0
Education	3	1	25	1	26	1	9	20	1	1	1
Tenure	5	3	24	1	31	1	10	19	2	1	1
Intrinsic Motivation	10	0	8	6	10	2	4	6	2	4	0
Extrinsic Motivation	3	0	5	2	6	1	4	3	0	1	0
Job Self-efficacy	2	1	4	1	5	1	4	2	0	0	0
Creative Self-efficacy	2	1	6	1	7	0	3	4	1	0	0
Job complexity	2	1	7	0	8	1	2	7	0	0	0
Autonomy	4	4	21	0	25	1	11	10	1	2	1
Role Expectations	2	2	6	0	9	0	6	3	0	0	0
Climate for Innovation	6	6	13	0	24	0	13	9	1	1	0
Positive climate	4	1	13	1	16	0	8	7	0	2	1
Resources	0	1	5	0	6	2	3	0	0	0	1
Supervisor Support(General)	6	2	10	1	13	2	9	4	1	0	0
LMX	2	1	5	0	6	1	1	5	0	0	0
Transformational Leadership	2	1	4	1	5	0	2	3	0	1	0

Table 2.
Meta-analysis of the overall relationship between correlates and innovation

Predictor	*k*	*n*	$\bar{r}$	$\hat{\rho}$	SD $\hat{\rho}$	80% CV (lower, upper)	95% CI (lower, upper)	% Variance	FSN
Creative Personality	9	1,159	.20	.25	.20	(-.04, .51)	(.10, .40)	23	27
Openness	9	1,868	.19	.24	.17	(.03, .45)	(.12, .36)	23	24
Education	27	5, 181	.14	.15	.15	(-.05, .34)	(.08, .21)	20	47
Tenure	32	6,053	.04	.05	.12	(-.10, .21)	(.00, .10)	30	3
Intrinsic Motivation	16	3,417	.20	.24	.14	(.06, .43)	(.16, .32)	25	48
Extrinsic Motivation	8	1,319	.11	.14	.00	(.14, .14)	(.08, .19)	151	9
Job Self-efficacy	6	1,257	.22	.26	.16	(.05, .46)	(.12, .40)	20	20
Creative Self-efficacy	8	1,746	.28	.33	.11	(.19, .46)	(.24, .42)	33	36
Job complexity	8	1,678	.29	.32	.10	(.20, .45)	(.24, .41)	36	38
Autonomy	25	4,011	.27	.32	.19	(.08, .56)	(.24, .40)	19	110
Role Expectations	9	2,480	.38	.44	.08	(.34, .55)	(.38, .51)	35	59
Climate for innovation	24	5,904	.17	.18	.13	(.02, .35)	(.12, .24)	23	57
Positive climate	17	3,092	.19	.23	.20	(-.02, .49)	(.13, .34)	16	49
Resources	6	1,440	.23	.27	.27	(-.08, .62)	(.04, .49)	6	22
Supervisor Support(General)	14	5,417	.17	.21	.05	(.15, .28)	(.17, .26)	57	34
LMX	6	1,049	.25	.29	.05	(.22, .36)	(.21, .37)	69	24
Transformational Leadership	6	1,691	.12	.13	.09	(.02, .25)	(.04, .23)	35	8

Note. *k*= number of correlations; N= combined sample size; $\bar{r}$ = average uncorrected correlation; $\hat{\rho}$ = estimated true score correlation corrected for unreliability in the predictor and criterion; SD $\hat{\rho}$ = standard deviation of the $\hat{\rho}$, CV= credibility interval; CI = confidence interval; % variance = percent variance in the corrected correlations attributable to all artifacts, FSN = Fail Safe *N*.

Table 3.

Meta-analysis of the relationship between predictors and innovation by stage of innovation process

Predictor	k	n	$\bar{r}$	$\hat{\rho}$	SD $\hat{\rho}$	80% CV (lower, upper)	95% CI (lower, upper)	Sig. Diff.
Openness								
Ideation	3	778	.26	.34	.13	(.17, .50)	(.17, .50)	a+
Innovation	6	1,090	.13	.16	.15	(-.03, .36)	(.02, .31)	b+
Tenure								
Ideation	5	1,081	-.01	-.01	.00	(-.01, -.01)	(-.07, .05)	
Implementation	3	617	.08	.08	.11	(-.06, .22)	(-.07, .23)	
Innovation	24	4,280	.04	.04	.15	(-.15, .23)	(-.03, .11)	
Education								
Ideation	3	542	.14	.12	.22	(-.17, .40)	(-.16, .39)	
Innovation	25	4,798	.14	.15	.15	(-.03, .34)	(.09, .22)	
Intrinsic motivation								
Ideation	10	2,400	.21	.26	.13	(.10, .42)	(.16, .35)	
Innovation	8	1,391	.18	.20	.13	(.03, .38)	(.09, .31)	
Extrinsic motivation								
Ideation	3	676	.16	.21	.00	(.21, .21)	(.15, .27)	
Innovation	5	643	.09	.11	.00	(.11, .11)	(.05, .18)	
Autonomy								
Ideation	4	675	.13	.19	.25	(-.14, .51)	(-.08, .46)	
Implementation	4	851	.35	.44	.00	(.44, .44)	(.38, .50)	
Innovation	21	3,440	.27	.32	.14	(.14, .50)	(.25, .39)	
Supervisor support								
Ideation	6	2,311	.13	.17	.13	(.01, .33)	(.06, .28)	
Innovation	10	3,468	.19	.23	.02	(.20, .26)	(.19, .27)	
Climate for innovation								
Ideation	6	2,116	.13	.15	.09	(.03, .27)	(.06, .24)	
Implementation	6	1,070	.30	.37	.00	(.37, .37)	(.32, .42)	
Innovation	13	2,526	.19	.21	.11	(.07, .35)	(.14, .28)	
Positive Climate								
Ideation	4	1,065	.19	.22	.01	(.21, .24)	(.16, .29)	
Innovation	13	2,027	.19	.23	.25	(-.08, .55)	(.09, .38)	

Note. *k*= number of correlations; N= combined sample size; $\bar{r}$ = average uncorrected correlation; $\hat{\rho}$ = estimated true score correlation corrected for unreliability in the predictor and criterion; SD $\hat{\rho}$ = standard deviation of the $\hat{\rho}$, CV= credibility interval; CI = confidence interval.

Letters in the right-hand column indicated means that are significantly different from each other at the .05 level. Those with a '+' denote significance at $p < .10$.

Table 4.

Meta-analysis of the relationship between predictors and innovation by rating source

Predictor	k	n	$\bar{r}$	$\hat{\rho}$	SD $\hat{\rho}$	80% CV (lower, upper)	95% CI (lower, upper)	Sig. Diff.
Creative Personality								
Self	3	360	.28	0.31	0.28	(-.05, .67)	(-.02, .64)	
Supervisor	5	738	.15	0.19	0.14	(.00, .37)	(.03, .34)	a
Trained rater	4	202	.47	0.56	0.20	(.30, .82)	(.32, .80)	b
Tenure								
Self	10	1,790	.07	0.08	0.14	(-.11, .26)	(-.02, .18)	
Supervisor	19	3,811	.04	0.04	0.12	(-.12, .20)	(-.02, .11)	
Education								
Self	9	1,526	.11	0.12	0.17	(-.10, .33)	(-.10, .34)	
Supervisor	20	3,877	.16	0.17	0.13	(.01, .34)	(.11, .24)	
Intrinsic Motivation								
Self	4	665	.18	.20	.23	(-.10, .49)	(-.05, .44)	
Supervisor	6	1,446	.16	.19	.00	(.19, .19)	(.14, .24)	
Trained rater	4	667	.16	.20	.00	(.20, .20)	(.16, .23)	
Extrinsic Motivation								
Self	4	620	.11	.15	.00	(.15, .15)	(.06, .24)	
Supervisor	3	624	.14	.18	.00	(.18, .18)	(.11, .25)	
Creative Self-efficacy								
Self	3	435	.39	.45	.00	(.45, .45)	(.06, .24)	
Supervisor	4	1,132	.25	.29	.11	(.16, .43)	(.11, .25)	
Requirements								
Self	6	2,017	.38	.44	.08	(.33, .54)	(.36, .52)	
Supervisor	3	463	.38	.47	.09	(.36, .58)	(.33, .61)	
Autonomy								
Self	11	1,882	.36	.45	.19	(.21, .69)	(.33, .57)	
Supervisor	10	1,450	.23	.26	.00	(.26, .26)	(.21, .31)	
Supervisor Support								
Self	9	4,254	.16	.20	.03	(.17, .24)	(.16, .24)	
Supervisor	4	952	.20	.24	.03	(.21, .27)	(.16, .32)	
Climate for Innovation								
Self	13	3,657	.21	.24	.13	(.07, .40)	(.16, .32)	a+
Supervisor	9	2,087	.10	.11	.08	(.01, .20)	(.04, .17)	b+
Positive Climate								
Self	8	1,154	.23	.27	.25	(-.05, .59)	(.16, .29)	
Supervisor	7	1,407	.14	.16	.16	(-.04, .37)	(.09, .38)	

Note. k= number of correlations; N= combined sample size; $\bar{r}$ = average uncorrected correlation; $\hat{\rho}$ = estimated true score correlation corrected for unreliability in the predictor and criterion; SD $\hat{\rho}$ = standard deviation of the $\hat{\rho}$, CV= credibility interval; CI = confidence interval. $\hat{\rho}$. Letters in the right-hand column indicated means that are significantly different from each other at the .05 level. Those with a '+' denote significance at $p < .10$.

Table 5.

Meta-analysis of the relationship between predictors and innovation by type of sample.

Predictor	k	n	$\bar{r}$	$\hat{\rho}$	SD $\hat{\rho}$	80% CV (lower, upper)	95% CI (lower, upper)	Sig. Diff.
Creative Personality								
Students	5	588	.26	.33	.25	(.01, .66)	(.09, .58)	
Employees	4	571	.14	.16	.00	(.16, .16)	(.06, .26)	
Intrinsic Motivation								
Students	6	1,530	.23	.29	.15	(.10, .48)	(.15, .42)	
Employee	10	1,884	.18	.21	.13	(.04, .38)	(.11, .31)	

Note. k= number of correlations; N= combined sample size; $\bar{r}$ = average uncorrected correlation; $\hat{\rho}$ = estimated true score correlation corrected for unreliability in the predictor and criterion; SD $\hat{\rho}$ = standard deviation of the $\hat{\rho}$, CV= credibility interval; CI = confidence interval. $\hat{\rho}$. Letters in the right-hand column indicated means that are significantly different from each other at the .05 level. Those with a '+' denote significance at p < .10.

Figure 1. Current Model of the Antecedents of Individual Innovation (based on Farr, Sin, & Tesluk, 2003)