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A Lifespan Perspective on Creativity and Innovation at Work

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ABSTRACT

In this review, we address the relationship of aging with creativity and innovation at work. Organizing our review around the triad of person, environment, and behavior, we first discuss relevant theories and empirical findings from the creativity/innovation and aging literatures, and then review meta-analytical and primary studies on the aging-creativity/innovation relationship. In contrast to prevalent age stereotypes, we show that the empirical literature does not support direct, zero-order relationships, but that more complex (moderated, indirect, and curvilinear) relationships are highly plausible. We illustrate this point with a discussion of research on aging and scientific creativity. Finally, we outline opportunities for future research, both methodological and conceptual.

Every biography of a creative person tries to explain the achievements of its subject in light of a more or less implicit dynamic theory of lifespan development.

(Nakamura & Csikszentmihalyi, 2003, p. 186)

Workforce aging and the innovation imperative are two trends that will have a fundamental impact on employees and organizations over the next decades. On the one hand, the average age of the workforce is rising, and older employees are increasingly encouraged to remain employed as long as possible to reduce government spending and boost productivity. At the same time, organizations are now competing in a global “war for talent” to attract and retain members of the shrinking cohort of young and highly qualified employees. Consequently, research on the role of age in the workplace and the role of work in successful aging is rapidly growing (Truxillo, Cadiz, & Hammer, 2015; Zacher, 2015). On the other hand, due to economic, technological, social, and demographic changes, employee creativity and innovation have become more and more important for organizational performance, growth, and survival (Audretsch, 1995; Rosenbusch, Brinckmann, & Bausch, 2011).

Despite the significant consequences of workforce aging and employee creativity and innovation for organizations, and despite early calls to examine relationships between age and creativity at work (Shearring, 1992), there is a striking lack of studies on this topic (Rietzschel & Zacher, 2015). There is a great need to better understand the associations of age with creativity and innovation, particularly in light of prevalent age stereotypes suggesting that older employees are less creative and innovative than young employees (Binnewies, Ohly, & Niessen, 2008; Ng & Feldman, 2012). The main goals of this article,

therefore, are (a) to review and critically discuss the literature on aging, creativity, and innovation at work, and (b) to outline directions for future research. To this end, we first introduce the topic of creativity by outlining basic concepts, themes, and theories. In doing so, we also address the relation between creativity and innovation, and some of the challenges in moving from one to the other. Second, we describe several perspectives on aging and lifespan development in relation to creativity and innovation at work, such as age-related changes in individual characteristics and behaviors that may contribute to creativity and innovation, as well as prevalent stereotypes of both young and older workers and other contextual facilitators and constraints of creativity and innovation. Third, we integrate these topics in a review of empirical research on relationships of age with creativity and innovation at work, and discuss the specific case of scientific creativity as an illustration of research in this area. Finally, in the discussion, we offer a methodological critique of the existing literature and outline several suggestions for future research.

The main tenet of this article is that studying the relations of aging with creativity and innovation at work requires an *interactionist* or *triadic* approach, with attention for the complex, interactive, and bidirectional relations between personal characteristics of employees, their environment, and their behavior (e.g., Bandura, 1989; Lewin, 1939; Robinson-Morral, Reiter-Palmon, & Kaufman, 2013; Woodman, Sawyer, & Griffin, 1993). We argue that it is essential to go beyond questions such as “are older employees less creative than their young colleagues?” because such questions do not take into account the complexity of reality.

For one thing, age, other individual characteristics (such as abilities, personality, and motives), and contextual factors (such as work characteristics, climate, and interpersonal relations) may not influence creativity and innovation independently, but interactively: the effects

of one factor may be moderated by other factors (Robinson-Morral et al., 2013; Woodman et al., 1993). In other words, whether or not certain employees (such as young or older employees) show more or less creative and innovative behavior than others will depend not only on their personal characteristics but also the context they are working in, and whether or not certain contexts are conducive to creativity or innovation will depend on the characteristics (including age) of the persons working within those contexts.

Moreover, the relations between person, context, and behavior are not only interactive, but in many cases also bidirectional. Bandura's (1989) theory of reciprocal determinism states that individual characteristics and the environment both *influence and are influenced* by a person's behavior, and each other. Thus, the degree to which workers of different ages are creative in the workplace is a function of their (age-related) individual characteristics and their environment, but their creative performance can, in turn, also shape their characteristics and aspects of the environment. For example, an employee's sense of creative self-efficacy (a person factor) will likely affect his or her creative performance, and this behavior will also influence the employee's sense of self-efficacy. Similarly, the feedback or monitoring behavior on part of a supervisor (an environment factor) may affect an employee's creative or innovative performance, and this behavior will likely also shape the supervisor's future feedback and monitoring behavior (e.g., because the supervisor feels that the employee requires more extensive feedback).

In this article, we use the triad of person, environment, and behavior as an overarching organizing principle, allowing us to first review and discuss relevant research on each of these factors separately, and to subsequently address their interrelations. The model in Figure 1 illustrates specific person and contextual variables that we propose to be linked to both age and creative and innovative work behavior, and that we will discuss in this paper. In brief, the model suggests that aging impacts on certain person and contextual characteristics which, in turn, influence—and are influenced by—creative and innovative behavior by themselves or in combination. Moreover, age may also moderate the effects of certain person and contextual characteristics

on creative and innovative behavior, such that these characteristics may be more or less important for young or older employees' behavior.

Although we use the terms “young employees” and “older employees” consistently throughout this article, age is a continuous variable, and therefore there is no clear cut-off for the distinction between “young” and “older” employees. Thus, consistent with the lifespan literature, we focus on the entire working lifespan (roughly between 18 and 65 years, but in some individual cases also starting earlier or ending later) and use the labels “young employees” and “older employees” for descriptive purposes only. For instance, a positive association between age and experiential knowledge could also be interpreted as older employees possessing greater knowledge than young employees.

AN OVERVIEW OF CREATIVITY AND INNOVATION AT WORK

In this section, we introduce the topic of creativity and innovation at work. First, we address the definitions of our core constructs, followed by an overview of some important and relevant themes within the research literature. This overview aims to set the stage for the theoretical and empirical work on aging that will be discussed subsequently. Table 1 provides a summary of the research on age, creativity, and innovative behavior at work that we review, as well as propositions on potential effects of aging on creativity and innovative behavior at work.

Defining Creativity at Work

Creativity at work is, first and foremost, a form of job performance, and as such is highly valued by most organizations (Gilson, 2007; Welbourne, Johnson, & Erez, 1998). Depending on the nature of the job, creativity could constitute *in-role* performance (i.e., be part of the regular job duties) or *extra-role* performance (i.e., job-related behaviors that the employee displays over and above the regular job duties; e.g., Organ, 1977, 1988). For example, for a scientist, being creative is explicitly part of the job description; it would not be possible to do the job well without contributing at least some original work to the field. In contrast, a construction worker is not usually required to come

Figure 1. Lifespan perspective on creative and innovative behavior at work.

Table 1. Summary of Research on Age, Creativity, and Innovative Behavior at Work

Domain	Links to Creativity and Innovation at Work	Links to Aging and Development Across the Working Lifespan	Suggested Effects of Aging on Creativity and Innovation at Work
<i>Person characteristics</i>			
Cognitive abilities	Fluid and crystallized cognitive abilities positively predict creativity and innovation (fluid more strongly for creativity; crystallized more strongly for innovation).	Some fluid cognitive abilities and working memory decline across the working lifespan; crystallized abilities increase with age.	Negative relation of aging with creative behavior (<i>Proposition 1</i>); crystallized abilities may moderate (i.e., weaken) some of the negative effects of changes in fluid abilities (<i>Proposition 2</i>). Positive relation of aging with innovative behaviors (<i>Proposition 3</i>).
Personality characteristics	Openness to experience predicts creativity; conscientiousness, extraversion, and emotional stability should predict innovation (specifically, selling and implementation of ideas).	Openness decreases at higher ages, whereas conscientiousness, agreeableness, and social dominance increase with age.	Declines in openness suggest a negative relation between aging and creativity (<i>Proposition 4</i>); increases in conscientiousness, extraversion, and emotional stability suggest a positive relation between aging and innovative behaviors (<i>Proposition 5</i>).
Motivation	Motivation is positively related to creative/innovative behavior, particularly intrinsic motivation.	Work motivation (e.g., intrinsic motivation, job involvement) and generativity motivation increase across the working lifespan.	Increases in work and generativity motivation with age suggest a positive effect of aging on creative/innovative behavior (<i>Proposition 6</i>).
Self-efficacy	Creative self-efficacy positively predicts creativity at work, over and above more general job self-efficacy.	Self-efficacy beliefs increase across the working lifespan (but may decrease at the end of working life).	Positive relation between age and creativity/innovation (<i>Proposition 7</i>).
Affect	Positive affect relates positively to creativity, particularly after experiencing negative affect.	Older workers seek and experience more positive affect than young workers.	Age-related increases in positive affect suggest a positive relation between age and creativity/innovation (<i>Proposition 8</i>).
Self-regulation	Approach (vs. avoidance) goals and a promotion (vs. prevention) focus relate positively to creativity.	Use of selection, optimization, and compensation strategies is particularly effective at higher ages; use of primary and secondary control strategies increases with age.	Increased use and effectiveness of self-regulation strategies with age suggest positive effects on creative and innovative behavior (<i>Proposition 9</i>).
<i>Contextual characteristics</i>			
Team collaboration and diversity	Collaboration is potentially useful for creativity (i.e., exchange of ideas), but other factors (i.e., social comparisons?) may mitigate its effects. Age diversity can diminish effective information exchange and processing, and thus creative and innovative behavior; its effects may be buffered by positive diversity beliefs in teams.	Age stereotypes hold that young employees are creative, innovative, and tech savvy; older employees are typically seen as less creative, innovative, and open to change than young employees. Stereotype threat may exacerbate negative effects of age stereotypes.	Increased negative age stereotypes (and stereotype threat) regarding creativity and innovation with age suggest negative effects of aging on creative and innovative behavior (<i>Proposition 10</i>).

Table 1. *Continued*

Domain	Links to Creativity and Innovation at Work	Links to Aging and Development Across the Working Lifespan	Suggested Effects of Aging on Creativity and Innovation at Work
Climate	Climate for innovation relates positively to creative and innovative behavior.	Members of teams and organizations might share negative age climates for young and/or older employees.	There is currently no evidence suggesting that teams and organizations hold more negative age climates regarding older workers' creativity compared to young workers (<i>no proposition offered</i>).
Work characteristics	Job autonomy, complexity, and support for creativity and innovation relate positively to creative and innovative behavior, but not for all employees.	Age is positively related to perceptions of job autonomy and negatively related to perceptions of job stressors.	Increased positive perceptions of the work environment suggest a positive effect of aging on creative and innovative behavior (<i>Proposition 11</i>).
Social networks	The size and quality of social networks relates positively to creative and innovative behavior.	Socioemotional selectivity theory suggests that young people have larger networks, whereas older people focus more on the socioemotional quality of their smaller networks. Older employees are more likely to have built up extensive networks of work-related contacts.	Effects of aging could be positive or negative, as both size and quality of networks seem to matter (<i>no proposition offered</i>).

up with creative ideas, although they may certainly be appreciated and implemented. For example, the worker may notice a novel opportunity to further enhance safety or efficiency at the construction site.

Creativity is commonly defined as the ability to produce work that is both novel and useful (or appropriate) in a given domain (e.g., Amabile, 1996; Sternberg & Lubart, 1999). Thus, creativity requires the generation and expression of ideas that are somehow new, original, or surprising (at least within the context in which they are generated and expressed), but also feasible, practical, or sensible. While this definition is context-independent, and hence could be applied equally well to creativity at work and to creativity displayed in nonwork settings, *organizational creativity* has been defined as “the creation of a valuable, useful new product, service, idea, procedure, or process by individuals working together in a complex social system” (Woodman et al., 1993, p. 293). Given that organizational creativity can occur on several levels (individual creative behavior, team creativity, and organizational creative or innovative performance), in this article, we will use the term “creativity at work” when we refer to individual employees’ creative behaviors in the organizational context.

Defining Innovation

Although creativity is often mentioned together with the concept of innovation, especially in the context of organizations, they are not the same. *Innovation* is defined as “the intentional introduction and application within a job, work team or organization of ideas, processes, products or procedures which are new to that job, work team or organization and which are designed to benefit the job, the work team or the organization” (West & Farr, 1990, p. 9). Thus, whereas creativity is about the generation of ideas, innovation is about implementing these ideas in practice. Although both creativity and innovation have been studied extensively, the psychology literature has focused mainly on

micro-level creativity (mostly looking at the individual and team level), whereas innovation tends to be studied more (but not exclusively) by business scholars from a meso- or macro-level perspective, at the organizational, industry, and societal levels. Our theoretical framework focuses more strongly on creativity than on innovation, but we will discuss empirical results and practical implications with regard to both.

Perspectives on Creativity

Creativity is studied from a broad variety of theoretical perspectives, both within and outside of the work and organizational context. Originally, the study of creativity had a strong emphasis on the person perspective (rather than environment or behavior). One of the goals was to identify and reliably measure the characteristics (traits, abilities) of those individuals capable of highly creative thought and behavior (Guilford, 1950). A common view was that creative ability is something that only few people possess, and that true creative performance can only be displayed by a small minority of people (see also Sternberg & Lubart, 1999). This would imply that any interventions aimed at stimulating creativity should be geared towards this small minority and would not be especially relevant to the rest of the population or workforce. In contrast, creativity researchers now generally endorse Guilford's (1950) *continuity principle*, which states that the difference between creative and less creative individuals is gradual, rather than fundamental. Nevertheless, there are substantial differences between people in terms of creative performance or the ease with which such performance is attained. A distinction is often made between *Big-C* creativity (eminent and extraordinary creative achievements, e.g., a scientific breakthrough) and *little-c* creativity (more ordinary, every-day creative achievements; e.g., performance in an amateur music ensemble; Csikszentmihalyi, 1997). Kaufman and Beghetto (2009) extended this division into a four-C Model by adding *mini-c* creativity (individual creative insights

and experiences, e.g., during a learning process) and *pro-C* creativity (creativity at an advanced, professional level, such as creative performance at work, that is not at the unique level of big-C creativity).

Kaufman and Beghetto's (2009) four-C model takes an explicitly *developmental* perspective; that is, people are thought to be able to move from one level of creative achievement (such as mini-c) to another level (such as pro-C) through specific trajectories (e.g., by formal training). The model does not explicitly address the issue of aging, but it does, tentatively, distinguish between different stages that might follow after having attained pro-C creativity: people might achieve greatness in their field and perhaps even move on to Big-C achievements, or they might end up in *stasis*: "In the academic field, for example, there are some professors who reach tenure and keep achieving and striving for new and different ideas and studies—but there are other professors who may reach tenure and, in effect, mentally retire" (Kaufman & Beghetto, 2009, p. 8). Thus, the four-C model recognizes that people at an advanced career stage may still develop different levels of creativity—in other words, older creators are not necessarily doomed to stasis.

All in all, it is not the case that some people are creative and others are not, nor is it the case that certain groups of employees (e.g., older employees) are generally "uncreative." Below, after describing important dimensions of creativity and its link with innovation, we will discuss several factors that have been found to relate to creativity. Providing a comprehensive summary of all relevant factors is beyond the scope of our article; instead, we focus on those factors that are considered most important within the field of creativity at work and that have links with the aging process (for a summary and propositions, see Table 1).

Creative Behavior

Dimensions of creative behavior

Creativity at work is a complex construct, encompassing many behaviors, and hence is operationalized in several ways. In organizational studies, supervisory ratings of creative (and sometimes, innovative) job performance are often used. Supervisors are asked to indicate how often an employee shows specific behaviors (such as coming up with novel and useful ideas, or trying to get support for these ideas; e.g., George & Zhou, 2001; Madjar, Oldham, & Pratt, 2002). Other measures of creativity or innovation are, for example, the number of patent disclosures or contributions to an internal suggestions program (Frese, Teng, & Wijnen, 1999; Oldham & Cummings, 1996), while the historiometric method (see e.g., Simonton, 1997, 2004, 2009) is based on the study of existing creative output, such as that produced over the careers of eminent or less eminent creators.

Experimental lab-based studies use different operationalizations, allowing for more process-based work in analyzing the ideas people produce in trying to solve a problem (e.g., when brainstorming). Following early recommendations (Guilford, 1950) and more recent empirical developments (e.g., Amabile, 1996; Stroebe, Nijstad, & Rietzschel, 2010), creativity researchers often distinguish between outcomes such as *fluency* (or productivity: the total number of non-redundant ideas that a person or work group produces), *idea quality* (such as originality and feasibility), *diversity* (the degree to which the ideas put forward tap into a broad range of semantic categories), and—more recently—*within-category fluency* (or *depth*, the degree to which people generate multiple ideas within the same semantic category). Although these different outcome measures are sometimes

positively correlated (e.g., Stroebe et al., 2010), they need not be, since they reflect different aspects of the creative process (e.g., De Dreu, Baas, & Nijstad, 2008; Nijstad, De Dreu, Rietzschel, & Baas, 2010). For example, an employee might show high creative fluency, but low originality, if he or she simply puts forward every mundane and run-of-the-mill idea that occurs to him or her, without wondering whether these ideas are worth mentioning at all. Another example of the importance of distinguishing between different operationalizations comes from Jauk, Benedek, Dunst, and Neubauer (2013), who suggested that the threshold for the relation between cognitive ability and creative behavior may depend on the specific form of the criterion: the more demanding the criterion, the higher the threshold should be. In their study, they found that this threshold was 86.09 IQ points for ideational fluency (disregarding idea quality), 104 for ideational originality (generating at least two highly original ideas), and about 119.6 for a more demanding measure of originality (generating many highly original ideas). Real-life creative achievements, however, showed no threshold at all, suggesting that "intelligence fosters creative achievement across the whole range of intellectual ability" (p. 219).

From creativity to innovation

One topic that has received extensive attention in recent years is the complex relation between creativity and innovation (e.g., Grant, 2016; West, 2002). As explained above, creativity can be understood as the generation of ideas, whereas innovation entails their implementation. Creativity, then, is a necessary condition for innovation to occur, but it is not a sufficient condition: creativity does not automatically carry over into innovation. For example, brainstorming groups and individuals are not very good at selecting their best ideas (e.g., Faure, 2004; Putman & Paulus, 2009; Rietzschel, Nijstad, & Stroebe, 2006, 2010), team creativity does not necessarily lead to team innovation (Somech & Drach-Zahavy, 2013), people who say they value creativity can still display an unconscious bias against creativity (Mueller, Melwani, & Goncalo, 2012), and creative ideas may actually be at a disadvantage (as compared with less creative ideas) when it comes to implementation (Baer, 2012). Thus, one of the major challenges in stimulating innovation lies not so much in stimulating the generation of ideas as in overcoming people's resistance to the selection and implementation of truly creative ideas (Baer, 2012; Mueller, Wakslak, & Krishnan, 2014; Mueller et al., 2012; Rietzschel, Nijstad, & Stroebe, 2010; West, 2002). For example, Baer (2012) found that employees were better at getting their creative ideas implemented when they had strong networking skills and a high number of buy-in ties (i.e., strong network ties with others whose support would be instrumental for their innovative efforts). Somech and Drach-Zahavy (2013) found that teams composed of members with a creative personality and with high functional heterogeneity were more creative, but this only translated into implementation of ideas when the team had a favorable climate for innovation. Nevertheless, innovation inevitably starts with the generation and contribution of creative ideas, and much of our theoretical framework will focus on this.

As we will see, issues surrounding aging not only relate to young and older employees' creative abilities (i.e., are they able to come up with creative ideas?), but also raise some interesting questions with regard to innovation (e.g., are they able to recognize creative ideas or convince others of the value of these ideas?).

Person Predictors of Creativity

Cognitive abilities

General cognitive ability is the strongest single-order predictor of work performance, because it involves information processing, learning, and problem-solving abilities (Schmitt, 2014), and as such might be expected to strongly relate to creative job performance as well. However, the literature does not unequivocally show a linear zero-order relation between cognitive ability and creativity (e.g., Furnham, 2008). A more sophisticated approach to the cognitive ability-creativity relation is put forward by threshold theory (Guilford, 1967), which states that cognitive ability contributes to creativity up to a certain point, but that above that threshold, other characteristics (such as personality, experience, or specific creativity-relevant skills) become more important. Jauk and colleagues (2013) argue that the threshold for the cognitive ability-creativity relationship further depends on the way creativity is measured, with less demanding criteria (e.g., ideational fluency disregarding idea quality—see above) having a lower threshold.

An important distinction has been made between fluid and crystallized cognitive abilities (Cattell, 1943). Whereas *fluid cognitive ability* is assumed to reflect the neuro-physiological hardware of the brain involving the speed and accuracy of processes such as attention, visual motor memory, and discrimination, *crystallized cognitive ability* reflects mainly learned abilities and knowledge (e.g., reading, writing, language comprehension, job-relevant expertise). Of the two, fluid cognitive ability is most obviously related to creativity: fluid abilities are measured with tests of novel problem-solving and reasoning, which are at least partly what creativity is about (e.g., Nusbaum & Silvia, 2011). Crystallized abilities, in turn, mainly reflect acquired knowledge and skills, such as job-related expertise, that might be more strongly related to conventional and routine performance than to creativity (although they might be positively linked to innovation; Ng & Feldman, 2013b). However, people can learn to be more creative, particularly through learning specific techniques and behaviors (e.g., Scott, Leritz, & Mumford, 2004), suggesting that crystallized abilities could relate to creative performance as well.

Another issue that relates to cognitive ability concerns people's ability to control, monitor, and maintain the contents of *working memory* (e.g., Baddeley, 1996; Baddeley, 1986). Despite the name, working memory capacity is not exclusively a matter of storage, but also of executive control. Thus, people have higher working memory capacity to the extent that they are better able to preserve information in consciousness and to monitor and coordinate their cognitive activities. As such, working memory is closely related to fluid cognitive ability, or could even be considered a part of it (Colom, Rebollo, Palacios, Juan-Espinosa, & Kyllonen, 2004; Kyllonen & Christal, 1990). Working memory capacity has also been linked to creative performance (Benedek, Jauk, Sommer, Arendasy, & Neubauer, 2014; De Dreu, Nijstad, Baas, Wolsink, & Roskes, 2012; Lee & Theriault, 2013), especially the executive control component. De Dreu and colleagues (2012) argue that working memory capacity predicts the degree to which people are able to devote persistent and focused effort to a creative task, which might be especially relevant when it comes to work-related creativity (cf. Amabile, 1996).

As we will show later on, age-related changes in cognitive abilities have been studied extensively, and one of the most common stereotypes about older employees is that they no longer have the cognitive

resources (such as working memory capacity) to perform optimally; however, we will also see that this view is incomplete at best.

Personality

A second important area of person-oriented research on creativity revolves around the personality characteristics that contribute to creative performance. In terms of the five factor model of personality, openness to experience emerges as the most consistent predictor of creativity (e.g., Feist, 1998; Furnham, 1999; McRae, 1987). Openness is defined as the degree to which people are curious, explorative, interested in new ideas and experiences, and open to new perspectives. Thus, people who score high on openness are more likely to search for new solutions for problems, to try out new opportunities, and to be open to novel and unconventional ideas—and hence to be more creative. Further, creative individuals tend to be autonomous and individualistic (e.g., Feist, 1998; Goncalo & Staw, 2006). The contribution and implementation of creative ideas is likely to lead to a certain amount of criticism or even conflict (Janssen, 2003), so people who are able to deal with (or ignore) such criticism are probably in a better position to perform creatively in organizations. Although personality has long been seen as stable, recent work on personality takes a more developmental perspective, showing how aging can relate to changes in personality traits—and hence to behaviors that are related to these traits, such as creativity (e.g., Roberts, Walton, & Viechtbauer, 2006).

Motivation

Besides cognitive abilities and personality, motivation arguably is the most important predictor of performance in any domain, and creativity is no exception. Most of the research in this area has revolved, directly or indirectly, around the role of intrinsic and extrinsic motivation (e.g., Amabile, 1996; Byron & Khazanchi, 2012; Eisenberger & Rhoades, 2001). *Intrinsic motivation* is defined as the motivation to engage in a task for its own sake, because one enjoys it; *extrinsic motivation*, on the other hand, is defined as the motivation to engage in a task in order to attain or avoid a certain outcome (such as rewards or punishments). Many studies have addressed the role of motivation for creativity and have found that intrinsic motivation is generally positively related to creative performance (see Byron & Khazanchi, 2012, for a meta-analysis). Extrinsic motivation, on the other hand, is often thought to be detrimental to creativity because it will decrease intrinsic motivation, will detract from autonomy, and will focus people's efforts on performance that is most likely to meet with approval or a positive evaluation (Amabile, 1996; Shalley & Perry-Smith, 2001; Shalley & Zhou, 2008). However, the issue is somewhat more complex. What appears to be important is not so much whether people are working for a reward, but rather the degree to which these rewards (and other extrinsic motivators) make people feel controlled by external factors—when this is the case, intrinsic motivation and, in turn, creative performance, indeed suffer. Thus, one thing that is particularly important is *reward contingency* (Byron & Khazanchi, 2012; Eisenberger & Cameron, 1996; Eisenberger & Rhoades, 2001): when people are rewarded for creative performance, this stimulates creative performance. When people are rewarded for “performance” or simply for doing a task, however, creativity is not stimulated and is even likely to be inhibited.

Although the debate on intrinsic and extrinsic motivation has dominated much of the literature on creativity and motivation, motivation

in the broader sense of the word is important as well—in all domains, people must be willing (and able) to invest directed effort in order to perform at a high level, and creativity is no exception to this rule. Thus, when people are not willing to invest effort in creative performance and mentally disengage from a creative task, for example, because they feel that their efforts are dispensable (e.g., Diehl & Stroebe, 1987), or that their input is not valued (e.g., Shalley & Zhou, 2008), creative performance is likely to drop.

As we will see later on, research suggests that aging is associated with a shift in work-related motives, making the issue of motivation especially relevant to a lifespan perspective on creativity and innovation.

Self-efficacy

One construct that has been studied extensively in the domain of motivation and performance is self-efficacy. Self-efficacy refers to the degree to which people feel that they are able to attain their goals, even in the face of obstacles or difficulties. Bandura (1977, 1986) emphasized the role of self-efficacy in goal pursuit and task performance, and many studies have borne out its importance (see e.g., Sadri & Robertson, 1993; Stajkovic & Luthans 1998, for meta-analyses). Self-efficacy has also been stated and found to be important when it comes to creative and innovative behavior. For example, following up on Ford's (1996) model of creative action, which contains people's "capability beliefs" as one important class of facilitators for creative action, Tierney and Farmer (2002) studied the effects of creative self-efficacy in an organizational setting and found that it predicted creativity over and above the effects of job self-efficacy. Adopting a multilevel perspective, Richter, Hirst, Van Knippenberg, and Baer (2012) found that employees with higher creative self-efficacy were more creative, but especially when they worked in teams with high functional diversity and team members had considerable shared knowledge of the distributed expertise in the team. Further, and especially relevant to the current article, Tierney and Farmer (2011) addressed the development of employees' creative self-efficacy, showing that beliefs about one's creative capacities are malleable and related to such factors as creative role identity and supervisory expectations of creativity—in other words, employees tended to develop stronger creative self-efficacy beliefs when creativity was a salient part of their identity and when they were aware that their supervisor expected them to perform creatively.

Given the importance of creative self-efficacy for creative performance, the question arises how this might relate to aging. One possibility is that, as employees get older, they develop a stronger sense of self-efficacy (because they accumulate task-relevant knowledge and expertise), including creative self-efficacy. Then again, aging employees may experience a decline (real or perceived) in abilities, and may become more aware of the limitations of their personal control. In line with these contradictory notions, Lachman, Teshale, and Agrigoroaei (2015) suggest that the development of people's sense of control may follow an inverted U-shaped trajectory across the lifespan (with a peak in middle-age—that is, between 40 and 60 years), which might hold for self-efficacy beliefs as well (see also Heckhausen, Wrosch, & Schulz, 2010). Further, contextual factors might play an important role: for example, if supervisors tend to expect less creativity from their older subordinates (see the section on age stereotypes below), this could

inhibit the development of creative self-efficacy beliefs, with lower creative performance as a result.

Affect

It was commonly thought that positive affect stimulates creativity, because it would broaden attentional focus and stimulate cognitive flexibility (e.g., Isen, Daubman, & Nowicki, 1987), whereas negative affect was thought to decrease creativity, because it would lead to a narrow attentional focus and decreased flexibility (e.g., Carnevale & Probst, 1998). However, more recent research suggests that this view is too simple, because there is more to affect than valence, and there is more to creativity than flexibility. For example, De Dreu and colleagues (2008; also see Gable & Harmon-Jones, 2010a, 2010b) argue that the effects of affective states on creative performance also depend on the degree to which they are cognitively *activating* or *deactivating* (cf. Posner, Russell, & Peterson, 2005). The dual pathway to creativity model (De Dreu et al., 2008) states that positive, activating mood states (such as happiness) stimulate creativity through enhanced cognitive flexibility, that is, the ability to generate ideas in multiple semantic categories, and to easily link ideas or knowledge in a variety of domains. In contrast, negative activating mood states (such as anger) can stimulate creativity through enhanced *persistence*, or focused and sustained cognitive effort resulting in "deeper" idea generation (i.e., more ideas *within* semantic categories). Both can lead to higher creative output (such as fluency or originality), but persistence does require more cognitive effort and hence is more depleting (Roskes, De Dreu, & Nijstad, 2012).

Self-regulation

Although creativity is sometimes thought to be mostly spontaneous, it often is goal-directed and can be stimulated by clear creativity goals (Litchfield, Fan, & Brown, 2011; Shalley, 1991). This implies that people's strategic inclinations regarding goal pursuit and processes of self-regulation are also relevant to creative performance. One basic issue that has been found to relate to creative behavior is the distinction between *approach* and *avoidance* tendencies (e.g., Friedman & Förster, 2002; Elliot, Maier, Binser, Friedman, & Pekrun, 2009): are people primarily motivated to strive toward positive outcomes, or away from negative outcomes? The strength of people's approach and avoidance tendencies has been linked to a variety of outcomes, including creative performance: all other things being equal, approach motivation tends to be more favorable for creative performance than avoidance motivation (Elliot et al., 2009; Friedman & Förster, 2002, 2005; but also see Roskes et al., 2012). Another important topic in the domain of self-regulation is Higgins' (1997) regulatory focus theory. This theory distinguishes between a *promotion focus*, characterized by a risky and eager approach strategy, aimed at maximizing hits and gains, and a *prevention focus*, characterized by a risk-averse processing style, mainly concerned with avoiding mistakes and attaining security. Regulatory focus has been repeatedly found to relate to creative and innovative performance (e.g., Friedman & Förster, 2001; Rietzschel, 2011) and related behaviors such as risk-taking (Crowe & Higgins, 1997). Self-regulation is important in a lifespan context, not only because people's goals and goal-related behavioral tendencies change with age, but also because self-regulation issues are relevant to the issue of age stereotypes and their potentially devastating consequences.

Contextual Predictors of Creativity

Team collaboration and diversity

Many of the environmental factors that have been studied most extensively in the context of creativity revolve around group or team work. Teamwork has several potential advantages: if a team is composed of coworkers with different knowledge, experience, preferences, or opinions, this could stimulate the team's idea generation and decision-making processes (Paulus & Nijstad, 2003). Being exposed to ideas generated by others can indeed stimulate ideational output (Dugosh & Paulus, 2005; Nijstad, Stroebe, & Lodewijckx, 2002), and group creativity and decision-making can benefit from minority opinions and possibly even conflict (Nemeth, Brown, & Rogers, 2001). Thus, there is a clear creative potential in teamwork. However, groups and teams often perform below their creative potential, in terms of creativity and decision-making (e.g., Chirumbolo et al., 2004; Diehl & Stroebe, 1987; Paulus, 2008; Paulus & Nijstad, 2003; Stasser & Titus, 1985, 2003; Stroebe et al., 2010); the challenge seems to be getting groups to reap the benefits of their available resources, such as cognitive diversity (e.g., Van Knippenberg, De Dreu, & Homan, 2004).

Even though diversity is inevitable and often thought to be desirable, teams have difficulty dealing with it effectively, especially when there is *demographic* diversity, also called surface-level diversity (e.g., age, ethnic, or gender diversity). Surface-level diversity can easily give rise to subgroup formation and conflict; moreover, this can in turn diminish effective information exchange and processing, and hence decrease the workgroup's creative output and performance (Van Knippenberg & Schippers, 2007). One aspect that seems to be important is the way in which group members perceive and think about diversity: if group members hold positive *diversity beliefs* (i.e., think that diversity is valuable and has the potential to enhance group performance), they will utilize the diverse knowledge and experience better, and attain higher levels of creative performance, than groups that do not hold positive diversity beliefs (e.g., Homan, Greer, Jehn, & Koning, 2010; Nakui, Paulus, & Van der Zee, 2011).

In the presence of older employees within a generally young team (or vice versa, the presence of young workers within a generally older team) this age diversity could easily become problematic for the team's creative performance, unless the team members hold positive beliefs about the creative potential inherent in age diversity—e.g., if the team members do not hold age stereotypes and believe that the team can benefit from their young or older colleagues' knowledge, skills, and abilities. Thus, the way people perceive members of different age groups, and the beliefs they have about what these can contribute to a team's creative and innovative performance, will shape the relation between team member age and team creativity and innovation.

Work climate

One particularly important precondition for creativity and innovation at work appears to be the existence of a favorable team and organizational climate. *Climate* has been defined as “the shared perception of the way things are done” within a team or organization (Schneider, 1990), and can refer to several dimensions of collective functioning, such as safety (Zohar, 1980), errors (Van Dyck, Frese, Baer, & Sonnentag, 2005), regulatory focus (Rietzschel, 2011), or creativity and innovation (Anderson & West, 1996; Anderson & West, 1998; Ekvall, 1996). Anderson and West's (1996); Anderson and

West's (1998) team climate for innovation model has been particularly influential; it encompasses four dimensions: *vision* (a clear goal that all team members subscribe to), *participative safety* (a sense that one's input, opinions or ideas are welcome), *task orientation* (a strong commitment to excellent performance), and *support for innovation* (searching for creative improvements and actively supporting creative input). Research has shown that team climate for innovation indeed predicts team creativity and innovation (e.g., Anderson & West, 1996; Anderson & West, 1998; Hülsheger, Anderson, & Salgado, 2009). As mentioned before, Somech and Drach-Zahavy (2013) found that the presence of a favorable climate was crucial in enabling teams to turn their creativity into actual innovation. A different take on team climate was reported by Rietzschel (2011), who measured teams' collective regulatory focus. Results showed that a promotion climate positively predicted idea generation and idea promotion within teams, but not idea implementation.

The issue of climate could be especially relevant in the context of aging at work for several reasons. As we will see, as employees get older, their orientation toward their social environment changes, and they begin to attach less weight to instrumental and knowledge-related goals and more weight to positive and meaningful relations with their coworkers (e.g., Kooij, De Lange, Jansen, Kanfer, & Dijkers, 2011). This might make the presence of a favorable social team climate particularly important for older employees. However, both young and older employees might also be at risk of falling victim to an unfavorable *organizational age climate* for their age group, that is, shared negative beliefs and stereotypes about either young or older employees in the organization (Kunze, Böhm, & Bruch, 2011; Zacher & Gielnik, 2014).

Work characteristics

Employee creativity generally appears to be enhanced by work characteristics that bring about creativity-relevant states, such as a sense of autonomy and intrinsic motivation, or that stimulate the expression of creativity-relevant traits, such as openness to experience or a promotion focus. Employee creativity has been found to relate positively to work characteristics such as autonomy, job complexity, and organizational or supervisor support for creativity (e.g., Baer & Oldham, 2006; Hammond, Neff, Farr, Schwall, & Zhao, 2011; Joo, Yang & McLean, 2014; Mathisen, 2011; Oldham & Cummings, 1996; see Shalley & Zhou, 2008, for an overview). This is partly due to the motivating potential of such jobs conditions: employees who work in complex, autonomous jobs where they feel supported are more likely to be intrinsically motivated for their work and will be more likely to display creative behavior as a result. As we will see, some of these work characteristics, and the way employees relate to them, tend to change with age.

Other research also emphasizes the importance of taking individual differences (e.g., in growth need strength or in personal need for structure) into account when studying the relation between work characteristics (such as job complexity or organizational support) and work outcomes such as intrinsic motivation and creativity (e.g., Baer & Oldham, 2006; Oldham & Hackman, 2005; Rietzschel, Slijkhuis, & Van Yperen, 2014; Shalley, Gilson, & Blum, 2009; Slijkhuis, Rietzschel, & Van Yperen, 2013). Given that job complexity or job autonomy are not equally conducive to creativity for every employee, it is possible that moderating effects of age exist as well (e.g., Gould, 1979; Kemp & Cook, 1983).

Social networks

Even outside of the team context, creativity and innovation at work rarely are purely individual endeavors. One social aspect that has been found to contribute to individual employee creativity is an employee's social network: the interpersonal ties that an employee may have with others within and outside of the organization (Perry-Smith, 2006; Perry-Smith & Shalley, 2003). Such social networks can be a source of knowledge and novel perspectives, especially when ties are relatively weak, as these are more likely to represent unique, nonredundant ties, and hence have more informational value than stronger ties that may only provide an employee with information that is already available through other channels (Baer, 2010; Granovetter, 1973; Perry-Smith, 2006). Thus, social networks have the potential to contribute to the generation of new ideas, but—in line with the above-mentioned notion of bi-directionality—an employee's creativity can also affect his or her position in the social network (Perry-Smith & Shalley, 2003).

Social networks are also highly relevant from a lifespan developmental perspective. Given that older employees typically have had a longer tenure in their job or organization, it could be assumed that they are more likely to have built up extensive social networks over the years compared to young employees who are just starting their careers. However, the lifespan theory of socioemotional selectivity (Carstensen, Isaacowitz, & Charles, 1999) suggests that young employees, who tend to prioritize instrumental and knowledge-related goals that maximize future outcomes, have broader social networks, yet they also have less intense ties with individual network members. In contrast, the theory argues that older employees, who tend to prioritize socioemotional goals due to their limited time perspective, have smaller networks with more intense (i.e., meaningful) personal connections.

PERSPECTIVES ON AGING AND LINKS WITH CREATIVITY AND INNOVATION

In this section, we describe perspectives on aging in the work context that match with the structure of the review of predictors of creativity and innovation in the previous section. First, we focus on age-related changes in person factors that are relevant for creativity and innovation, in particular cognitive abilities, personality, motivation, self-efficacy, affect, and self-regulation. Second, we outline age-related changes in relevant environment factors, in particular age stereotypes, work characteristics, and organizational climate. Table 1 summarizes the research on aging, creativity, and innovative behavior at work that we review, as well as propositions on potential effects of aging on creativity and innovative behavior that follow from our review.

Age-Related Changes in Person Factors

The lifespan developmental perspective provides a theoretical framework to investigate stability and change in individual characteristics, experiences, and behavior with age (Baltes, 1987; Baltes, Reese, & Lipsitt, 1980). One of the central assumptions of the lifespan perspective is that development is multidimensional and multidirectional, including patterns of growth, maintenance, and decline (as well as curvilinear patterns) in various person characteristics. In this section, we describe how factors that have been shown to predict employees'

creative behavior develop in multiple directions across the adult lifespan.

Cognitive abilities

The distinction between fluid and crystallized cognitive abilities has been adopted by lifespan theories of cognitive development (Baltes, Staudinger, & Lindenberger, 1999; Salthouse, 2012). There is considerable evidence that some cognitive abilities decline with age. However, the rate of decline appears to vary for different types of cognitive abilities, and the results are to some extent affected by methodological characteristics of studies. Evidence from cross-sectional studies suggests that, whereas crystallized intelligence increases until around the age of 60 years, and then only declines gradually, fluid intelligence begins to decline quite early, beginning around age 20 and possibly even accelerating with age (Salthouse, 2012). A meta-analysis of correlations between age and fluid cognitive abilities by Verhaeghen and Salthouse (1997) found a negative correlation for perceptual speed ($-.52$) and somewhat lower correlations for reasoning ($-.40$), spatial ability ($-.38$), and episodic memory ($-.33$). A limitation of this meta-analysis is that it included mostly cross-sectional studies, so the apparent age difference could also be attributable to cohort differences and selective drop-out effects.

Summarizing the findings of a major prospective study, which assessed cognitive abilities of more than 5,000 adults over a period of 35 years, Schaie (1994) concluded that "average age decrements in psychometric abilities cannot be reliably confirmed prior to age 60, except for word fluency, which shows a significant decline by age 53"—moreover, "this decrement is modest until the 80s are reached. ... Even at age 81, less than one half of all observed individuals showed reliable decrements over the preceding seven years" (p. 308). On the whole, then, some age-related declines in cognitive abilities do exist. However, they appear to be late in onset and relatively modest in magnitude (at least until people reach their 80s).

From an organizational perspective, the important question is whether age-related declines in cognitive abilities actually translate into decreases in work performance, and creative and innovative job performance in particular. The fact that the age-related decline is most pronounced for fluid intelligence would seem to place creativity more at risk than other aspects of job performance that rely more on crystallized intelligence and job experience, such as organizational citizenship behavior (Kanfer & Ackerman, 2004). Creativity research suggests that both fluid and crystallized cognitive abilities predict employee creativity and innovation (e.g., Batey, Chamorro-Premuzic, & Furnham, 2009; Nusbaum & Silvia, 2011), with fluid abilities probably having a stronger effect on creativity and crystallized abilities probably having a stronger effect on innovation-related behavior (e.g., idea implementation; Ng & Feldman, 2013b). Lifespan theories and findings would suggest that the generation of creative ideas is a strength of young and middle-aged adults (roughly between 40 and 60 years of age). Declines in fluid abilities should negatively impact on older adults' creativity (*Proposition 1*), unless they can compensate for it using crystallized cognitive abilities (such as a repertoire of creativity-relevant skills they may have developed over time) or by increasingly focusing on implementation of ideas rather than their generation (*Proposition 2*). In contrast, the lifespan literature suggests that innovation-related behaviors that require crystallized cognitive abilities should be strengths of middle-aged and older adults (*Proposition 3*).

Personality

While personality has for a long time been conceived of as temporally stable after the age of approximately 30 years, several contemporary theories focus on short- and longer-term temporal variability in personality characteristics due to biological processes and environmental factors (Roberts & Jackson, 2008; Roberts & Mroczek, 2008; Roberts & Wood, 2006). Several longitudinal studies suggest that conscientiousness, agreeableness, and social dominance (a facet of extraversion) increase across the adult lifespan, whereas neuroticism and openness to experience slightly decrease at higher ages (Lucas & Donnellan, 2011; Roberts et al., 2006; Soto & John, 2012). As mentioned above, openness to experience is a personality characteristic that is particularly important for creativity at work (Hammond et al., 2011). Openness declines slightly at higher ages and thus may negatively impact on older employees' creativity (Proposition 4). In contrast, conscientiousness, social dominance, and emotional stability (the reverse of neuroticism) slightly increase across the lifespan and may benefit innovation-related behavior (e.g., selling ideas, implementation) among older employees (Proposition 5).

Motivation

Meta-analyses suggest that overall work motivation and related job attitudes (e.g., intrinsic motivation, job involvement) are generally positively related to age (Ng & Feldman, 2010, 2013b). Moreover, meta-analytic evidence suggests that motives shift with age, such that older employees are more motivated than young employees by intrinsic factors such as need for autonomy and the motivation to use existing skills, whereas age is negatively related to extrinsic factors such as development/challenge, advancement/promotion, recognition, and compensation/benefits (Kooij et al., 2011). Moreover, based on Erikson's work on the stages of psychosocial development (e.g., Erikson, 1950), developmental researchers have suggested that middle-aged adults become increasingly interested in the *generativity* motive, which includes caring for the next generation and taking responsibility for others, but also being creative and productive to leave a lasting legacy for future generations (McAdams & de St. Aubin, 1992). These findings on increases in intrinsic and generative motivation with age suggest an advantage of older employees in terms of creativity and innovation at work (Proposition 6).

Self-efficacy

According to the motivational theory of lifespan development (Heckhausen et al., 2010), which integrates Heckhausen and Schulz's earlier theories of control and successful aging (Heckhausen & Schulz, 1995; Schulz & Heckhausen, 1996), boosting one's self-efficacy to deal with developmental challenges can be conceived as a secondary control strategy (i.e., adapting the self to age-related changes in internal resources and external demands). Moreover, the theory assumes that the use of these strategies gradually increases across the lifespan in order to compensate, in the second half of life, for losses in primary control strategies (i.e., the ability to modify the external environment according to one's needs and preferences; Heckhausen et al., 2010). Overall, this research suggests that self-efficacy, and creative self-efficacy in particular, may slightly increase across the working lifespan and positively contribute to the creative and innovative performance of older employees (Proposition 7).

Affect

The lifespan theories of socioemotional selectivity (Carstensen et al., 1999) and strength and vulnerability integration (Charles, 2010) suggest that, due to age-related changes in perceived remaining life time, older adults are more focused on positive emotions and meaningfulness, whereas young adults tend to prioritize instrumental and knowledge-related goals (Carstensen et al., 1999). Consistently, empirical research has shown that older adults focus more strongly on positive compared to negative emotional information (Löckenhoff & Carstensen, 2007). Moreover, older adults have been shown to be less affected by low-arousal negative situations and to possess better emotion regulation skills; in contrast, regulation of high-arousal negative situations is more difficult for older adults (see Scheibe & Zacher, 2013, for a review). Similar to research on age-related shifts in motives and motivation, these findings on higher levels of positive affect with age suggest that older employees might be more creative than young employees (Proposition 8).

Self-regulation

Several lifespan theories focus on individuals' self-regulation in the context of age-related changes in demands and resources. The model of selective optimization with compensation suggests that employees can engage in three strategies to adapt their goals and behavior to age-related changes in internal and external resources and demands—which, in turn, leads to successful adaptation and development (Baltes & Baltes, 1990). Employees can select and prioritize goals based on personal preferences or due to a loss of resources (*selection*), improve goal-relevant means or resources (*optimization*), and replace goal-relevant means or resources when facing losses (*compensation*). Research in the work context has shown that the combined use of strategies is positively associated with job performance and occupational well-being, and that older employees may particularly benefit from using the strategies (e.g., Abraham & Hansson, 1995; Yeung & Fung, 2009). The use of selection, optimization, and compensation strategies may also benefit creativity in the work context, because these strategies help employees to make the most out of limited personal resources (e.g., fluid cognitive abilities, human capital, physical health; see Jopp & Smith, 2006).

The motivational theory of lifespan development (Heckhausen et al., 2010) suggests that the desire to exercise control is an important need across the lifespan and that individuals use both primary and secondary control strategies to maintain high levels of "primary control capacity." Creativity involves attempts to change (primary control strategies) as well as attempts to adapt to the environment (secondary control strategies). By introducing a new and potentially useful idea, the environment is changed. However, changing processes in creative ways can also help individuals to better adapt to larger environmental changes in demands. According to the motivational theory of lifespan development, the use of primary control strategies takes the form of an inverted U-shape across the lifespan, with increases from birth to a peak in middle-age (40–60 years) and subsequent declines. Thus, according to this theory, older employees should be most likely to change their work environment by exercising primary control and introducing changes. In contrast, the use of secondary control strategies increases continuously across the lifespan and is particularly important at higher ages to compensate for declines in primary control strategy use. This

suggests that older employees should be more likely to introduce and implement ideas that can help them compensate for age-related losses in resources (e.g., in fluid cognitive abilities).

These propositions by the motivational theory of lifespan development are in line with other recent work on self-regulation. For example, Roskes and colleagues (2012) found that avoidance-oriented participants were able to attain high levels of creativity if creative performance was required to achieve their avoidance goals; similarly, Scholer, Zou, Fujita, Stroessner, and Higgins (2010) found that prevention-focused participants (who would normally tend to be risk-averse) displayed more risk-seeking behavior when this was functional for achieving their prevention goals. Thus, an important difference between young and older employees may lie in the kinds of ideas they generate, or in the situations that prompt them to perform creatively. Overall, research on self-regulation and aging suggests positive effects of aging on creativity and innovative behavior at work (*Proposition 9*).

Age-Related Changes in Environmental Factors

Age stereotypes

Among the most powerful age-related changes in environmental factors that employees are confronted with are *age stereotypes*: beliefs about individuals based on their age (Zaniboni, 2015). Stereotypes can consist of both positive and negative beliefs about members of a group. In contrast, *prejudice* is defined as a negative attitude toward group members. Prejudice is a major cause of *discrimination*: that is, negative behaviors toward individuals based on their group membership. The general societal stereotype of older people is mixed, but on the whole not very positive. Extensive research (mainly conducted in the United States) indicates that people stereotype older people as warm (e.g., friendly, good-natured), but also incompetent (Cuddy, Norton, & Fiske, 2005; Fiske, Cuddy, Glick, & Xu, 2002). Old age is generally expected to lead to a decline in such areas as memory, intellectual performance, and physical skills (Lamont, Swift, & Abrams, 2015).

Age stereotypes are especially relevant in the context of teamwork and other social interactions (e.g., with supervisors): older (and young) employees who work together with members of different age groups (i.e., in age-diverse teams) may be confronted with other people's, and their own, age stereotypes on a daily basis. In the specific context of work and organizations, age stereotypes have been assessed in numerous studies (e.g., Bal, Reiss, Rudolph, & Baltes, 2011; Posthuma & Campion, 2009) and their results have been fairly consistent—and mostly unfavorable for older employees (however, see Chan, Hui, Cheng, & Ng, 2013). Older employees are thought to be less motivated, less healthy, less productive, less interested in training and development, less able to learn, and more vulnerable to work-family imbalance. Further, and particularly importantly for the current review, older workers are considered to be less open to change, less flexible, less creative, and less able to innovate (Ng & Feldman, 2012; Shearing, 1992). However, one positive belief about older workers is that they are more stable and reliable than their young colleagues.

While the focus of most research has been on stereotypes of older employees, research suggests that young employees are often stereotyped as unreliable, self-centered, having a strong sense of entitlement, but also as full of energy, tech savvy, and creative (such as the so-called millennials, e.g., Lyons & Kuron, 2014; Twenge & Campbell, 2008).

Especially the latter beliefs may lead to the common association between youthfulness and innovativeness. Thus, even though young employees may be stereotyped as much as older employees, the nature of these stereotypes is completely different and is not as likely to inhibit creative performance.

Stereotype threat effects

Regardless of the “true” magnitude of age-related declines, people tend to *believe* that there are such declines, and this can be problematic in itself. To the extent that older individuals accept the stereotype as a self- or meta-stereotype (Finkelstein, King, & Voyles, 2015), they might underperform in situations where stereotyped abilities are being tested—and this may be particularly likely for tasks that relate to creativity. Thus, consistent with the triadic model, environment, person, and behavioral factors influence each other reciprocally in this situation. There is some evidence that older people's acceptance of the negative age stereotype contributes to the cognitive and physical decline often observed in older people (e.g., Haslam et al., 2012; Hess, Auman, Colcombe & Rahhal, 2003; Lamont et al., 2015). Most of this research has been guided by the “stereotype threat hypothesis” (Steele & Aronson, 1995). According to this hypothesis, members of stigmatized groups, who are aware of the negative stereotype society holds about their own group, are in fear of confirming this stereotype when asked to perform some task that clearly requires this ability. As a result of this stereotype threat, negative stereotypes about a group may have a detrimental impact on the performance of members of that group in situations where they are in a position of potentially confirming this stereotype.

Explaining stereotype threat effects

Two process accounts for these stereotype threat effects have been proposed. One focuses on the role of cognitive resources. Common to the various tasks for which performance reduction due to stereotype threat has been observed, is that they all require a certain degree of controlled attention, effortful processing and active self-regulation (Schmader, Johns, & Forbes, 2008). When people are reminded that they are the targets of negative stereotypes, this creates uncertainty about their own ability in domains that are important to them. This self-doubt raises anxiety, a negative emotion that is unpleasant and distracting and motivates individuals to try to suppress it. Furthermore, the uncertainty about their own ability induces individuals to monitor their own performance for signs that they might be confirming the stereotype. Both coping with the negative emotional response and monitoring their performance requires cognitive resources and taxes working memory capacity. This reduces their ability to focus their attention on a goal-relevant task, while inhibiting task-irrelevant information (Schmader, 2010; Schmader & Johns, 2003). In light of earlier research showing that effective use of cognitive resources, including working memory, is important for creative performance, it would seem likely that stereotype threat could detract significantly from older employees' creative and innovative performance.

A somewhat different—but by no means incompatible—interpretation for the effects of stereotype threat on performance has been offered by Seibt and Förster (2004). Their interpretation is based on regulatory focus theory (Higgins, 1997). Seibt and Förster (2004) argue that stereotype threat induces a vigilant prevention focus state,

slowing down performance on any task where speed or guessing answers is important for task performance. Most stereotype threat research has assessed performance on gain-based tasks (e.g., how many hits were made), which are difficult for prevention-focused individuals. In support of this interpretation, Barber and Mather (2013) demonstrated that with a task where remembering led to gains, stereotype threat significantly impaired the working memory of performance of older adults, whereas it improved their performance when forgetting led to losses. Since preventing losses fits with the strategic inclinations of prevention-focused people, such loss-framing should enhance their performance. Moreover, given research results strongly suggesting that it is promotion, not prevention, that contributes most to creativity, the prevention state induced by stereotype threat situations is likely to be especially detrimental to creative performance (*Proposition 10*).

Stereotype boost effects

Given the apparent existence of positive stereotypical beliefs about younger employees (as being more creative, more flexible, more trainable), it is conceivable that being exposed to such beliefs on part of supervisors and coworkers might actually stimulate young employees' creative and innovative performance. Such *stereotype boost* effects have been documented (Shih, Pittinsky, & Ho, 2012), although other research suggests that positive stereotypes can also turn into pressure that causes people to "choke" and underperform (Smith & Johnson, 2006).

Interestingly, Gocłowska, Crisp, and Labuschagne (2012) and Gocłowska and Crisp (2013) found evidence that thinking of, or being exposed to, counterstereotypical examples could in itself boost creativity (by stimulating a more flexible mindset). This suggests that age-diverse teams, while potentially suffering from stereotyping and the associated stereotype threat effects, could also serve as an intervention against such stereotyping, as long as the creative contributions by older team members are recognized and valued as such.

Climate and work characteristics

Besides age stereotypes, workers may face changes in the characteristics of their work and organizations as they age (Farr & Ringseis, 2002; see also Zacher, Feldman, & Schulz, 2014, for a review). In particular, research suggests that older workers perceive higher levels of job autonomy and lower levels of job demands and role stressors than young workers (Ng & Feldman, 2010). Creativity at work is influenced by contextual factors such as job autonomy and stressors (Hammond et al., 2011; Volmer, Spurk, & Niessen, 2012; Shalley & Zhou, 2008), suggesting a positive relation of age with creativity and innovative behavior at work (*Proposition 11*). Age stereotypes can partly influence these contextual factors; for example, Rosen and Jerdee (1976) found that participants in a managerial decision task were less likely to support retraining or development initiatives when they believed these concerned older rather than younger employees, and Armstrong-Stassen and Ursel (2009) found that employees perceived more organizational support when they also felt that the organization provided developmental and training opportunities for older workers. However, findings on the relation between age and support are mixed. For example, Yoon and Lim (1999) reported positive zero-order correlations of age with organizational support (but not supervisor support) and autonomy, whereas Binnewies and colleagues (2008) did not find a significant correlation between age and perceived support for creativity.

Some research suggests that organizational climates regarding aging—shared perceptions of how aging and older workers are perceived in an organization—may have similar effects such as age stereotypes, such that they influence older workers' experiences and behaviors, including creativity (Kunze et al., 2011; Zacher & Gielnik, 2014). For instance, Zacher and Gielnik (2014) found that employees in small businesses distinguished between organizational climates regarding young and older workers; interestingly, overall, older employees were perceived more positively on different attributes (e.g., flexible, motivated, high in initiative) than young employees. However, there is currently no evidence suggesting that teams and organizations hold more negative age climates regarding older workers' creativity compared to young workers, and therefore we do not offer a proposition on this topic.

As argued earlier, another question is not so much whether employees of different ages perceive different work environments, but whether they respond differently to the environment they perceive; in other words, whether age and work characteristics have an interactive effect on work outcomes (such as creativity and innovation). Some research on the relation between job complexity and job satisfaction suggests that this may indeed be the case (with younger employees showing a stronger correlation between job complexity and satisfaction), although it is not clear whether these results are best explained by actual age or by job tenure, and none of these studies have addressed creative or innovative behavior (e.g., Gould, 1979; Katz, 1979; Kemp and Cook, 1983). In contrast to these results suggesting that older employees tend to become less responsive to job complexity, Zacher, Heusner, Schmitz, Zwierwanska, and Frese (2010) found that higher levels of job complexity buffered the negative effects of age on employees' focus on opportunities, as well as on performance, suggesting that job complexity actually might be a particularly important resource for older employees.

Review of Empirical Research on Age, Creativity, and Innovative Behavior at Work

Thus far, we have discussed behavior, person, and environment factors in the creativity/innovation and aging literatures more or less separately, although some links have already been briefly addressed (Table 1). In this next section, we aim to integrate these literatures. To this end, we first give an overview of empirical work explicitly addressing the relation between age and creativity/innovation at work. We conducted a literature search using electronic databases, and identified two meta-analyses (based on cross-sectional studies that included age as a substantive or control variable) and seven recent primary studies that specifically investigated associations among age, creativity, and innovation. We first broadly describe the results of the meta-analyses, and then address the primary studies, which suggest a slightly more complicated picture. We will then argue that the existing research results are difficult to interpret, for several reasons.

Meta-Analyses on Age, Creativity, and Innovative Behavior

The first meta-analysis showed that age was not significantly related to self- and supervisor ratings of creativity and innovative behavior (Ng & Feldman, 2008; note that creativity and innovation were not distinguished in this meta-analysis). Specifically, the relationship between age and self-ratings of creativity and innovation was $\rho = -.01$ ($k = 8$ studies, $N = 1,537$ participants), and the relationship between age and supervisor

ratings of creativity and innovation was $\rho = .01$ (.02 after correcting for interrater reliability; $k = 9$, $N = 1,662$). Ng and Feldman (2008) suggested that these zero relationships may be explained by strong, situation-based expectations that encourage employees of all ages to show creative and innovative behavior. Another explanation put forward by the authors is that employees with low levels of creativity and innovative performance leave the organization over time, resulting in a lack of age-related differences between the remaining employees. Due to missing information provided by the studies included in the meta-analysis, Ng and Feldman were unable to investigate possible moderators of these relationships.

The second meta-analysis examined bivariate relationships between age, job tenure, and innovation-related behaviors (specifically, the generation, dissemination, and implementation of new ideas) (Ng & Feldman, 2013b). Based on human capital theory, and contrary to common age stereotypes (see above), Ng and Feldman (2013b) argued that age and job tenure would be positively related to innovation behavior due to age-related increases in declarative and procedural knowledge. They found a weak positive relationship between age and overall self-rated innovation behavior ($\rho = .07$; $k = 36$, $N = 9,779$). The relationship between age and a combination of the more specific outcomes of idea dissemination and implementation (i.e., without idea generation) was even weaker and nonsignificant ($\rho = .03$; $k = 6$, $N = 1,548$). Age was also not significantly related to non-self-report measures of innovation behavior ($\rho = .01$; $k = 45$, $N = 11,817$). Using a subset of studies that examined age, job tenure, and innovation behavior, Ng and Feldman (2013b) showed that partialing out the effects of job tenure did not substantially change the relationships between age and self-report ($\rho = .03$; $k = 18$, $N = 3,376$) and non-self-report measures of innovation behavior ($\rho = -.01$; $k = 28$, $N = 7,325$). Overall, the authors' hypothesis of a positive relationship between age and innovation behavior did not receive strong empirical support. Moreover, Ng and Feldman (2013b) did not find support for a curvilinear relationship between age and innovation behavior.

Primary Studies on Age and Creativity

All in all, the meta-analytical results do not provide strong evidence for a direct, zero-order relation between age and creativity at work (also see Frosch, 2011, for a review). The seven primary studies we identified paint a slightly different picture, however; specifically, they illustrate that individual characteristics and job-related resources, as well as broader context characteristics may play a role in the complex relationships between age and creativity, and that it matters which operationalization of creativity/innovation one uses. Using a sample of 117 nurses between 19 and 60 years (mean age = 34.4 years, $SD = 10.2$), Binnewies and colleagues (2008) failed to find a zero-order relation of age, job control, and support for creativity to subject matter experts' ratings of nurses' creative ideas. However, job control and support for creativity moderated the relationship between age and creativity, such that age was positively associated with idea creativity when job control was high, and negatively associated with creativity when job control and support for creativity were low. Further, Rizzuto (2011) conducted a field study with purchasing agents and directors, and found that young workers reported less satisfaction with the implementation of an innovative information technology initiative than older workers, and that this relationship was stronger in departments with a younger average age (no mean age and age range for the total sample were reported). Moreover, in two organizational samples, Verworn (2009) failed to find evidence for an age-related decline in the number of ideas submitted by employees to an internal

suggestion system, but actually found an age-related increase in (estimated) idea quality for one of the two studied locations.

Ng and Feldman (2013a) conducted a three-wave longitudinal study across 12 months with 196 employees between 22 and 66 years (mean age 39.59 years, $SD = 11.13$). They found a three-way interaction of employee age, employee proactive personality, and supervisor undermining, such that the highest innovation-related behavior was displayed by older employees with a highly proactive personality who experienced high supervisor undermining. Finally, Schaffer, Kearney, Voelpel, and Koester (2012) reported a study with 211 employees working for a high-tech company (age range = 16–61 years, mean age = 39.83 years, $SD = 11.69$). They found that feedback from coworkers moderated the relationship between employee age and supervisor ratings of radical innovative work behavior (including idea generation, promotion, and implementation) assessed six months later. Specifically, the association between age and innovative behavior followed an inverted U-shape, but only when employees perceived high levels of useful feedback from coworkers.

In a study on age diversity and creativity, Choi (2007) found that age diversity was positively related to individual creative behavior in teams, but unrelated to group creative performance. Choi further reports that this age was probably due to older respondents reporting higher levels of creative performance, and speculates that "increasing age might reflect increasing organizational experience, skills and power to initiate changes, all of which may promote creative behavior" (p. 228). Park and Kim (2015) recently found that workforce aging was positively related to exploitative innovation performance (except when age diversity was high), and had an inverted U-shaped relation with explorative innovation. However, in a meta-analysis on demographic diversity and team performance (not specifically creativity), Bell, Villado, Lukasik, Belau, and Briggs (2011) found no effect of age diversity.

In short, studies have found relations between age and creativity at work, but these tend to be complex, are sometimes nonlinear, and usually moderated by contextual or other individual factors. As yet, these relations are still largely understudied. One exception is the professional domain of science. In the following section, we will summarize the work in this area, since it further illustrates the complexity of the age–creativity relationship.

AGE AND SCIENTIFIC CREATIVITY

In science as in other work domains, it is important to separate assumed age effects (i.e., age stereotypes) and real age effects. Regarding the former, it is often considered nearly a truism that science is a young person's game. As a former Nobel Laureate—the economist Gary Becker—commented: "Important new ideas in different fields come disproportionately from younger persons, and academic research is no exception. Significant advances not only in mathematics, but also in biology (such as Crick and Watson), in economics, and even in humanities have typically been made by younger rather than older persons" (Becker, 2008). Similarly, in an article on aging in biomedical research in the United States, motivated by the increasing age of principal investigators receiving grants from the National Institutes of Health (NIH), Matthews, Calhoun, Lo and Ho (2011) asked: "With the increasing age of those obtaining funding from NIH, could the United States be losing out on innovative research and discourage promising students from entering or continuing science?" (p. e29738). In light of such concerns, it is interesting to note that whereas the percentage of principal investigators aged 36 and younger decreased from a high of 18% in 1982 to less than 4% in 2010, the percentage of researchers of 66 years and older only increased from less than 1% to 7% in 2010 (Matthews et al., 2011).

Science by definition is a creative endeavor, since all scientific research aims to either introduce new knowledge, theories, or models (which of course includes falsification of established theories, thereby forcing us to change our view of a particular phenomenon) or to refine and further explore existing knowledge or ideas (such as replications and extensions of earlier work, specifying boundary conditions and underlying processes for a specific phenomenon). Thus, in the context of this review, *all* valid indices of scientific output could be considered indices of scientific creativity. We focus on two classes of indices: recognition in the form of prestigious awards (the Nobel Prize being studied most extensively), and actual scientific output—which in turn can be divided further into *quantity* of output (similarly to ideational fluency in creativity tasks) and *quality* of output (e.g., citations). We will discuss these three in turn.

Age and the Nobel Prize

Although examples such as those mentioned by Becker (2008) are familiar and striking, the question is whether the suggested pattern of science, and particularly Nobel Prize-winning science, as a young person's game is borne out by empirical data. In fact, the data suggest that the game of science is best played by those in mid-career, rather than the young (also see Wray, 2004). For example, studies by Zuckerman (1977) and Stephan and Levin (1993) showed that the average age of Nobel-prize winners at the time they did their prize-winning research was between 35 and 40. These results are in line with the above-mentioned changes in demographics among NIH applicants. Moreover, a recent analysis of the ages of Nobel laureates in different disciplines found that the average age at which they conducted their prize-winning research has increased markedly over the last century (Jones & Weinberg, 2011).

Age and Scientific Output

Bearing in mind the distinction between Big-C creativity and Pro-C creativity (Kaufman & Beghetto, 2009), it is doubtful whether the Nobel Prize is the most useful indicator for studying the association between age and scientific creativity. The vast majority of scientists, even the most productive and prominent ones, will never get the award. A more realistic criterion might be the number of scientists' publications. In line with other work on creative performance (e.g., Stroebe, Nijstad, & Rietzschel, 2010), it is important to distinguish between *quantity* and *quality* of scientists' creative output.

Quantity of publications

Summarizing the findings of a great number of studies published before 1990, Stroebe (2010) concluded that (a) the overwhelming majority of studies reported a curvilinear relationship between age and productivity, with a peak somewhere around the ages of 40–45 years and that (b) past performance was a much better predictor of productivity than age, with age typically accounting for less than 10% of the variance in productivity (e.g., Cole, 1979; Horner, Rushton, & Vernon, 1986). However, results after 1990 show a somewhat different pattern. Gingras, Larivière, Macaluso, and Robitaille (2008) categorized their sample into two groups: “all professors” (researchers who had published at least one article between 2000 and 2008), and the subsample of “active professors” (who had published at least one article at their particular age at the time of the study). This distinction turned out to be quite important, as the publication rate for all professors was positively associated with age until 50, and negatively associated after

50, but the curve for the active professors did not show a significant decrease after the age of 50 years, suggesting that they maintained their high levels of productivity for the remainder of their careers.

It is interesting to theorize about possible causes for the discrepancy between the findings of this study and that of earlier studies conducted before 1990. Maybe the most plausible explanation is that something has changed in contextual factors (e.g., organizational, social, or even legal) impacting on scientific output. For example, Quebec abolished compulsory retirement in 1980, which means that older professors had more opportunities to remain productive for a longer time. Further, the discrepancy could be due to changes in the competitiveness of the academic environment. Kyvik and Olsen (2008) found in a series of surveys in Norwegian universities that the typical curvilinear pattern (see above) essentially disappeared between 1989 and 1998. These authors further discussed several environment-related reasons for these changes: In 1993, the possibility was introduced for associate professors to apply for promotion to full professorship, based on their scholarly achievements; financial support for attendance at international conferences had increasingly been made dependent on paper presentations; funding of research was increasingly based on past performance; finally, academic staff has increasingly been evaluated in terms of their publishing behavior. Thus, in line with the triadic approach (Bandura, 1989), some academic work environments changed in such a way as to make academic opportunities and resources contingent upon academic performance, which in turn may have substantially changed the relation between age and performance.

Quality of publications

The patterns for quality of publications are somewhat more complex than those for quantity. Gingras and colleagues (2008) calculated different indices of the quality or scientific impact of the research published by the different age groups, such as the number and proportion of publications in high impact journals (i.e., top 10%) and papers that fall into the category of 10% most cited papers in a given discipline. Their result show that, although sheer productivity tends to decline a bit after 50, the average relative impact factor, citations, and papers in top 10% journals seem to display a U-shaped distribution, with declines until about 50–55 years, and an increase after that. Thus, when they reach the age of 50, researchers appear to be less affected by the “publish or perish norm,” and seem to focus more on quality (publishing high-impact work) than on quantity (number of publications). Then again, in a study among biomedical researchers, Falagas, Ierodiakonou, and Alexiou (2008) found that more than 70% of these researchers were between 31 and 45 years old when they published their single most cited article. However, this study focused on articles for which the respondents were first author, and the results by Gingras and colleagues (2008) show that first-author publications tend to decrease with age: in fact, the older researchers get, the farther away from the first author position they tend to move—which is in line with their taking on a different role in the research process. Thus, these data may have been inadvertently skewed against senior researchers. Further, Simonton's (1997) equal-odds rule, derived from his extensive historiometric research, states that the relation between quantity of output and number of “hits” (high-impact output) tends to be linear and stable, which would imply that some researchers show both relatively high productivity and high impact throughout their careers (also see Simonton, 2004).

Age and scientific creativity: Summary

Briefly stated, the empirical data do not support the notion that scientific creativity is exclusively, or even mainly, found among young researchers. To the extent that relationships between age and indicators of scientific creativity (in terms of measurable output) exist, these seem to be nonmonotonous and dependent on the exact criterion used. Thus, we propose that the question whether young or older scientists are more creative is misguided. Moreover, in line with the triadic and interactionist perspective (Figure 1), we argue that if there is an empirical relationship between the two dimensions, this is mostly due to external factors interacting with age, rather than to age itself. For example, the results from Kyvik and Olson (2008) imply that organizational changes in the university context can have significant effects, and the results presented by Gingras and colleagues (2008) suggest that social processes relating to the shifting role of older professors can explain at least part of the changes in scientific output. All in all, the case of scientific creativity is a good illustration for the complexities surrounding the relation between aging and creativity and innovation.

DISCUSSION

The goals of this review were to describe potential links of aging with creativity and innovation at work, to summarize the state of empirical evidence, and to outline directions for future research. Our review suggests that research on the relations of age with creativity and innovation has yielded many interesting results, but has a long way to go yet. The development and testing of more sophisticated models that go beyond direct, zero-order relationships may have been impeded to some extent by the prevalent age stereotypes (focusing research on the question whether older employees are less creative than young ones), and indeed these stereotypes seem to be remarkably resilient, despite empirical data to the contrary. This brings us to the next goal of this review: to outline directions for future research. Our suggestions fall into two broad categories: methodological considerations (possible changes and improvements in the way we conduct studies on aging, creativity, and innovation), and conceptual considerations (possible research questions and models). Table 2 provides a summary of our recommendations for future research.

Future Research: Methodological Considerations

The results discussed so far are quite divergent, so it is difficult to draw general conclusions from them. What they do suggest, is that the role of age may not be that it predicts how creatively employees of different ages perform, but rather how they respond to contextual characteristics, such as work characteristics. However, in addition to the relatively limited number of empirical studies addressing these (zero-order and moderated) relationships, there are other reasons to be careful in drawing conclusions. Specifically, the existing studies (both primary and meta-analytical) have a number of methodological and statistical drawbacks and complications, that make substantial interpretations of their results difficult, and that might perhaps be avoided in future research (cf. Frosch, 2011). We will briefly summarize the most important of these drawbacks and complications.

Cross-sectional designs

In most studies on the topic (including studies included in the two meta-analyses), employees from different age groups are compared

at one point in time. Such cross-sectional studies can only be used to investigate age-related differences between employees, but not age-related *changes* (i.e., aging) within persons over time (Shultz & Adams, 2007). Moreover, cross-sectional designs cannot disentangle age-related changes from cohort, measurement period, and selection effects (Hofer & Piccinin, 2010). Nevertheless, most cross-sectional research in this area assumes that age differences between employees are the consequence of intraindividual age-related changes over time (Zacher, 2015). Long-term longitudinal designs, in which the same participants are assessed repeatedly over several years and decades, are necessary to examine age-related changes as well as between-person differences in change trajectories (Baltes & Nesselroade, 1979; Ferrer & McArdle, 2010). However, even such longitudinal designs cannot rule out cohort effects, selective sampling and drop-out, or retest effects. Thus, developmental researchers have suggested the use of cohort-sequential designs with continuous resampling as a gold standard (Baird, Pitzer, Russell, & Bergeman, 2012). Research on aging and creativity has yet to begin employing such designs.

Limited respondent age range

Although much of the research on aging at work is inspired by demographic and economic changes leading to a greater work participation of older workers (e.g., older than 50 or 60), the average age of employees who participated in studies on creativity and innovation (including the studies included in the meta-analyses) tends to be relatively young. For instance, in their first meta-analysis on age and creative performance, Ng and Feldman (2008) reported that ages across all samples with detailed age information ranged from 17 to 59 years (mean age = 36.6 years, $SD = 8.8$ years). Similarly, in the second meta-analysis by Ng and Feldman (2013b) on age and innovation behavior, ages across samples ranged from 24 to 49 years (mean age = 36 years, $SD = 8.3$ years). It remains an open question whether the findings of these meta-analyses generalize to individuals older than 50 or 60 years, and hence whether these findings will prove informative in dealing with the phenomenon of the “aging workforce.”

Confounding variables

Not all studies control for alternative time-related variables related to age, such as job, organizational, and occupational tenure. While some meta-analyses (e.g., Ng & Feldman, 2013b; Sturman, 2003) statistically controlled for job tenure and did not find an impact on age-outcome relationships, this is not commonly done in primary studies. Including such control variables is essential, because only then does it become possible to disentangle age effects from effects of variables that happen to be correlated with age. For example, many aspects of job performance depend strongly on the job-relevant expertise an incumbent has built up over the years (Kanfer & Ackerman, 2004). On the whole, older workers are of course more likely to have built up such expertise. Thus, without controlling for tenure or job-relevant expertise, any effects are impossible to interpret. Moreover, should a zero relationship be found (as in the meta-analyses discussed previously), it is not clear whether this indeed indicates the absence of an effect, or whether possibly a negative age effect exists (e.g., due to declining fluid cognitive abilities) that is compensated by another, tenure-correlated variable (such as job experience).

Table 2. Summary of Recommendations for Future Research

Research Need	Explanation and Recommendation
<i>Methodological considerations</i>	
Investigate effects of the aging <i>process</i> on creativity and innovation	Most studies on age and creativity/innovation used cross-sectional designs. However, longitudinal and cohort-sequential designs are necessary to examine age-related changes, and to disentangle aging from cohort, time period, and selection effects.
Sample employees across the <i>entire working lifespan</i>	Many studies on creativity/innovation include very few older employees. Future studies need to collect data from young, middle-aged, and older employees to ensure generalizability of findings.
Control for potential <i>confounding variables</i>	To rule out alternative explanations for relationships between age and creativity/innovation, studies should control for other time-related variables such as job, organizational, and occupational tenure, as well as experience.
Examine <i>curvilinear</i> relationships	Middle-aged employees may differ from, or may be more similar to, either young or older employees with regard to their creative and innovative behaviors. Multiple nonmonotonous mediators may play a role, leading to inverse U-shaped relations.
<i>Conceptual considerations</i>	
Investigate links between aging and <i>different dimensions</i> of creative and innovation behavior	Creativity and innovation are not homogeneous constructs. Future research should take a more fine-grained perspective and examine how aging relates to dimensions such as problem recognition, idea generation, idea selling/dissemination, and idea implementation.
Explore <i>changing motives</i> for creativity and innovative behavior	Future research could examine reasons why employees of different ages engage in creative and innovative behaviors. Age-related changes in motives (e.g., instrumental/knowledge-related goals vs. socioemotional and generativity goals) will probably influence different aspects of creativity and innovation.
Testing the limits: <i>Plasticity</i> of creativity and innovation	Researchers could conduct and test interventions to enhance creative/innovative behaviors among young and older employees. Moreover, research could investigate how creative/innovative behaviors may benefit the process of successful aging.
Study how employees can <i>invest in their future creativity</i>	How can young employees invest in their future potential for creativity and innovation (e.g., investing in training and networking)? What can employees do to retain their creative and innovative capacities?
Take a <i>multilevel perspective</i>	Aging and creative/innovative behaviors take place in, and are influenced by, the social environment. Studies should examine the roles of teams, leaders, organizations/employers, and society.
Explore <i>responses</i> to creativity and innovation	Research could study positive (e.g., support) and negative reactions (e.g., resistance) to creative ideas proposed by employees from different age groups, and the consequences of these reactions to employee and organizational outcomes.

Curvilinear relations

Finally, most primary studies only examined linear relationships of age with creativity and innovative behavior. However, these relationships may also be *curvilinear*, with middle-aged employees differing from or being more similar to either young or older employees (cf. Schaffer et al., 2012). For example, it is likely that task performance has an inverted U-shaped relationship with age in less complex jobs (McDaniel, Pesta, & Banks, 2012; Sturman, 2003). Further, we have seen that the relation between age and scientific output tends to be curvilinear as well.

Grant and Schwartz (2011) have argued that curvilinear relationships (and particularly those with an inverted U-shape) are very

common in psychology, but are not routinely hypothesized or tested.

One reason why such relationships could occur is the existence of two opposed nonlinear relations. Thus, if one age-related variable (say, job experience) happens to have a positive but nonmonotonic relation with creativity (i.e., it follows the law of decreasing marginal returns; e.g., McDaniel, Schmidt, & Hunter, 1988), and another age-related variable (say, decrease in fluid cognitive abilities) happens to have a negative nonmonotonic relation with creativity (following a pattern of increasing marginal costs), the net effect would be an inverted U (Grant & Schwartz, 2011). Given that age itself is correlated with several performance-related variables that are likely to have different kinds of positive and negative effects (which could easily turn out to

be nonmonotonic in nature), the need to look beyond simple linear relations seems obvious.

Future Research: Conceptual Considerations

Having reviewed work on aging, creativity, and innovation, as well as their combinations, several themes arise as promising avenues for future research that would also fit with the triadic and interactionist approach that served as conceptual background for this article (Figure 1).

Dimensions of creativity and innovation

One aspect that has become very clear is that relations of creativity and innovation with any other variable depend on the specific criterion under consideration. This has been shown repeatedly in creativity research outside of the aging field (e.g., De Dreu et al., 2008; Stroebe et al., 2010), but also when it comes to aging. For example, innovative behavior seems to relate differently to aging depending on whether one includes idea generation or only looks at idea dissemination and implementation (Ng & Feldman, 2013b). Thus, one of the most important directions for future research would be to take a more fine-grained approach to the criterion variable, and theorize more explicitly about which dimension of creative or innovative behavior is likely to relate to aging in what way and why (i.e., considering mediating mechanisms). Importantly, some of the basic materials for such theorizing are already in place. An example is the distinction between fluid and crystallized cognitive abilities. Although age-related declines in fluid abilities may not be as steep as age stereotypes suggest, the data do suggest developmental changes, with some fluid abilities declining across the working lifespan and crystallized abilities increasing. We earlier discussed work by Jauk and colleagues (2013) on the threshold theory of the intelligence-creativity relation, and work by Baer (2012) showing that successful implementation of creative ideas requires networking capabilities and “buy-in” relationships. In light of such findings, it is possible that older employees may become (somewhat) worse at generating many ideas that are highly novel (a criterion with a high threshold for intelligence as a predictor), but do *not* become less productive overall (a criterion with a lower threshold); in fact, they may actually get better at selling and implementing their ideas (because they are more likely to have developed the relevant social capital; cf. Ng & Feldman, 2013b; however, also see Simonton, 1997). Given that most empirical and meta-analytical work has tended to conflate dimensions of creativity and innovation, making such distinctions would be a particularly fruitful area of future research.

Changing motives for creativity at work

Research in the lifespan and aging at work literatures suggests that certain motives, which are also relevant for creativity and innovation at work, change with age. Future research based on socioemotional selectivity theory (Carstensen et al., 1999) could investigate how age-related changes in motives impact on creativity and innovation. For instance, young adults may engage in specific creative behaviors to expand their knowledge base and social networks (e.g., job crafting more challenging and interactive work environments), whereas older employees may be more strongly motivated by expected positive-emotional outcomes to implement creative ideas. Moreover, older employees are more likely to be motivated by generativity concerns, which encompass being creative and productive to benefit others and

to leave a positive legacy behind for future generations (McAdams & de St. Aubin, 1992). This suggests that employees become increasingly interested in generating and implementing ideas that lead to outcomes that have a positive and lasting impact on others and future generations (e.g., ideas about sustainable organizational practices, or ideas with a positive impact on working conditions within the organization).

Plasticity and creativity

A central tenet of the lifespan perspective is the notion of plasticity, or intraindividual modifiability (Baltes, 1987). It suggests that development is not pre-determined, but that person and environment factors can lead to changes in developmental trajectories at any age, including older ages. Future research could investigate how specific interventions can lead to changes in creative and innovative behavior among older employees. For instance, self-regulation strategies such as selection, optimization, and compensation or the dynamic interplay between primary and secondary control may help older employees to overcome age-related losses in creative and innovative ways (i.e., the deficits-breed-growth hypothesis; Baltes, Freund, & Li, 2005) or to make the most out of their limited resources (e.g., time, energy, fluid cognitive abilities) with regard to creative outcomes. Alternatively, creativity itself may be a resource that can help employees deal effectively and proactively with aging. Fehr (2012) proposed that creativity might help people deal with the stress of retirement, but even before retirement, the ability to come up with new ideas or perspectives could be helpful (e.g., Weber, De Assunção, Martin, Westmeyer, & Geisler, 2014). It is conceivable that highly creative employees are better at reappraising their own aging process, which might decrease associated negative affect (Weber et al., 2014); it is also likely that highly creative employees deal with their own aging more proactively (Joo et al., 2014), taking advance measures to reduce age-related declines in abilities, or shaping their work environment according to their future needs and preferences.

Investing in future creativity and innovation

One way in which employees could deal proactively with their own aging process, is by making long-term investments in their own creativity and innovation. For example, if it is the case that the creative and innovative performance of older employees is more dependent on crystallized, rather than fluid cognitive abilities, one implication would be that young employees who wish to retain their creative edge in the long run would do well to invest in “crystallizing” their creative abilities. That is, rather than relying on whatever creative and innovative performance comes naturally and spontaneously, young employees should aim to develop an extensive repertoire of creativity-relevant techniques, for instance through training and deliberate practice (i.e., skill routinization). A meta-analysis by Scott and colleagues (2004) showed that creativity training works best when people learn concrete techniques (e.g., brainstorming), rather than “open” techniques that are likely to rely mostly on fluid abilities, such as free association. Thus, creativity training could be construed as a long-term investment that will ultimately pay off in the form of higher creative output when people get older. Similarly, young employees who invest in building up “social capital” in the form of extensive social networks, might be expected to be in a better position for innovative performance later (e.g., Perry-Smith, 2006). This would be an interesting area for future

work, especially in combination with the methodological improvements described above.

Aging in a social environment

It is striking that research on aging and creativity at work has predominantly taken an individual-level perspective, even though creative behavior takes place in a social and organizational context (Woodman et al., 1993). This means that the environment and employer perspectives are largely neglected (except in those studies that explicitly look at person–environment interactions, such as Binnewies et al., 2008; Ng & Feldman, 2013a). However, aging researchers have long been aware that aging is not only an individual-level phenomenon, but a social and contextualized phenomenon as well (Baltes, 1987; Staudinger, 2015), and as such needs to be addressed on multiple conceptual levels. This is most obvious when reflecting on the issue of age stereotypes, meta-stereotypes, and stereotype threat: the social environment, in explicitly or implicitly expressing a belief in age stereotypes, exerts a very real and potentially damaging influence on both an older individual's performance and his or her self-construal.

In the literature, the presence of a supporting environment consistently emerges as one of the most important contextual predictors or facilitators of creative performance and innovation (Hülshager et al., 2009; Shalley & Zhou, 2008). In line with this, research shows that support moderates the relation between age and employee creativity (Binnewies et al., 2008). Supervisors can play an important role in shaping such a supportive environment; for example, through the use of autonomy-supportive feedback styles (e.g., Shalley & Perry-Smith, 2001), rewarding employees for creative performance (Byron & Khazanchi, 2012), or stimulating a team climate conducive to creativity (Anderson & West, 1996). Moreover, organizations would do well to invest in addressing the pervasive negative age stereotypes, not only among employees, but also in their organizational culture and communication (e.g., when automatically linking “innovative” to “a new generation”; Rietzschel & Zacher, 2015), and in hiring practices (e.g., striving for an age-diverse workforce). Further, organizations should strive to facilitate creative and innovative behaviors for employees with different (age-related) motives, preferences, or styles. Thus, for example, it might be worthwhile to give older employees more room for innovation-related behaviors, without creating stereotype threat regarding the generation of new ideas. Another possibility is to work on an organizational climate where different kinds of creative and innovative behaviors (e.g., more incremental creativity, or creative ideas that arise as a response to avoidance concerns) are recognized and valued more explicitly.

Thus, one particularly fruitful area for future research might be the issue of organizational age climates regarding young and older employees (Kunze et al., 2011; Zacher & Gielnik, 2014); research should address its antecedents (such as the presence of age diversity in the organization; Kunze et al., 2011) and consequences (particularly creative and innovative behaviors), and its relations to such interpersonally oriented constructs as diversity beliefs and innovation climate (e.g., Anderson & West, 1996). For example, it is conceivable that organizational age climate is correlated with age-related diversity beliefs or with innovation climate. In the case of strongly negative age stereotypes, it might even be the case that dimensions of an innovation climate, such as participative safety (the degree to which input, novel ideas,

and divergent perspectives are invited and welcomed within a team) are not perceived the same by team members of different ages: creative ideas might be welcomed when they come from young team members, but not when they come from older colleagues. Alternatively, less creative ideas might not be remarked upon when they are expressed by young employees, but might be seen as confirmation of the age stereotype when expressed by older employees.

Responses to creativity

Resistance to creative ideas is thought to underlie the difficulty in moving from creativity to innovation (e.g., Mueller et al., 2012, 2014; Rietzschel et al., 2006, 2010). Older employees are often believed to be less open to change (even though there is some suggestion that the opposite may be true; cf. Kunze et al., 2013), and as such might (according to the age stereotype) be expected to be more conservative and less open to creative ideas. A complementary hypothesis is that people could also be more resistant to highly creative ideas when these are expressed by older employees, because these violate the stereotype of the noncreative older colleague. In social psychology, negative reactions to counter-stereotypical behavior are referred to as the *backlash effect* (cf. Rudman, 1998; Rudman & Fairchild, 2004); it would be interesting to see whether there also is something as a “creative backlash effect” with regard to older employees. If the creative ideas that are contributed by older employees are not recognized or valued, this not only increases the risk of a missed opportunity for innovation, but would also increase the chance that the older employee will refrain from expressing future ideas. Thus, future work might do well to extend questions about the age–creativity relationship beyond the creativity of the aging employees themselves, and take the responses of the employee's social environment into account as well.

CONCLUSIONS

In this article, we have reviewed and discussed the literatures on aging, creativity, and innovation, as well as their combinations based on an interactionist and triadic approach (Figure 1). Creativity and innovation at work involve multiple distinct behaviors, from problem identification and idea generation to idea selling and implementation, which are influenced by the interplay of multiple person and contextual factors. The lifespan developmental literature suggests that these factors may change across the adult lifespan, which, in turn, should result in different (or, in the case of compensatory effects, similar) levels of creative and innovative behavior among young and older employees (Table 1). While meta-analyses have generally found no significant bivariate relations of age with creativity and innovation, primary studies and research on age and scientific creativity suggest a more complex pattern consistent with the interactionist and triadic perspectives. Future research should adopt these perspectives, as well as more sophisticated methodologies, to develop and test models that help better understand the increasingly important topic of aging and creativity/innovation at work (Table 2). Interesting as questions about direct, zero-order relations of aging with creativity and innovation may be, they do not do justice to the complex and multifaceted nature of aging, creativity, innovation, and the organizational context. Taking a broader perspective on these complex constructs will, we believe, have substantial benefits both for fundamental research and for practical applications.

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