

## **Creativity and Aging: What We Can Make With What We Have Left**

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Much research suggests that neural conduction, speed, memory, and stamina decline as we get older. Historiometric studies (the historical study of human progress or individual personal characteristics, using statistics to analyze references to geniuses, their statements, behavior and discoveries in relatively neutral texts) have shown that creativity productivity in the arts and sciences tends to peak within a few decades of the start of one's career, and then decreases gradually afterwards. There are of course exceptions: Kan, Verdi, Pavlov, etc.

Consider, however, that some people are able to maintain and enhance their creative abilities as they age. If this is possible, then we should examine which factors do in fact deteriorate with age, which elements do not, and what factors enable them to do so.

### **Defining Creativity**

We start by clarifying our working definitions of four constructs as they provide a framework for understanding creativity: imagination, prospection, originality, and innovation

The first and core skill is **imagination**, which consists of mental representations (visual, verbal, auditory) of things that are not present to the senses. Imagination is about some alternative to present perception and includes all of the following: mental imagery of things that may or may not exist, counterfactual conjecture, alternative pasts, day-dreaming, fantasizing, pretending, mental simulation of other minds, mental rehearsal, and aspects of night dreaming. Imagination itself is neutral but can be adaptive or maladaptive and it can be about the past, present or future.

**Prospection** is imagination about possible futures. These possibilities contain elements that are not present to the senses now. It can have visual, verbal, kinesthetic and auditory representations.

**Originality** is prospecting that introduces novelty - introducing new variables, perspectives and possibilities.

> Creativity requires originality, which in turn requires prospection, which in turn requires imagination. Creativity, crucially, also requires usefulness and a good sense of the audience who will make use of the idea or product and that it is "surprising" and "nonobvious".

Finally, **innovation** refers to bringing an idea to scale by successfully implementing it on a large scale within an organization or society at large.

> Thus, researchers have suggested that the creative process may best be characterized by a *generation* phase, in which original ideas are freely invented without scrutiny, followed by an *evaluation* or *exploration* phase, during which value of ideas is examined, and ideas are elaborated and refined as needed.

Some of the factors reviewed here may primarily influence either generative or evaluative processes, many probably contribute to both.

## **The Present Review**

Based on literature examining psychological elements at play in creativity, consider these three sets of factors to understand the effects of aging on creativity:

- a. Cognition and Expertise - including cognitive abilities, originality, mind-wandering, knowledge and expertise, intuition, pattern recognition, and heuristics.
- b. Personality and Motivation - including flexibility, openness to experience, integrative complexity, strength of interest, intrinsic motivation, ambition, grit, optimism, confidence, self-efficacy, and energy.
- c. Interpersonal Processes - such as having a good sense of the audience and engaging in collaboration.

### **A. Cognition and Expertise**

#### **Cognitive Abilities**

The modern synthesis of the past 100 years of intelligence research, cataloging covariations among various cognitive abilities, takes the form of the [Cattell-Horn-Carroll \(CHC\) theory](#) of cognitive abilities. It consists of nine broad cognitive abilities that have been consistently validated during the past decade.

1. Fluid reasoning - the deliberate but flexible control of attention to solve novel “on the spot” problems that cannot be performed by relying exclusively on previously learned habits, schemas, and scripts.
2. Crystallized intelligence - depth and breadth of knowledge and skills that are valued by one’s culture.
3. Short-term memory - the ability to encode, maintain, and manipulate information in one’s immediate awareness.
4. Long-term storage and retrieval - the ability to store, consolidate, and retrieve information over periods of time measured in minutes, hours, days, and years.
5. Visual processing - the ability to make use of simulated mental imagery (often in conjunction with currently perceived images) to solve problems.
6. Auditory processing - the ability to detect and process meaningful nonverbal information in sound.
7. Processing speed - the ability to perform simple repetitive cognitive tasks quickly and fluently.
8. Quantitative knowledge - depth and breadth of knowledge related to mathematics.

9. Reading and Writing - depth and breadth of knowledge and skills related to written language.

While partially distinct, all nine of these abilities are positively correlated with each other, and are positively correlated, in varying degrees, with a more global cognitive ability factor - *g*.

**How do these cognitive abilities relate to creativity?** It appears that cognitive abilities facilitate creative cognition up to a point (depending on the domain). Beyond this threshold, cognitive abilities may still have an important influence on the extent to which creative ideas are translated into actual creative achievements - perhaps by aiding in the evaluation and usefulness of the ideas. Research has also suggested that global cognitive ability *g* and divergent thinking were much stronger predictors of creative achievement in the sciences than the arts. In fact, there appeared to be no cognitive ability threshold for the arts (Scott Barry Kaufman, et al, 2015).

### > **Cognitive Abilities and Aging**

More than 50 years of research has consistently found that fluid reasoning, processing speed and short-term memory all likely decline with age and thus can contribute to a possible decline in creative thinking and achievement.

However, crystallized intelligence (knowledge), long-term retrieval, visual and auditory processing, verbal knowledge (vocabulary), academic knowledge, reading abilities, oral expression and listening comprehension are maintained at least until the age of 65 before declining, in general.

### **Originality**

Originality is the mental representation of novel ideas, or the ability to imagine and generate multiple possibilities, ideas, and solutions to a problem.

Originality is likely to decline after the age of 40 due to its reliance on fluid reasoning, however, older individuals may retain their originality if they use different cognitive strategies, such as accumulated knowledge. You can start to see here and later that as we age we must acknowledge the possible organic cognitive declines, and then be “creative” in working around those particular to us individually.

### **Daydreaming and Mind-Wandering**

In the past 10 years there has been a resurgence of research on the costs and benefits of daydreaming (mind-wandering).

First, the human default network of the brain is a set of regions more active during passive tasks than tasks demanding focused attention on the external world. The default network plays a role in imagination by constructing dynamic mental simulations based on personal experiences such as used during remembering, thinking about the future, and generally when imagining alternative perspectives and scenarios in the present (Buckner, Andrews-Hanna, & Schacter, 2008, pp 18-19). It is for this reason we are fond of thinking of it as the “imagination” network. Recent research suggests that the default network interacts with other large-scale brain systems to maintain an internal train of thought

Second, the default network is related to mind-wandering and this has implications for the generation of creative insights. Creative insights, the “Aha!” experience rarely comes while the mind is intensely focused on a problem. Instead, they typically arise unsupervised, when the conscious mind has wandered away from the task, enabling spontaneously generated novel connections. Evidence suggests, unlike machine models of the mind, that the ability to generate original ideas, as well as actual creative achievement, is associated with diffuse, unfocused attention to the external environment (Jung et al., 2013; Martindage, 1981; White & Shah, 2006).

### **> Mind-Wandering and Aging**

Mind-wandering and task-unrelated thoughts have been found to decrease with age in laboratory conditions due to reduced activity in the default mode network.

### **Knowledge and Expertise**

One significant source of individual differences not assessed by traditional sources of cognitive ability is domain-specific knowledge, defined as knowledge of the particular domain culture (occupational and avocational). It has been referred to as the “dark matter” of adult intelligence (Ackerman, 2000), and underappreciated yet critical determinant of achievement.

Domain-specific knowledge is “expertise”, and takes two forms:

Procedural knowledge - knowing how to do something, heavily required for athletic domains such as sports and dancing.

Declarative knowledge - factual information stored in long-term memory, necessary for more cognitive domains.

Expertise, mastering the tradition within a traditional domain requires very long hours of learning and practice (Ericsson & Ward, 2007).

Of course, creativity is not mere expertise. It requires the creator to find the right balance between tradition and originality - the creator must be just the right distance ahead of tradition: too short and the idea is banal, too long and the idea is outlandish.

Note that the amount of expertise required to obtain world-class expertise varies between domains and the rate at which different people master the domain differs. Also, the success of the actual training depends on more than time spent on task and includes motivation, environment (mentors and role models) and cognitive factors (working memory).

Lastly, creative people often call on what they know from other domains - general knowledge - to penetrate problems, which also accumulates over time.

### **> Knowledge, Expertise and Aging**

Not surprisingly, older adults have acquired more domain-specific knowledge than younger adults. From a life-span perspective, general knowledge, domain-specific knowledge and procedural skills, once acquired, tend to be preserved over most of the life span (Ackerman,

2011) and the acquisition of knowledge has been shown to help compensate for the decline of cognitive ability in a wide variety of domains, from football to music to chess to science. Early success provides advantages that initiate a virtuous cycle, with early knowledge stimulating the discovery and use of more knowledge, so multiplying the chances that creative ideas will emerge. Knowledge and expertise increase as we age, and these factors play a major, necessary role in creativity

### Intuition, Pattern Recognition and Heuristics

Over the past 30 years, research has revealed that much information processing takes place implicitly - without intent, awareness or conscious reasoning - and this implicit form of knowledge plays a crucial role in thinking, reasoning, and creativity (Kihlstrom, 1987). This has led to dual-process theories, which distinguish between two types of thinking (Kahneman, 2011).

**System 1** processes operate fast, automatically, and are not dependent on slower, conscious, and voluntary control systems. These processes are fast, unconscious, effortless and involuntary and include pattern recognition, intuition, heuristics, implicit learning and latent inhibition.

**System 2** processes require attention, are associated with global cognitive ability -  $g$  - , and are voluntary, supervised, executive functioning (controlled processes of information). These processes are slow, linear, conscious, and effortful, and they come into play when and if we bother to question and then check the output of the System 1 processes.

Intuition, pattern recognition and heuristics and System 1 processes.

### Intuition and Pattern Recognition

Much well-practiced knowledge involves the automatic recognition of situations that resemble situations encountered previously. We sometimes refer to this as **intuition**. One of the core processes at play in intuition seems to be the **recognition of patterns**, which also underpins **analogical reasoning**, which consists of mapping knowledge from a base domain to a target domain.

Per Hawkins and Blakeslee (2007), when confronted with a novel problem, we conjure memories of similar situations, and find out how to solve it using analogical reasoning. Although they deem all analogies creative, they explain that creativity is most obvious when “our memory-prediction system operates at a higher level of abstraction, when it makes uncommon predictions using uncommon analogies”.

### Heuristics

Accumulated knowledge leads to the ability to use fast shortcuts, or heuristics, to make decisions rather than rely on effortful decision-making (Baron, 2000; Peters, et al., 2000). Importantly, heuristics are not cookie-cutter algorithms, but involve a certain degree of flexibility that allows them to be useful for creative solutions. They are often automatic (but still flexible) ways of processing information and making decisions.

Heuristics can be broadly categorized as:

Negative heuristics - what to avoid

Positive heuristics - what to do

A major caveat about negative heuristics is in order: not getting in wrong does not equal getting it right. This is where positive heuristics come in, by providing us with shortcuts to figure out the right thing to do. However, to complicate matters such heuristics often lead to biases.

If you consider the “availability heuristic”, or the ease with which instances come to mind, this heuristic is quite frequently colored by the current narrative input allowed by individuals at any moment in time - mass media, social media, friends, etc.

However, heuristics may not usually lead to errors in thinking. System 1 and the shortcuts it relies on are at the heart of the adaptive prospecting of possible futures. By and large, they are our first and most robust way of navigating the future. When they do not come from biases, or lead to biases, positive heuristics allow goodness, beauty and truth to occur.

The degree to which positive heuristics can be domain-general remains unclear. Many heuristics may be domain-specific and work because they succinctly convey domain-specific knowledge, yet some broad general principles may also apply across fields. Positive heuristics may constitute a major source of creativity and likely are a good part of what “wisdom” means.

### **> Intuition, Pattern Recognition, Heuristics and Aging**

As with all cognitive abilities, seeing patterns sometimes requires abstract integration and fluid reasoning and so will show some deterioration with aging. But those aspects of pattern that are automatic draw heavily on knowledge of domain-specific expertise, which are factors that likely improve with age.

Analogies, pattern recognition and intuitions may constitute paradigm cases of the “compensatory” mechanisms that Baltes and Baltes (1990) invoked in their theory of “optimization with compensation” as we age. The older we get, the more information and experiences are available to us, and the more examples of successful (or unsuccessful) patterns, heuristics, and intuitions we have to draw on. As time passes, we may also be able to refine the dimensions along which we intuitively weigh information.

## **B. Personality and Motivation**

### **Diversity and Flexibility**

Initial research showed that cognitive ability and divergent thinking (originality) were both important predictors of creative achievement (Plucker, 1999). At the 50-year follow up of a longitudinal study by Torrance (1993), cognitive ability was a weak predictor of both personal and publicly recognized creative achievement (Runco, et al., 2010). Those characteristics found to be more important predictors of creative achievement were: love of work, persistence, deep

thinking, tolerance of mistakes, purpose in life, diversity of experience, high energy, creative self-concept, risk taker, openness to change and being comfortable being a “minority of one”.

Aging brings the risk of rigidity: finding tradition more appealing than originality, and the delicate balance between the old and the new may shift as time passes. To prevent rigidity, two factors may be important, that specialization (over-training) may have a negative effect and versatility (cross-training) may have a more positive effect.

Increased flexibility is likely one of the main mechanisms explaining the benefits of diverse experience. Recent research suggests that any unusual and unexpected experience can increase cognitive flexibility (Ritter, et al., 2012).

### **> Diversity, Flexibility and Aging**

To the extent that we stay open to experience, and to the extent that is not just more repetition, aging allows us to welcome, instead of reject, being comfortable and perpetually “standing at the crossroads”.

### **Openness to Experience, Flexibility, and Integrative Complexity**

“Openness to experience”, which is one of the Big Five personality traits, is consistently related to creativity (S. B. Kaufman, 2013). This trait reflects a drive toward exploration and includes openness to fantasy, feelings, actions, ideas, values, and “interest in varied experiences for their own sake” (McCrae, 1987, p.1259). Thus, individuals who are open to new experiences are more likely to make connections among seemingly unrelated pieces of information, as well as to see new patterns.

The two main subcomponents are:

**Openness** - engagement with sensory and perceptual information, primarily through implicit reasoning (to be able to automatically detect complex and noisy regularities in the environment).

**Intellect** - engagement with abstract information, primarily through explicit reasoning (reasoning expressed in language).

Openness specifically predicts creative achievement in the arts, whereas intellect predicts creative achievement in the sciences (SB Kaufman, 2015).

Openness to experience is closely related to integrative complexity, the capacity and willingness to find links among multiple competing perspectives. McAdams et al. (2004), found that openness to experience predicted the extent to which participants wrote complex narratives including points of view, mixed motivations, complex emotions, and contradictory aspects of self. These traits have been noted among U.S. Presidents and MBA students.

### **> Openness to Experience, Integrative Complexity and Aging**

Staying open to experience with age may play an important role in maintaining cognitive abilities. Low openness to experience in older adults was a marker of cognitive decline over the next 12 months per Williams, Suchy, and Kraybill (2013). This was especially true of older adults who reported being insensitive to and uninterested in art and beauty (aesthetics) and who



endorsed dogmatic and rigid social, political and religious values. People tend to either stay stable or decrease in openness to experience with aging.

It is predicted that linguistic markers of cognitive complexity (using causation or insight words), as well as “wise reasoning” (a construct closely related to integrative thinking), significantly increase with age.

Social factors may also foster more openness with age in academic fields if scholars feel much freer to consider new or outlandish ideas once they have established themselves and obtained tenure. Thus, social factors may increase willingness, but not necessarily openness. It is also possible that openness decreases with age as older people tend to take less risks and tend to be less revolutionary in their ideas (Simonton, 1994). Thus, we can not conclude how, on balance, openness and integrative complexity fare with aging.

### Interest and Motivation

In keeping with Fredrickson’s (1998, 2001) “broaden and build” theory, positive emotions may also guide us toward novel stimuli and help us “fall in love” with something (Torrance, 1983). One of these emotions is **interest**, defined by Silva (2001, p.285) as “a basic emotion with significant long-term adaptive functions; it cultivates knowledge and diversifies experience at all stages of life,” and thus leads to covertly building skills and expertise.

The vast literature on the “social psychology of creativity” has shown that intrinsic motivation, the degree to which one engages in an activity for its inherent reward, rather than for external outcomes, enhances creative thinking (Amabile, 1996). It can also keep us going during otherwise daunting practice.

Intrinsic motivation may enable “flow” during creative processes. **Mihalyi Csikszentmihalyi** - a living example of general knowledge who brings his knowledge of the arts to bear on his science - first documented this phenomenon in the 1960’s as a result of observing artists painting. **Flow** is a psychological state defined by the presence of both high skills and high challenges, a sense of control over the activity, intense focus and concentration, a merging of action and awareness, and losing track of time. In flow, individuals pursue and master noble yet manageable challenges. After experiences of flow, individuals report a sense of satisfaction and enjoyment.

### > Interest, Motivation and Aging

There is only speculation on whether these attributes change with age. It is unknown if flow, or the ability to achieve flow, changes with age. These two attributes would therefore be very subjective over the course of one’s lifetime.

### Psychological Resources: Grit, Self-Efficacy, and Energy

There are a number of psychological resources that are not specific to creativity, but are critical for achievement in general: grit, optimism, and self-efficacy.



Gritty individuals do not give into helplessness readily and they persist in the face of obstacles. Optimism and self-efficacy have similar benefits (Bandura, 1997, Seligman, 1991). As Bandura noted, “above all, innovativeness requires an unshakable sense of efficacy to persist in creative endeavors.”

These resources call on energy and stamina. Mental and physical energy enable cognitive processes requiring sustained effort and self-discipline (Chaiken & Trope, 1999). High mental energy and vigor predict higher levels of work involvement in the workplace, however, there is no modern literature that delves into the notions of energy - both mental and physical - since the demise of Freudian dynamics. Biographies of great achievers often emphasize their exceptional levels of energy (Jamison, 2004).

### > **Grit, Self-Efficacy, Energy and Aging**

Duckworth et al. (2007) found that grit increased with age. Alternatively, older adults may learn through experience that perseverance pays off. In addition, self-efficacy undergoes important increases over the life span, increasing from childhood to adulthood as we learn to master the demands of each life stage. Self-efficacy seems to hold with old age, especially if they are immersed in supporting and challenging environments.

In contrast, findings on the effects of aging on energy and stamina suggest that these resources decline with age, which may well result in a decrease in creative achievement.

## **C. Interpersonal Processes**

### **Sense of the Audience**

Creators think how others will react. This “sense of the audience” probably plays a very large role in both the generation and the evaluation of creative ideas - the two defining components of creativity. Sense of the audience is at the heart of the crucial distinction between originality and usefulness.

In science and academic disciplines, “audience” refers to people at the cutting edge of the discipline, embodied by “gatekeepers,” who are the group of individuals with the power to decide which contributions will be smiled upon (Csikszentmihalyi, 1999). A good sense of the audience may rely on perspective taking, as it allows us to accurately judge what others will see as novel and valuable. Some of the default brain regions that conjure “mental simulations of the minds of others” have been found to be crucial for a positive audience reception (Falk et al., 2013).

Perspective-taking has been defined as one’s ability to imagine the world from another person’s point of view (Galinsky, 2005) and to understand other people’s thoughts, motivations, and emotions (Parker, 2008). Having a well-developed sense of audience allows the creator to anticipate what the audience and the domain of interest will *ultimately* benefit from, even if the audience may *not* find the idea to be “pleasing” in the short run (Silvia, 2012).

A growing body of research on prosocial motivation shows that working for the benefit of others is linked to increased creativity (Forgeard & Mecklenburg, 2013). In addition, there is an ability to inspire and persuade others that is important. Gardner (1993) suggested that the key similarity among the seven geniuses of the 20th century - Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, and Ghandi - was effective and relentless self-promotion.

### **> Sense of Audience and Aging**

There are good reasons to believe that age helps perspective-taking. Some of this stems from an increasing concern for the well-being of others and thinking more about legacy. Not infrequently, creators produce successful works at the very end of their lives (Simonton, 1989). On balance, aging likely leads to an enhanced sense of audience thanks to the accumulated knowledge of the audience - unless, of course, the audience changes faster than the creator.

### **Collaboration**

Two-thirds of the nearly 300 Nobel Prize laureates named between 1901 and 1972 received the prize for work done collaboratively (Zuckerman, 1977) and the number of authors on an article predicts its number of citations in other authors/researcher's work (Nemeth & Goncalo, 2005).

Collaboration may enhance creativity by providing diversity of thought and the challenge to justify ideas and opinions (Shenk, 2014). Most creators do not work alone, instead, they consult and discuss their ideas with others, who help them refine and fully understand the germ of insight.

### **> Aging and Collaboration**

Older adults may use collaboration as a way to compensate for general cognitive decline and maturation probably helps us be better able to pick the right collaborators - people who share a similar vision, yet offer different perspectives. Older adults may also have a larger network of potential collaborators to choose from.

## **Summary**

The following elements likely decline with age:

- Processing speed
- Short-term memory
- Fluid reasoning
- Originality
- Mind-wandering
- Energy and stamina
- Openness to experience

The following elements likely increase or remain stable with age:

- Domain-specific knowledge and expertise
- General knowledge

- Pattern recognition, intuition, and heuristics
- Diversity of experience
- Interest and motivation
- Grit and self-efficacy
- Effective collaboration

For some elements, including sense of the audience, perspective taking, and integrative complexity, the current state of empirical evidence is murky.

Lay theories of genius often seek to explain greatness through a single extremely rare talent. Scientific theories suggest otherwise. Indeed, rare achievement can be arrived at when the individual is merely very good - say one in a hundred - at each of the several skills that are the components of a domain-specific effort. Creative genius might, therefore, not reside in excelling surpassingly in just one component, rather it may occur when someone is “merely” very *good* in all of them.

If creativity is indeed componential, creativity becomes much more trainable by improving each of the components to a high, but not superhuman, level. But much more research is needed to identify components within each possible domain. The componential view suggests that the effects of aging depend on what the components turn out to be.

The number of components, as well as the importance of cognitive ability, may explain differences in developmental trajectories between domains. Creative achievement tends to peak early (in the early 30's) and drop off rapidly in domains such as lyrical poetry, pure mathematics, and theoretical physics, which tend to rely heavily on fluid reasoning. In contrast, creative achievement peaks later (in the early 40's) and exhibits a more gradual decline (if any) in fields that draw more on knowledge and expertise, such as novel writing, history, philosophy, and medicine.

At this time, the conclusion is likely that a componential analysis by domain will find that some components wane with age and others wax and that several (but not all) processes central to human creativity likely remain stable or increase with age. All of the capacities that likely improve with age may be teachable, and teaching them explicitly should make for a more creative world.

“Sometimes it is the artist's task to find out how much music you can still make with what you have left.” Itzhak Perlman, violinist.