

Imagination is the Seed of Creativity
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Abstract:

Imagination—the ability to mentally simulate situations and ideas not perceived by the physical senses—lays the foundation for creativity. Yet, imagination alone is insufficient to produce creativity. We define two types of imagination important for creativity: social-emotional and temporal. Social-emotional imagination is the ability to conceive of and reflect on multiple social perspectives and scenarios, and the implications of these for one’s own and others’ lives. It promotes creativity by helping individuals understand multiplicities of identity and experience within themselves and others, reason ethically, and appreciate human diversity and potential. Temporal imagination is the ability to engage in mental time travel, counterfactual thinking, and mind-wandering. It can lead to creativity by allowing individuals to engage in the kind of non-literal, divergent and future-oriented thought creativity necessitates. For creativity to happen, imaginative thought is infused into mental simulations that are regulated, evaluated and integrated to conjure new ideas and concepts. As such, in the brain, creativity relies heavily on the default mode network, which is known to be involved in mental simulations across time and especially about social content. Creativity also relies on organized interactions between the default mode network and the executive attention and salience networks, in order for imaginings to be strategically organized into coherent, meaningful plans and actionable ideas. To harness the potential of imagination, individuals need conducive personal qualities, including openness to experience and intrinsic motivation, as well as a supportive context. To better support individuals in developing their creative potential, for example in schools and in the workplace, we must continue to explore the mechanisms by which imagination leads to creativity and the biological, mental, and cultural constraints and affordances.

Key Words:

Social-emotional imagination, temporal imagination, default mode network, creativity

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Imagination does not become great until human beings, given the courage and strength, use it to create.

— *Maria Montessori, 1948 (P. 21)*

Across domains and levels of sophistication of creativity, there is one fundamental skill that makes creativity possible. Without imagination, there can be no creativity. This chapter explores cognitive and affective processes common to both imagination and creativity, advancing the argument that the former enables the latter in conjunction with other personal factors such as expertise, personality, and motivation, as well as environmental support (S. B. Kaufman & Gregoire, 2015; Seligman, Forgeard, & Kaufman, 2016; Sternberg & Lubart, 1991).

Imagination refers broadly to the human capacity to construct a mental representation of that which is not currently present to the senses (Markman, Klein, & Suhr, 2009; Seligman et al., 2016). We engage in imaginative thought both intentionally and unintentionally and both solitarily and collectively. Across social-emotional and temporal domains, there are a number of forms of imaginative thought, including perspective-taking, identity construction, constructive internal reflection, thinking informed by an understanding of multiple cultures, pretend play, prospection, memory construction, counterfactual thinking, and mind-wandering (Abraham, 2016; Runco & Pina, 2013). Many forms of imagination—especially imagination about people, including oneself, across time and space—draw heavily on the brain’s default mode network (DMN), a network composed of several brain regions along the midline of the brain in the frontal and parietal lobes, including the medial prefrontal cortex, medial parietal cortex, lateral parietal cortex, and regions within the medial and lateral temporal cortex (Andrews-Hanna, Smallwood, & Spreng, 2014; Schacter, Addis, & Buckner, 2007; Immordino-Yang, Christodoulou, & Singh, 2012; Raichle & Snyder, 2007; Spreng & Andrews-Hana, 2015; Tamir & Mitchell, 2011). Other

forms of imagination that involve visualizing physical objects or physical space are thought to recruit more heavily the brain's executive attention network (EAN) and dorsal attention network (DAN), a network involving communication between the frontal eye fields and the intraparietal sulcus (Andrews-Hanna et al., 2014; Jack et al., 2013). An understanding of the brain networks that support imaginative thought can help elucidate the confines of the imagination construct. Regardless of the specific large-scale brain network interactions involved with specific forms of imagination, we see a unifying theme across all of these imaginative cognitive and emotional processes—the capacity to see in one's mind what is not present— which serves as a critical foundation for creative thinking.

Like imagination, creativity involves thinking about content that is removed from the here and now. It can be a messy process characterized by the harmonizing of seemingly contradictory ways of thinking or being (S.B. Kaufman & Gregoire, 2015). Like imagination, creativity in the social domain is thought to be supported by the default mode network (Beaty et al., 2014a) because of its role in the development of “originality”—or the mental representation of novel ideas (Jung, Mead, Carrasco, & Flores, 2013). The executive attention network, on the other hand, is important for making plans and keeping track of strategies employed while pursuing a creative goal. People exhibit creativity in big and small ways; we can engage in creativity that is personally meaningful and useful in our everyday lives or creativity that helps us learn new ideas and concepts. Some individuals pursue creative endeavors professionally, even producing works that change thoughts and behaviors of groups and society (J.C. Kaufman & Beghetto, 2009; S.B. Kaufman & Gregoire, 2015). Creativity is rarer than imagination, as it demands both usefulness and a good sense of the audience—knowing when to be original and when to conform to societal conventions (Seligman et al., 2016). It also requires enough domain-

specific knowledge to gauge how well received one's idea will be by a given audience

(Sternberg & Lubart, 1999). Therefore, researchers have proposed that the creative process be divided into two main phases: the generation phase, through which imagination enables the relatively unconstrained invention of ideas, and the exploration phase, in which those ideas are evaluated and refined (Finke, Ward, & Smith, 1992). It is apparent, however, that creativity depends on imagination and so is essential for it. We turn now to exploring specific cases of the imagination-creativity relationship.

Social-emotional imagination

Social-emotional imagination is the ability to conceive of multiple possible cognitive and affective perspectives and courses of actions and to skillfully reflect about each of these and their ties to one's own value and understanding of the world (Gotlieb, Hyde, Immordino-Yang, & Kaufman, 2016). It is composed of several specific imaginative skills, including perspective-taking, identity construction, constructive internal reflection (Immordino-Yang, Christodoulou & Singh, 2012), and cultural awareness (Gotlieb, Hyde, Immordino-Yang, & Kaufman, 2016; Gotlieb, Jahner, Immordino-Yang, & Kaufman, 2016). Social-emotional imagination also involves or is related to meaning making, narrative construction, pretend play, planning, self-regulation, and moral decision-making. Each of these processes is made possible by imagination, and each also has the potential to support people in exhibiting creativity.

Individuals who frequently and deeply engage in social-emotional imaginative thought may demonstrate their creativity by being leaders in advocating for just social policies, pioneering entrance into domains others have not previously entered, and applying solutions to problems from one social context to another. The creative vision of Martin Luther King, Jr. and the bravery of Sally Ride (a physicist who became the first American woman astronaut to fly in

space) may have stemmed from skilled social-emotional imaginative abilities. The creativity of those adept in social-emotional imagination may also manifest it in smaller ways, such as by being able to put others at ease, helping a group of individuals coalesce, or being able to find something to admire in most people.

Pretend play: the genesis of social-emotional imagination

Before people develop social-emotional imaginative abilities in perspective-taking, identity construction, constructive internal reflection, or cultural awareness, they develop precursor imaginative abilities. Pretend play, which is “the acting out of stories which involve multiple perspectives and the playful manipulation of ideas and emotions” (S.B. Kaufman, 2012, para. 1; see also Russ, this volume) is recognized as an essential contributor to children’s social and emotional development and may represent an early form of social-emotional imagination. There are several processes that combine to make pretend play, such as divergent thinking, associative thinking, insight and problem-solving, narrative development, emotional expression, joy in pretending, and integration of affect (i.e., appropriately expressing emotion within a storyline; Russ, 2014). In addition to pretend play with peers, even when children use toys to construct narratives or characters alone, they can cultivate social skills through the representation of multiple points of view and practiced communication (Hughes, 1999). Participating in make-believe games supports children’s capacities for self-regulation, delay of gratification, civility, and empathy (Berk, Mann, & Ogan, 2006; Hirsh-Pasek, Golinkoff, Berk, & Singer, 2009).

Through the development of these skills, pretend play may support creativity. Many experts regard play as a natural form of creativity for children between the ages of 2.5 and 10 (Fein, 1987). Children who have or have had imaginary friends tend to score more highly on measures of creativity (e.g., on the “unusual uses” test and on a measure of involvement in

creative hobbies) than do children who report never having had an imaginary friend (Hoff, 2005). Central to appreciating its role in laying the ground work for creativity is the notion that through pretend play, children practice, manipulate, and deeply engage with images, ideas, fantasy, and affect (Russ, 2014). This is especially true of the role-playing form of pretend play, through which they learn to hold multiple representations in mind and to flexibly switch between them. This process provides children with experience in the aforementioned generation phase of creativity by allowing them to practice designing fantastical characters and plots (Sachet & Mottweiler, 2013). However, it may also help them build skills relevant to the exploration phase of creativity, which is dedicated to the evaluation and refinement of unconstrained, imaginative thought. For instance, if by engaging in role-play, children improve their understanding of others' mental states, that very understanding could help them discern which of their ideas others would consider novel and original. Thus, social understanding would mediate the relationship between pretend play and creativity (Runco, 2007; Sachet & Mottweiler, 2013). Another important mediator in the relationship between pretend play and creativity is affect. In particular, Russ, Robins, and Christiano (1999) found that the affect children display through pretend play can furnish them with a wide range of associations that they can later draw on when engaging in problem solving and divergent thinking (i.e., a free-flowing manner of generating multiple related ideas or solutions to a problem). Children learning to experience, regulate, and fluidly alternate across a broad range of emotions through engagement in pretend play can strengthen affective processes supportive of adult creativity.

Perspective-Taking

Empathic perspective-taking, one aspect of the social-emotional imagination, is the ability to imagine what another person thinks or feels or to imagine oneself as another person

Rebecca Gotlieb, Elizabeth Hyde, Mary Helen Immordino-Yang, and Scott Barry Kaufman (Batson, 2009). Affective perspective-taking is inherently an act of imagination in that it requires simulating another person's experiences. It is known to be supported by several regions within the aforementioned default mode network, as well as by some regions outside of the default mode network that are associated with visceral feelings (Fan, Duncan, Greck, & Northoff, 2011; Lamm, Decety, & Singer, 2011; Schurz, Radua, Aichhorn, Richlan, & Perner, 2014).

Perspective-taking may facilitate a number of social functions that support creativity. For example, if we take the perspective of the person to whom we are relaying a story, we may be able to tell the story in a way that is clearer to that person and that will require him to surmise less information on his own. In so doing, we can increase the listener's enjoyment of the story (Cooney, Gilbert, & Wilson, 2017). As such, this act of perspective-taking may facilitate fluid conversing, which can be an act of creativity in that two people are working together to create a novel shared experience that they find valuable in some way (e.g., serving an important social function, establishing a collaboration that later results in a tangible creative product, etc.). When individuals learn about ideas expecting to have to teach them to others, and thus encode the content while imagining what others would think or need to know to understand the idea, they learn the content more thoroughly and can communicate it more effectively than if they had learned the content without expecting to teach it (Chang, Berger, & Chang, 1981; Nestojko, Bui, Kornell, & Bjork, 2014; Fiorella & Mayer, 2014). That is, drawing on perspective-taking skills while processing information helps us learn the information in a way that is longer-lasting and useful.

Perspective-taking also increases cooperation among individuals and reduces negative misinterpretations of others' behaviors (Rumble, Van Lange, & Parks, 2010). The ability to cooperate and alter one's own ideas in light of others' recommendations may support the

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generation of creative insights (Sawyer, 2007; 2017). Relatedly, perspective-taking can improve the outcome of a negotiation such that each party finds a previously undiscovered and mutually beneficial outcome (Galinsky, Maddux, Gilin, & White, 2008). Teams with greater diversity, including diversity of perspectives, tend to be more creative, and engaging in more perspective-taking helps people work more effectively with people who are different from them (Hoever, Van Knippenberg, Van Ginkel, & Barkema, 2012; Galinsky & Moskowitz, 2000). For example, when Italian elementary school children were asked to think of all the uses of an object that they could—a classic task used to measure creativity—they generated a greater number of uses when they had previously worked on an unrelated task in a team with an immigrant to Italy, than when they had worked on the unrelated tasks with only Italian-born peers. Moreover the creativity benefits of diverse teams were greatest when participants focused on the similarities between people, rather than the differences (Vezzali, Gocłowska, Crisp, & Stathi, 2016).

Notably, the aforementioned benefits of perspective-taking support creative thought that happens in groups (e.g., Sawyer, 2007; 2017), and yet solitude is extremely important for creativity. Indeed, many creative geniuses (e.g., Proust) demand that they work alone (S.B. Kaufman & Gregoire, 2015). Yet, even for creative work that an individual produces alone, perspective-taking abilities may be helpful. For example, fiction writers have greater empathy and perspective-taking abilities than the general population (Taylor, Hodges, & Kohányi, 2003). Further, fiction writers who have published their work or who earn some income from their writing, as compared with those who have not published and do not earn any income from their writing, are more likely to state that the fictional characters they create have thoughts and feelings separate from their own (Taylor et al., 2003). Similarly, actors, individuals who are creative in performance art, are better able to read the emotions and imagine the thoughts of

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others than are non-actors (Goldstein, Wu, Winner, 2009). Perspective-taking training among
young children has been associated with enhanced divergent thinking (Doron, 2017).

Flexible Identity Construction

Another aspect of social-emotional imagination that supports creativity is the flexibility with which people construct their identity. *Flexible identity construction* requires maintaining a sense of one's core self while also conceiving broadly of and skillfully moving between the many aspects of one's identity. It also involves developing and utilizing strategies to refine an aspect of one's identity or to become a hoped-for future self (Gotlieb, Hyde, Immordino-Yang, & Kaufman, 2016). Both the acts of conceiving of an array of identities that one currently possesses and envisioning possible identities one might possess in the future require imagination. This process of identity construction calls for an individual to reflect about how her different actions and relations can be combined or disentangled to make her who she perceives herself to be and who she might be in the future.

By calling to mind aspects of identity that are associated with success in an array of environments, individuals make it possible to demonstrate creativity in more domains. Further, they may be willing to put themselves in a greater diversity of circumstances, which could provide fodder for creative thinking. Conceiving of one's identity as multi-faceted can make it easier to connect with a greater range of individuals because it is easier to find a shared aspect of identity. Consequently, the exposure to more individuals and ideas that a broadly construed identity can facilitate may spur creativity (Kang & Bodenhausen, 2015). Individuals can also switch among varied aspects of their own identities (e.g., an individual can shift to see herself as a woman, mother, scientist, marathon runner, etc.) to assume the ones that are most helpful or appropriate for the task at hand (Kang & Bodenhausen, 2015). In instances when an aspect of

one's identity is threatened, if the individual focuses on non-threatened or positively stereotyped aspects of her identity or core values, she is typically buffered from the adverse performance effects of the identity threat (Gresky, Eyck, Lord, & McIntyre, 2005; Rydell & Boucher, 2009; Rydell, McConnell, & Beilock, 2009; Taillandier-Schmitt, Esnard, & Mokoukolo, 2012). For example, when a woman is taking a math test, if instead of focusing on her identity as a woman, she focuses on: a) her identity as a college student, which is an identity that is positively stereotyped for success in math; b) the fact that there are a large number of aspects of identity that she possess besides her gender identity or; c) some of the traits or characteristics that she possess that are most important to her (e.g., humorous, sensitive, loyal), she may not show the suppressed performance on the math task that is typical of people experiencing stereotype-threat.

While the benefits of the aforementioned stereotype threat-reducing strategies have mostly been examined relative to performance on convergent thinking tasks (e.g., solving multiple-choice math problems), it is conceivable that these benefits would also support divergent thinking and creative expression. For example, as women and racial and ethnic minorities gain popularity as mainstream artists in fields from which they have historically been excluded or underrepresented, the ability to draw on the similarities they have to others in their field (e.g., in being exceptionally talented at their art) may help them overcome hurdles to entry associated with being one of the first of a particular identity group to enter that field. Flexible identity construction may reduce stereotype threat effects on people's ability to demonstrate their creativity. It is also the case that assessing people's creative abilities may be a way to measure students' potential and ability without inducing stereotype threat effects (J.C. Kaufman, 2006). Thus including creative assessments in the college admission review process, for example, might be a fairer way to assess diverse students (J.C. Kaufman, 2010). Having a more diverse student

body entering college may, in turn, expand the possible identities that these youth and members of their community ascribe to themselves or conceive of as possible.

Constructive Internal Reflection

The way in which we learn to construct our identity is through reflection about who we are and what our lives mean. *Constructive internal reflection* is the ability to connect complex ideas and think about one's own values and beliefs and the social meaning of one's quotidian encounters in order to guide actions and thoughts (Immordino-Yang et al., 2012). To engage in this deep reflection, people likely need uninterrupted and relaxed time with their thoughts. Like other aspects of social-emotional imagination, constructive internal reflection occurs when the default mode network is active, and is unlikely to occur when attention is focused outward (Immordino-Yang et al., 2012). Constructive internal reflection is a skill that can facilitate creativity in the social realm, such as in generating novel solutions to, and actions against societal inequalities, or simply cleverly navigating an awkward or emotionally charged encounter with a friend or co-worker.

Constructive internal reflection helps us make meaning of our lives and guides moral actions. For example, adults who express greater concern for advancing the health and well-being of future generations are more likely to construct their own life story as one in which, disturbed by others' suffering and guided by a strong sense of morality, they worked to improve one negative situation after another in order to make the future better for other people (McAdams & Guo, 2015). In the midst of difficult circumstances, people are less likely to see their personal narrative as one of transforming hardship into triumph (Dunlop, Guo, & McAdams, 2016). And yet, even in devastating circumstances, when people interact with others and carry out kind deeds that benefit others, they are better able to make meaning of their lives and maintain a sense of

purpose (Frankl, 1946). The ability to find a way to altruistically help other people even while facing tremendous personal struggles is an example of creative thinking about how to direct one's energy. Similarly, when people feel inspired by others' virtuous actions, as compared to inspired or impressed by their skillful actions, they are more likely to think about implications of that person's story for their own life purpose. They often spontaneously describe wondering how they can use their life to better serve others, or how they should be more grateful for the good-fortune they have (Immordino-Yang, 2010; Immordino-Yang, McColl, Damasio, & Damasio, 2009). That is, the act of imagining and making meaning of alternative situations and life stories can inspire creativity in leading a life of service.

Polycultural Thinking

The final core component of social-emotional imagination that we will discuss here is *polycultural thinking*, or thinking informed by an awareness of multiple interacting cultures (Morris, Chiu, & Liu, 2015). Polycultural thinking is a form of cultural awareness that can be developed among people who live and interact with others from a variety of cultures, and who often themselves belong to more than one cultural group. It can promote creativity by providing an individual with multiple frames through which to think about problems. Evidence suggests that just one year of positive and meaningful interactions with diverse peers—which may stimulate polycultural thinking—can improve students' problem solving, complex thinking, and leadership skills, as well as their concern for the common good (Hurtado, 2005). One study of multi-racial adolescents compared those adolescents who identify as multicultural with those who identify with only one of their groups. The adolescents who identified as belonging to more than one racial group showed greater self-esteem, positive affect, and participation in community (Binning, Unzueta, Huo, & Molina, 2009). This may suggest that capitalizing on polycultural

thinking or ways of being supports psychological well-being and civic engagement. As culture shapes the way we understand the physical, social, and emotional dimensions of our world (Immordino-Yang & Gotlieb, 2017; Immordino-Yang, Yang, & Damasio, 2014; Oyserman & Lee, 2008; Shweder & Bourne, 1982), then having a larger repertoire of cultural frames may facilitate skills for viewing and experiencing the world in a greater variety of ways, which in turn may allow us to generate new and useful ideas. Creative innovation typically arises from the unexpected rearrangement of products and ideas that already exist. The cultural experiences and lenses that individuals possess impact the products that they might rearrange and the way in which they might do so (Glăveanu, 2010). Consider, for example, that numerous novelists, poets, social scientists, and visual artists have characterized their multi-cultural or multi-racial identities and experiences as a driving force and a source of ideas in their work (O’Hearn, 2008).

Temporal Imagination

Beyond the social-emotional imagination, another form of imagination that supports creativity is the *temporal imagination*, which is characterized by one’s ability to engage in mental time travel. Mental time travel is being aware of subjective time and oneself in relation to it, or reconstructing and reasoning about the past and envisioning possible futures (Tulving, 1985, Tulving, 2002). Temporal imagination includes such processes as prospection, episodic memory construction, counterfactual thinking, and mind wandering. Like social-emotional imagination, many forms of temporal imagination are subserved by the default mode network (Spreng & Grady, 2010; Østby et al., 2012; Tamir & Mitchell, 2011). Many aspects of temporal imagination are indeed quite social in nature; however, they are characterized by being about imagination across time.

Individuals with strong temporal imaginations may be visionaries able to predict trends

ahead of others (e.g., Tetlock & Gardner, 2016), or they may demonstrate creativity in their ability to write engrossing works of fiction. Esteemed author and Nobel Prize winner Toni Morrison's ability to tell historical stories set across time periods and through a range of brilliant characters' perspectives may be the result of vivid temporal imagination. Paul Farmer, through his work as co-founder of Partners in Health and numerous efforts to provide health-care and to cure diseases in developing countries, may similarly possess exceptional temporal imaginative abilities. His ability to see a country's future health trajectory and imagine alternatives and ways to bring about those alternatives is an example of harnessing temporal imaginative abilities towards creative (i.e., novel and useful) ends. Although these individuals demonstrate exceptional temporal imagination, temporal imagination can be valuable for all of us in, for example, deriving greater meaning in life (Waytz, Hershfield, & Tamir, 2015).

Prospection

Gilbert and Wilson (2007) define prospection as the "ability to 'pre-experience' the future by simulating it in our minds" (P. 1352). These mental simulations include *navigational* (i.e., moving through physical space), *social* (i.e., speculating about others' minds, similar to perspective-taking discussed above), *intellectual* (i.e., evaluating new ideas) and *memorial* (i.e., recalling and reasoning about the past; Buckner & Carroll, 2007). The first three categories represent hypothetical simulations of future events, while the fourth allows one to run through counterfactual alternatives to events that have already occurred (Seligman, Railton, Baumeister, & Sripada, 2013). In recent years, researchers have tied these forms of mental simulation and self-projection to neural activity in the default mode network. The internally directed cognition that the default mode network supports facilitates imagination in

that it allows the individual to conduct simulations based on personal experiences using both episodic memories of the past and prospective representations of the future (Buckner, Andrews-Hanna, & Schacter, 2008).

Construal-level theory allows us to appreciate the role of prospection in supporting creativity. This theory stipulates that temporal distance—or the perceived proximity of an event in time—affects an individual’s mental representations of future events, and thus their responses to them (Trope & Liberman, 2003). In particular, the farther away an imagined event is from the present, the more likely it will be “construed” in terms of abstract, general, and decontextualized features rather than in more concrete, specific, and contextual detail (Förster, Friedman, & Liberman, 2004). Relatedly, Liberman and Trope (1998) asked participants to imagine engaging in a range of activities (e.g., reading a science fiction book) either the following day or the following year and to describe the activities. As predicted, descriptions of the near future “tomorrow” events elicited low-level, concrete descriptions, such as “I read a book by flipping the pages,” whereas descriptions of reading “next year” elicited high-level, abstract descriptions, such as “I broaden my horizons by reading a book”.

These findings suggest that more distant future perspectives—those enabled by prospection—promote abstract representations. Creativity and insight problem-solving, in turn, are known to benefit from abstract thinking (Förster et al., 2004; Finke, 1995; Ward, 1995). Similarly, research has shown that temporal distance can influence the breadth of object categorization. For example, in a study by Nussbaum, Trope, and Liberman (2003), participants were asked to imagine an event (e.g., a camping trip) either for the upcoming weekend or several months later and to organize 38 objects intended for the event (e.g., tent, toothbrush) into however many exhaustive and mutually exclusive groups they saw fit. Those who completed the

task with the belief that the trip was farther in the future used fewer, more eclectic categories than those who envisioned it as being just around the corner. These findings, too, provide evidence of how prospection, particularly that which projects thinkers months and years into the future, can serve creativity by helping them become open to broader categorizations and unlikely connections between objects and ideas.

Memory Construction

One might think that remembering the past is merely an act of recall. However, emerging research suggests that memory construction underlies imaginative thinking because humans are not able to “play back” the past like a movie-reel, but instead must cobble together a likely rendering of past events based on educated, imagined guesses (Schacter, 1996). Those who engage in more vivid memory construction may be able to think more creatively because they conjure more real-world details and experiences when thinking about current challenges, which may yield more realistic solutions to those challenges. They may be better at using their past actions to guide current and future behavior, which could support creativity by making it more likely that individuals will seek experiences they have not had previously.

Recent studies compared people provided with training in recalling details of an event (e.g., guided mental-imagery exercises) and a control group who were asked general questions about the event, but not supported in remembering it better. Both younger and older adult participants in the recall-training condition significantly outperformed participants in the control condition on a subsequent, unrelated divergent thinking task, and they generated more new and creative ideas (Madore, Addis, & Schacter, 2015; Madore, Jing, & Schacter, 2016). This effect may occur because supporting people in remembering past events encourages them to focus on details. Activating this detail-orientation may also be helpful for creative thinking tasks that

similarly require an attention to specifics. Episodic memory, which is itself imaginative, may support creativity by promoting a focus on specificity and detail.

Counterfactual Thinking

Counterfactual thinking is a specific case of temporal imagination that combines both prospection and memory when individuals entertain thoughts of what might-have-been (Roese & Olson, 2014). When people engage in counterfactual thinking about their own life or the lives of other people, the default mode network is involved (De Brigard, Spreng, Mitchell, & Schacter, 2015). Specifically, people tend only to simulate what-if experiences in rich detail when they are proximal or similar to one's current experience in that they occur close in time, are physically nearby, likely to happen, or are relevant to close others (Liberman & Trope, 2008; Liberman, Trope & Stephan, 2007; Trope & Liberman, 2003; De Brigard et al., 2015). Individuals also run distal simulations—those dedicated to imagining events that seem far away in terms of time and distance and that are unlikely to occur or that involve the minds of strangers. However, the mental representations of such events are generally abstract and simplified by comparison. Tamir and Mitchell (2011) found that two regions of the default mode network—the medial prefrontal cortex and retrosplenial cortex—were more active when fMRI study participants were asked to think about proximal rather than distal events, regardless of whether the perceived “distance” between the current and imagined experience was spatial, temporal, social, or hypothetical.

This ability to simulate counterfactual experiences—to imagine alternatives for how past events could have unfolded—in different levels of detail also “may contribute to the uniquely human capacity for considering novel and hypothetical outcomes at arbitrary points in the future,” according to Mitchell, Schirmer, Ames, and Gilbert (2011, P. 863). Thus, “what-if” thinking about the past may support future creativity both through the practice of entertaining

other possibilities as well as by allowing the thinker to detach from the present and more flexibly imagine himself in different circumstances that may be more conducive to creativity. For example, individuals who are more skilled at counterfactual thinking are also more easily able to self-restrain (Mischel, 2014) and to delay gratification in the service of later reward (Mischel, Shoda, & Rodriguez, 1989), which could support one's ability to persist through the many obstacles a creative pursuit can present. One possible explanation for the relation between counter-factual thinking and self-restraint is that as people experience counterfactual emotions such as regret or relief, they may become motivated to make more adaptive choices going forward (O'Connor, McCormack, Beck, & Feeney, 2015). It is important to keep in mind, however, that imagination can be used for both positive-constructive ends as well as for potentially selfish purposes. Similarly, while creativity is widely regarded as being associated with desirable personal attributes and outcomes, it may also have a more malevolent side (e.g., being related to a lack of integrity) (Beaussart, Andrews, & Kaufman, 2013; Cropley, Kaufman, & Cropley, 2008). For instance, those who more frequently engage in counterfactual thinking may also be more skilled at lying and more likely to expect others to lie (Briazu, Walsh, Deepröse, & Ganis, 2017). Indeed, both counterfactual thinking and lying require imagining possible alternatives. Nevertheless, lying can be an act of creativity in that individuals typically generate a new "truth" to help achieve some goal they have involving the person to whom they are lying.

Whether counterfactual thinking is used to support benevolent or malevolent ends, it is a useful skill. It can, however, cease to be useful when people struggle to disentangle factual and counterfactual thinking. People who cannot discern what information is fact and what information is plausible, but inaccurate, may act based on wrong information. The issue of

assessing what is true and what is an “alternative fact” received intense political and media

attention preceding and following the 2016 U.S. presidential election. This inappropriate

application of counterfactual thinking has had and will continue to have deleterious implications

for how we are governed.

Mind Wandering

Mind wandering—or the experience of having one’s attention shift away from the objective world and its related perceptual input and toward internal reflection—often involves temporally imaginative thoughts (McMillan, Kaufman, & Singer, 2011). Notably, mind wandering can also be atemporal (Jackson, Weinstein, & Balota, 2013). The default mode network is active when individuals mind wander (Jung et al., 2013). Generally, mind-wandering is positively correlated with creativity (Preiss, Cosmelli, Grau, & Ortiz, 2016), but not all kinds of mind wandering promote creativity, and some kinds of mind wandering—such as negative rumination— can be maladaptive (Nolen-Hoeksema, 2000). However, the kind of mind wandering known as “positive constructive daydreaming,” which is characterized by “playful, wishful imagery, and planful, creative thought” (McMillan et al., 2011, P. 1), can serve four adaptive functions: future planning, creative incubation and problem-solving, attentional cycling (when an individual can flexibly switch between various informational streams), and dishabituation (which improves learning since an individual is taking short, recuperative mental breaks from externally demanding tasks; Schooler et al., 2011).

In a series of studies investigating the temporal dimensions of mind wandering, Smallwood et al. (2011) demonstrated the adaptive benefits of “prospective daydreaming”. It allows individuals to connect past and future selves, to devise long-term plans, and it can also serve as a wellspring of creative inspiration. In a later study, Smallwood, Ruby, and Singer

Rebecca Gotlieb, Elizabeth Hyde, Mary Helen Immordino-Yang, and Scott Barry Kaufman (2013) explored how mind wandering related to self-control as measured by delay discounting of distant rewards. They found self-generated thought engages processes associated with the effective management of long-term goals. In other words, as discussed above, those who are better able to imagine the future can recruit that ability to resist current temptations and to take steps toward achieving their goals, including those focused on creative achievement (Baird, Smallwood, & Schooler, 2011; S.B. Kaufman & Duckworth, 2015; Mooneyham & Schooler, 2013). When given the opportunity to mind wander, individuals engage in more creative problem solving (Baird et al., 2012).

Imagination and the Default Mode Network are not the whole story

One basic premise we wish to reemphasize is that imagination is necessary but not sufficient for creativity. As such, creativity must draw on skills, knowledge of the context, motivation, and a variety of traits other than imagination. In this same vein, if creativity goes beyond imagination, it is likely subserved by more than just the default mode network. Indeed, meaningful creativity draws on both imaginative abilities, executive control abilities, and flexible task switching, and is supported by the default mode network, salience network, and the brain's executive attention network (Beaty, Benedek, Kaufman, & Silvia, 2015; Beaty, Silvia, Nusbaum, Jauk, & Benedek, 2014; Bonnelle et al., 2012). Although the DMN and executive attention network are typically at odds with one another—when one is activated, the other tends to be deactivated—creative thinking is unique in that it requires these networks to work in concert with one another (Beaty et al., 2015; Zabelina & Andrews-Hanna, 2016). The salience network (which includes the anterior cingulate cortex, presupplementary motor area, and anterior insula) facilitates the flexible switching between these other large-scale brain networks (e.g., Andrews-Hanna et al., 2014; Bonnelle et al., 2012).

While a traditionally emphasized function of the executive attention network is to home in on relevant stimuli from an individual's external environment, the aforementioned research findings reveal that the executive attention network can also play a role in selecting meaningful associations that emerge from the inner stream of thought supported by default mode network activity, as well as in suppressing the more prepotent responses that are likely to be uncreative (see Beaty, Silvia, Nusbaum, Jauk, & Benedek, 2014). For instance, Kam, Dao, Stanciulescu, Tildesley, and Handy (2013) found that the executive attention network can work in tandem with the DMN to identify the most relevant ideas that arise from engaging in intentional episodic memory retrieval and processing. This has important implications when considering potential sources of creative inspiration. The types of imagination reviewed here (e.g., social-emotional and temporal) primarily draw on the default mode network—albeit with enhancement from flexible toggling between the DMN and the executive attention network.

Bearing Creative Fruits from the Seeds of Imagination

Without imaginative thinking there can be no creativity, and, yet, imaginative abilities alone will not ensure creativity. Individuals need enriching environments to provide fodder for their imaginative thought to produce creativity. As Lev Vygotsky said, “If we want to build a relatively strong foundation for a child's creativity, what we must do is broaden the experiences we provide him with. All else being equal, the more a child sees, hears, and experiences, the more he knows and assimilates, the more elements of reality he will have in his experience, and the more productive will be the operation of his imagination” (1931, P. 15).

We also need to create supportive environments that reward students engaging in imaginative thought and demonstrating their creativity. For example, some types of feedback about creative works can leave students feeling mortified and unlikely to maintain high creative

Rebecca Gotlieb, Elizabeth Hyde, Mary Helen Immordino-Yang, and Scott Barry Kaufman aspirations for themselves (Beghetto & Dilley, 2016). On the other hand, students who persistently and passionately pursue their creative interests and are praised for doing so are likely to continue to work hard towards their creative goals and achieve beyond what might be expected of them based on ability alone (S.B. Kaufman & Duckworth, 2015). To capitalize on individuals' imaginative capacities, we need to cultivate environments in which students can periodically disengage from external stimuli and take time to look inward, reflect, and make novel connections (Immordino-Yang et al., 2012). Students need to be given structured opportunities to reflect, and they need to be taught how to do so productively (Immordino-Yang et al., 2012; Gotlieb, Jahner, Immordino-Yang, & Kaufman, 2016). Although the role of imagination in creativity is critical and clear, in order for either process to unfold optimally and appropriately, people need to be in an environment that supports them.

In addition to the environment, there are several characteristics of an individual that affect the extent to which he or she is imaginative and the likelihood that his or her imagination will yield creative fruits. In their extensive review paper, Barron and Harrington (1981) identified the main characteristics supportive of creativity, including broad interests, attraction to complexity, independence of judgment, autonomy, intuition, self-confidence, comfort with ambiguity, propensity for risk taking, curiosity, and high valuation of aesthetic experiences. More recently, Oleynick et al. (2017), reviewing the literature on the personality trait of Openness/Intellect, labeled it “the core of the creative personality”(P. 9). This construct, like the other four comprising the Big Five model, contains two major subfactors as indicated by its compound name—*openness* and *intellect*—which show discriminant validity (DeYoung, Quilty, & Peterson, 2007). Openness reflects cognitive engagement with aesthetic, sensory, and affective information in perception and fantasy, whereas intellect reflects cognitive engagement with

abstract and semantic information through reasoning (S.B. Kaufman et al., 2015). While the *openness* and *intellect* facets can be parsed in order to differentially predict achievement in the arts (i.e., music and theater/film) and sciences (i.e., research discoveries and inventions) respectively, taken together as a single personality trait, they correlate more positively and consistently with all domains of creativity than do conscientiousness, extraversion, agreeableness, or neuroticism (J.C. Kaufman, Waterstreet, Ailabouni, Whitcomb, & Roe, 2010)

In order to better understand the strong association between openness/intellect and creativity, we can examine some of the cognitive processes common to both. Latent inhibition, for instance, is the ability to ignore presumably irrelevant stimuli and inconsequential events in one's environment (Lubow, 1989). While excessively decreased latent inhibition is a feature of psychosis (Lubow, Ingberg-Sachs, Zalstein-Orda, & Gewirtz, 1992), in more mild variants, it can benefit original thinking (Carson, 2011). Work by Carson, Peterson, and Higgins (2003) and Peterson, Smith, and Carson (2002) suggests latent inhibition correlates with both openness/intellect and creativity in psychologically healthy individuals because, as they contemplate the pertinence of a wider range of perceptual input, they are more likely to generate the kinds of novel associations that inspire creativity (see also Carson, this volume). Similarly, implicit learning—or learning of complex information that occurs outside of conscious awareness—is another cognitive process that may enable those scoring high in openness/intellect to detect unlikely connections within their surroundings, thereby fueling creativity (S.B. Kaufman et al., 2010). Divergent thinking is often considered an aspect of creativity and is supported by openness/intellect (McCrae, 1987). Divergent thinking tasks, such as those asking participants to come up with as many uses for a brick as possible, are scored for originality (i.e., how common a response is across participants). The ability of those high in openness/intellect to

generate original ideas is successfully captured on divergent thinking tasks, which can be predictive of creativity both inside and outside of the laboratory (S.B. Kaufman et al., 2015).

Motivation is a critically important personal factor that ensures these general tests of creativity translate into creative achievement in the real world. Again, this attribute aligns with the openness/intellect trait, which represents a motivation to explore the world through perception and reason based in curiosity and on the expectation of informational reward (DeYoung, 2013; Oleynick et al., 2017). Extending beyond the mere drive to navigate one's existing inner and outer worlds, individuals high in openness/intellect can go one step further by developing their creative ideas into something tangible, whether that be a piece of art or a scientific invention. To this end, inspiration, which is associated with both openness and creativity (Oleynick, Thrash, LeFevre, Moldovan, & Kieffaber, 2014; Thrash, Maruskin, Cassidy, Fryer, & Ryan, 2010), can play an important role in spurring individuals to transform hypotheticals into actual products. It is evident that the openness/intellect trait interacts with imaginative capacities to result in observable and measurable creative output.

Creative individuals are also characterized by their adaptability and proclivity to mix seemingly incompatible emotional and attentional states, such as calmness and euphoria, or deep focus and spontaneity, depending on the demands of the task in question (S.B. Kaufman, 2015). Furthermore, "affective engagement"—or the extent to which individuals are open to experiencing the full spectrum of their emotions—is a better predictor of lifetime creative achievement than is IQ (S.B. Kaufman, 2013; S.B. Kaufman, 2015). People who report that they rely on their emotions and empathic abilities to make decisions also report having a greater number of creative accomplishments in the arts than individuals who do not rely on their emotions to as great an extent (S.B. Kaufman, 2013). Relatedly, Fong (2006) has studied the

effects of “emotional ambivalence”—or the simultaneous experience of positive and negative emotions—on creativity. Her findings suggest that when individuals experience emotions that do not usually coexist (e.g., feeling both excitement and frustration about a product launch), it can serve as a signal they are in an unusual environment, which can then increase sensitivity to unusual associations, which can in turn, foster creativity.

Conclusion: Future Directions for Research on the Imagination-Creativity Relationship

The study of imagination and the study of creativity contribute to one another. While imagination helps us understand the mechanism by which we are able to be creative, creativity is a chief reason why imaginative thinking is important and valuable. Those studying these two constructs together may enrich our appreciation of each. As we continue to build an integrative understanding of the relationship between imagination and creativity, and the biological, mental, and cultural factors that support each, we believe that some of the most important questions for neuroscientists and psychologists to investigate are:

- What is the mechanism by which the mental experience of imaginative thought translates into the culturally relative demonstration of creativity? How does variability among individuals in proclivity for engaging in imaginative thought impact the imagination-creativity relationship? How might this relationship be impacted by variability among cultures in terms of what is considered novel and useful?
- How might an understanding of the different networks (especially the default mode network executive attention network, and salience network) that subserve different processes involved in imaginative thought and creativity support our understanding of how these diverse skills are related to one another?

- How does imagination differ across domains? How might an understanding of domain-specific imaginative abilities help us understand varying profiles of creative talent and differences in creativity across different fields?
- How might we support individuals in more frequently and successfully harnessing their imaginative abilities towards creative ends? How might we create educational and cultural institutions that teach individuals skills and inspire motivation to turn imagination into creativity? How will society change as youths are supported in transforming their imagination into creativity?

We have argued that imagination is the seed that may ultimately produce the rare fruit of creativity. If this is so, it is also the case that cultural context is the wind and angle of the sunlight affecting the direction in which the imagination tree grows. Environmental support for creativity and personality traits (e.g., openness to experiences) are the fertile soil that determines the extent to which the tree has needed nutrient to grow. The default mode network and other networks in the brain are the xylem and phloem tissue setting biological constraints on how the tree produces fruit. Research related to the above question will advance our ability to produce imagination trees that bare the sweet fruit of creativity.

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