Introduction
This research summary presents a review of the evidence base for seven components of creativity that are discussed in the research literature. With this review our intention is to provide a broad summary of the factors influencing creativity in youth ages 6–14 in out-of-school programs, and to group the information into components that are aligned with how the fields and bodies of research are organized in the academic literature. The research summary calls attention to the most notable and influential of the 101 studies reviewed by the research team.

We present the summary organized by developmental domains:

Cognitive
- Imagination and Originality – Imagine and explore original ideas
- Flexibility – Maintain openness to unique and novel experiences
- Decision Making – Make thoughtful choices that support creative efforts

Social/Emotional
- Communication and Self-Expression – Communicate ideas and true self with confidence
- Collaboration – Develop social skills that foster creative teamwork
- Motivation – Demonstrate internal motivation to achieve a meaningful goal

Physical
- Action and Movement – Boost creative potential through physical activity

Practical Implications
The next step in the research process will be to distill this summary into key messages and practical implications for applying the research findings in out-of-school settings with 6–14 year old youth.
Creativity involves producing original ideas that are unusual or even novel. It sometimes involves combining two or more different concepts to create a new, synthesized idea. Originality is a core component of creativity and is included in the standard definition of creativity (Runco & Jaeger, 2012). Children often express their imagination and original ideas through pretend play and the creation of imaginary companions and make-believe worlds (Cohen & MacKeith, 1991; Singer & Singer, 1990; Taylor, 1999). Many theorists have studied the relationship between pretend play and creativity and have proposed that pretend play is a way for children to practice original thinking—one of the main cognitive processes in creativity (Singer & Singer, 1990; Singer & Singer, 2005).

Imaginative play emerges in children toward the end of the second year and continues to be a prominent style of play throughout the preschool years and into early grade school. Dorothy and Jerome Singer—two of the leading experts on childhood imaginative play—asked preschool children and their parents about children's imaginary playmates and found that 65% of children answered "yes" when asked whether they had some form of make-believe friend (Singer & Singer, 1990). Furthermore, Singer and Singer found that children with imaginary playmates at home showed more imaginativeness and positive emotionality in their spontaneous play in preschool, more cooperative behavior with adults, and somewhat more advanced language use. In the landscape of imagination and play, the invention of imaginary companions and worlds is another outlet for children to express their creative capacity, and typically peaks at later ages (around the age of 9) and then fades in the late teenage years (Cohen & MacKeith, 1991).

A large body of work by Sandra Russ and her colleagues indicates a link between pretend play in early childhood and later creativity (Russ, 1993; Russ, 2003; Russ & Fiorelli, 2010; Russ, Robins, & Christiano, 1999). In a series of longitudinal studies using the Affective Play Scale (APS), Russ and colleagues provide evidence that pretend play is predictive of divergent (i.e., generating creative ideas by exploring many possible solutions) and original thinking over time. Russ, Robins and Christiano (1999) found that the quality of imagination and fantasy in early play predicted divergent thinking.
over a 4-year period (from grades 1 and 2 to grades 5 and 6), and this finding was independent of IQ. Most notably, research by Russ and Cooperberg (2003) supports a relationship between imaginary play in the early grade school years and divergent thinking ability in high school—an effect that spanned over 10 years. Recent research suggests that the school environment and interaction with parents play important roles in fostering early and frequent imaginative play. A school environment in which pretend games are encouraged during recess play has been linked to greater amounts of imaginativeness and curiosity, and researchers have demonstrated that parents who read or tell bedtime stories often are more likely to foster pretend play (Singer & Lythcott, 2004; Singer & Singer, 2005).

Research with adults known for their creative contribution provides further support for the link between childhood imagination and later creativity. Specifically, Goldstein and Winner (2009) interviewed a small group of adult professional actors (and a control group of “scientists-turned-lawyers”) and found that the actors were much more likely to engage in imaginative play and were much more involved in fictional worlds as children. Related work with creative individuals, such as MacArthur Fellows and Nobel Prize winners, demonstrates a bridge between children who invent imaginary worlds and adult innovation and invention (Root-Bernstein, 2013; Root-Bernstein & Root-Bernstein, 2006).

One way to produce original ideas is to combine two or more existing ideas, no matter how different they may seem. Focusing on finding their similarities is one way to synthesize creativity. Arthur Koestler (1964), throughout his seminal book called The Act of Creation, discussed the importance of bisociation, or the connecting of seemingly disparate ideas. Finke and Slayton (1988) conducted an innovative research experiment in which they asked undergraduate students to identify geometric shapes, numbers and letters that were used to construct recognizable objects. Some of the participants in the study were shown examples of visual combinations, while others did not, and their creative productions varied accordingly. Afterwards, most of the participants reported that they used a trial-and-error approach to synthesizing the symbols to create visual images. More recently, Robert and Michele Root-Bernstein included Synthesis as one of their 13 thinking tools in their book Sparks of Genius (1999). Synthesis includes combinations of the senses, but often results from being open to the serendipity of events from our pasts and the present moment.

Key researchers
- Arthur Koestler (Bilateral Association)
- Michele and Robert Root-Bernstein (Imaginary Worlds)
- Mark A. Runco (Divergent Thinking, Originality)
- Sandra Russ (Pretend Play, Creativity)
- Dorothy and Jerome Singer (Imaginative Play)
- Marjorie Taylor (Imaginary Companions)

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Description of component
The interaction of intelligence and creativity often begins with the flexible combination and modification of prior concepts or strategies to produce new representations. Children can experience flexibility by seeing from different perspectives, remaining open to new and challenging experiences, or (especially as they become older) gaining awareness of how only seeing from a single perspective can limit their creativity. To think and act flexibly is not just a benefit for creativity, but is also required to thrive in a world where change is the only constant.

Developmental emergence/trajectory of skill
Flexibility in children’s thinking first emerges in the form of perspective taking in the early preschool years—when children start to understand that what they see may be different from what another person sees (Flavell, 1992). As children develop, they are able to demonstrate flexibility in their thinking by understanding how their desires, beliefs and emotions may differ from other people and the causal relationship between desires, beliefs and actions (Bartsch & Wellman, 1995). During elementary school and beyond, children develop an ability to think about thinking (i.e., metacognition; Flavell, 1979), which provides a useful strategy for flexibility. Social pressures on young adolescents towards being like everyone else, unfortunately, leads many children to lose their capacity to be spontaneous and flexible. This phenomenon, known as the “fourth grade slump,” has been supported by researchers investigating divergent thinking and originality in children (Runco, 2011).

Notable studies
Researchers think about cognitive flexibility in three different ways. First, “flexibility” can be measured as part of a person’s basic personality. Second, researchers look specifically at a person’s ability to be flexible in their thinking, especially during tasks that require divergent thinking. And third, flexibility relates to a person’s ability to suppress easy answers in order to make more difficult connections, allowing for unique insight. (For a summary from a neuropsychology perspective see: Alexander, Hillier, Smith, Tivarus, & Beversdorf, 2007).

In what has been established as a predictor of creative potential, divergent thinking tasks (e.g., listing unusual uses for an ordinary object) are often scored by indices of fluency (number of ideas), flexibility (number of lexical categories) and originality (statistical infrequency) of responses given. Runco and Okuda (1991) looked at ways that explicit instruction affects flexibility and

“A hallmark of human intelligence is flexible cognition: adapting inference to unfamiliar or unexpected situations, creatively combining concepts, and modifying familiar knowledge and habits to produce novel representational syntheses or action sequences.”

(Deak, 2003, p. 272)
how using such a strategy increases creativity. Asking adolescents to give as many different ideas resulted in an increase in flexibility, not unlike the effect of explicitly asking to give ideas that no one else would think of had upon originality. These results suggest that aspects of divergent thinking can be enhanced through instruction. Cognitive flexibility can also be seen as a tendency towards an openness to experience that may not manifest during brainstorming. For example, the standard Five-Factor personality measures, namely the “openness to experience” factor has shown that people who are inclined to remain open to new experiences score higher on divergent thinking tasks (McCrae, 1987).

Throughout the lifespan, and especially during childhood, we have diverse experiences that require us to reconsider our prior ways of thinking in order to accommodate new information. In a recent study, Simone Ritter and her colleagues (2012) introduced a virtual reality simulation in which laws of physics (perspective, gravity, velocity) were broken, thus violating participants’ expectations. Active involvement in such novel experiences resulted in an increase in cognitive flexibility greater than those where individuals were actively involved, but in normal or common situations. The challenges brought forth through diverse experiences suggest that encountering new and challenging environments enhance creativity.

Flexibility, and its role in creativity, is something that we want to foster in children not only because we see great benefit for their development, but also due to its future relevance for them. Flexibility is relevant within our natural environment as we learn to adapt with how we deal with challenges and obstacles by reading books, being part of a family, working with colleagues, playing team sports, and learning new content that changes our perceptions of the world (Hofstadter, 1979).

Key researchers
- Mark A. Runco (Divergent Thinking and Explicit Instruction)
- Robert R. McCrae (Five-Factor Theory of Personality, Openness to Experience)
- Norbert Jaušovec (Neuropsychology of Flexible Thinking)
- Douglas Hofstadter (Cognitive and Computer Science of Flexibility)
- Joy P. Guilford & E. Paul Torrance (Divergent Thinking, Openness to Experience)

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Description of component
Discretion, judgment and decision making play an important role in the development and expression of creativity. The decision making of children, parents and teachers determine which experiences children will have and thus what opportunities are available to enhance their creative potential (Runco, Johnson, & Gaynor, 1997). Decision-making skills require convergent thinking, which is critical to creativity because it allows individuals to refine ideas and to select the best possible answer or answers from the ideas generated to solve a problem. By developing decision-making skills, children and early adolescents learn important conventions and even more importantly, the discretion to know when it is appropriate to exercise their originality (Runco, 2007).

Developmental emergence/trajectory of skill
Making thoughtful decisions involves metacognitive skills—the ability to think about one’s own thoughts. A series of studies by John Flavell and his colleagues illustrates how children’s ability to think about their own thought processes improves as they grow older (Flavell, Green, & Flavell, 1995). Flavell and his colleagues presented children, starting at age 5, with a situation that would be expected to cause them to think about something in particular (e.g., a puzzling object such as a large pear inside a bottle with a narrow neck). After the children were shown the puzzling object, the experimenter asked them what they had just been thinking about. Most 5-year-olds responded that they were not thinking about anything while 7-to 8-year-olds said they were thinking about the mysterious object, indicating they had greater awareness of their own thought processes. In relation to creative thinking, children may make choices, starting in the fourth grade, that lead them to conventional rather than creative thoughts and actions (Runco, 2011). With instruction, elementary and middle school children can learn strategies such as prototyping, testing, getting feedback, evaluating and revising to inform decision making (Boss, 2012).

Notable studies
An important part of the decision-making process related to creativity is making the choice about when to be original and when to follow conventions. Research demonstrates that decision making in children can be directed such that they choose to think in an original rather than conventional fashion. Runco (1986), for example, provided fourth, fifth and sixth grade children with definitions of originality and a process for finding original ideas. After the children practiced this process several times, they provided twice as many original ideas compared to a baseline. Later research investigating decision making about originality found differences depending on the specific type of information given to children. Runco interpreted the

“"The maximization of creative potential is partly a matter of making the right choices and having the right choices made by one’s parents and teachers. In this light, the study of choice, judgment, and the like should increase our understanding of the fulfillment of creative potential.”
(Runco, Johnson, & Gaynor, 1997, p. 116)
findings in light of metacognition (i.e., thinking about thinking), which can take the form of “know-how.” That is, directions given to children provided them with the “know-how” to identify original ideas.

One important component of the creative ideation process is the evaluation of ideas—selecting the ideas that have value and are useful. Theorists have suggested that truly creative ideas are both original and appropriate (Runco & Charles, 1993). Children’s ability to evaluate ideas has received little attention in the developmental literature. However, a few important studies suggest that children have the potential for accurate evaluations of ideas starting in early grade school. Runco (1991) examined children’s ability to evaluate the ideas of other children that were generated in an earlier study by asking fourth, fifth and sixth graders to rate ideas based on creativity or popularity. Interestingly, Runco found that the most accurate evaluations were given when children were asked to estimate the number of other children who would think of each idea (i.e., estimate the popularity of ideas) rather than rate the creativity of ideas. That is, children’s evaluative scores were influenced by instructions. In a more recent study, Charles and Runco (2000–2001) investigated divergent thinking and evaluative skill in third, fourth and fifth grade students and found that the accuracy of their originality judgments and preference for appropriate ideas increased with age.

Developmental researchers have also investigated judgment and decision making in children by examining many of the same mental shortcuts or “heuristics” that adults rely on to make everyday decisions (Jacobs & Klaczynski, 2002). Runco (1994) proposed that the anchoring heuristic is used when individuals generate ideas as part of the creative process. The anchoring heuristic explains why individuals make decisions based on initial information (the “anchor”). That is, once an anchor is set, there tends to be a bias towards interpreting other information in relation to that anchor. A common scenario for seeing the anchoring heuristic in action is buying a used car. The initial price offered for the car sets the standard for the rest of the negotiation. Hence, any price lower than the initial price will seem reasonable even if that price is much higher than what the car is really worth. Runco et al. (1997) emphasize the importance of understanding how choices are made by using heuristics such as the anchoring heuristic in the creative process.

**Key researchers**
- John Flavell (Metacognition, Theory of Mind)
- Janis Jacobs (Development of Judgment and Decision Making)
- Mark A. Runco (Judgmental Bases of Creativity)
- Robert Sternberg (Importance of Decision Making in Creativity)

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Description of component
Creativity involves communication and self-expression. Effective communicators use a variety of methods (language, visual and movement) to convey meaning and effectively adapt to a variety of audiences and circumstances. A sense of confidence and connection to authentic feelings allows individuals to express their unique insights and thoughts with others. To be creative in the language domain, children must learn the meaning of words, create new words, and construct phrases that have never existed before. To be creative in the social-cognitive domain, children must experience positive emotions that may unleash their creative potential.

Developmental emergence/trajectory of skill
As infants grow, they begin to practice joint attention with others by engaging in communicative acts such as social smiling (Tomasello, Carpenter, Call, Behne, & Moll, 2005) and they become aware of other people’s intentions to attract their attention and share in communicative exchanges (Brooks & Meltzoff, 2005). These attentional and communicative interactions contribute to what Bowlby (2008) proposed as forms of attachment. Secure attachment prepares children to be able to function normatively and appropriately in novel social situations, such as daycare, and may help them regulate negative emotions, increasing confidence (Sroufe, Egeland, Carlson, & Collins, 2009). Caprara, Barbaranelli, Pastorelli, Bandura, and Zimbardo (2000) found that students who had responded sensitively with care and compassion during their early childhood were more likely to gain self-efficacy in later years (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001). Thus, self-efficacy seems to be built, in considerable part, by early experience with caregivers. For students, especially during the difficult transitions from elementary to middle school and middle to high school, self-efficacy and the willingness to persist in the face of struggle are critical for academic success.

Notable studies
To begin their creative journey in language, children must first understand the words that are being spoken to them or around them. In recent years, noteworthy research has identified child-directed speech as an important antecedent of word processing speed as well as vocabulary development. Weisleder & Fernald (2013) found that there was a correlation between the number of words that parents generally direct toward children and children’s speed at pairing a physical object with a word. That is, when parents talk directly to children (rather than just having children passively listen to adult conversation), children get better at learning the mappings between words and objects. These results strongly suggest that the roots of human communication are social, and that children need considerable input to become strong consumers of words. As children

“Individuals who come to believe that they can effect change are more likely to accomplish what they set out to do. Bandura calls that conviction “self-efficacy.” People with self-efficacy set their sights higher, try harder, persevere longer, and show more resilience in the face of failure.”

(Kelley & Kelley, 2013, p. 9-10)
become increasingly skilled at learning words, they are able to creatively understand and produce complex aspects of language, such as metaphor and storytelling (Ramachandran & Hubbard, 2001; Ochs, Taylor, Rudolph, & Smith, 2009). As children become proficient in language use, they are able to integrate information more quickly, which allows them to more readily see connections—a core component of creativity.

Effective communication expands beyond skillful use of language to also include communication through visual arts and through expressive movement. The Partnership for 21st Century Skills framework also highlights the value of using multiple media and technologies to convey a message, and understand how to judge their effectiveness as well as assess their impact (Partnership for 21st Century Skills, 2009).

Social aspects of development also play an important role in children’s ability to innovate. To express themselves in innovative and creative ways, children must also experience positive emotions. The Broaden-and-Build Theory of Positive Emotions (Fredrickson, 1998) suggests that when students experience positive emotional states, they are able to generate more creative solutions to problems or to see new ways of solving the problem (Isen, Daubman, & Nowicki, 1987). In a study with young children, Renninger (1992) showed that when children experience a deep emotional sense of interest in play materials, they showed a greater range of play behaviors, as well as longer amounts of time spent playing. As such, a task is enjoyable for children when it triggers their ability to express themselves freely and openly.

Creative ideas are by definition unique (Runco & Jaeger, 2012), and they can often be perceived as troublesome or upset the status quo. The introduction of something new often includes failed attempts to convey creative insights to intended audiences, and a sense of confidence in self-expression may help children to express their unique ideas and thoughts with others. One prominent line of work has centered on the kinds of praise that children receive (Kamins & Dweck, 1999) and shown that praising the person (e.g., “you’re a smart child”) can decrease motivation in the face of challenges; when children are given praise for their “personality” they start to avoid challenge because failure would mean they are not truly “smart.” As such, an effective way to build confidence in the self may be for parents and teachers to praise process with comments such as “I notice that your hard work has paid off.”

Key researchers
- Albert Bandura (Self-efficacy, Social Learning)
- Carol Dweck (Mindsets, Motivation and Self-regulation)
- Anne Fernald (Child-directed Speech, SES Differences)
- Barbara Fredrickson (Positive Emotions, Positive Psychology)
- Michael Tomasello (Joint Attention, Culture and Development)

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Description of component
Collaboration allows for the exchange of ideas among children as they work to find a solution for a problem or project. Working together towards a shared goal fosters perspective-taking and provides opportunities for children to synthesize alternative viewpoints, formulate explanations to others, and expand their thinking in new ways.

Developmental emergence/trajectory of skill
Around the time that children start expressing autonomy, they also begin to develop an awareness of collaboration, or at least cooperation. Initially, collaboration may appear merely as the child pointing at what he or she wants, but it is important to note that perspective-taking is bolstered when a child shares joint-attention with others (Moll & Meltzoff, 2011). This ability to adopt the perspectives of others is fundamental in collaboration, and commonly results in opportunities for children to learn from each other through both their differences and similarities.

Notable studies
As infants, our growth stems from rich experiences provided by interactions with and imitations of others. Young children mimic those around them as they learn more about the perspectives of other children, adults, and even animals. Meltzoff and his colleagues (2009) simulated the role of immaturity with machine learning algorithms and found that imitation accelerates learning. In other words, even computers with all of their processing power learn more efficiently when programmed to act like children, imitating others out of curiosity. Furthermore, recent research on mirror neurons suggests that we are hard-wired to empathize with others in order to reach understanding (for a review see Iacoboni, 2009). Empathy and the ability to take the perspective of another are central ideas for human-centered design. Tom and David Kelley (2013) discuss the importance of empathy as a precursor to ensuring that creative products solve problems effectively as part of the design thinking process in their book Creative Confidence.

There is a long history of research investigating the relation of empathy to prosocial behaviors—actions that benefit others (for a review see Eisenberg & Miller, 1987). In general, research supports a positive association between empathy and prosocial behaviors including helping, giving and cooperation. Children as young as 18 months of age show simple prosocial behaviors such as trying to comfort another person that is obviously upset or hurt by hugging him or patting him (Zahn-Waxler, Radke-Yarrow, Wagner, & Chapman, 1992).

“Peer collaboration (as distinct from peer tutoring or cooperative learning) involves children working together to complete a single, unified task that represents the shared meaning and conclusions of the group as a unit.”

(Fawcett & Garton, 2005, p. 158)
In the early 1960s, W. J. J. Gordon introduced a methodology for creativity called Synectics, where he declared that individual and group creativity can be assumed to be analogous. If our own creativity allows the connection of seemingly unrelated ideas, then collaboration can provide opportunities to share diverse ideas amongst others. Katharina Hamann and her fellow researchers (2011) compared the collaborative capacities of two- to three-year-old children with those of chimpanzees, who also display cooperative social structures. What they discovered was that human children share more equally after collaboration, and more so than the chimpanzees. As such, collaboration itself requires sharing and promotes further sharing, which benefits creativity.

While creativity is not always social, it does provide alternative perspectives and processes. Through sharing, imitation, understanding, and including others’ contributions, both children and adults can brainstorm creative solutions (Paulus & Nijstad, 2003). Collaboration can also lead to collective creations that could not be accomplished by one individual alone (Fawcett & Garton, 2005; Sawyer & DeZutter, 2009).

Throughout our moral development, and also within the collaborative process itself, there are many potential obstacles for individuals working together. The discrepancies between what is shared amongst the group and that which harbors selfish needs—what Jennie Kaufman Singer (2010) called subjective benevolence—creates tension when not made explicit. It is important to convey to children that suspending their self-interests during collaboration is difficult to do. However, at least sharing what is personally important to them within the group helps with transparency and reduces confusion, and that not doing so may get in the way of accomplishing a shared goal with others.

Key researchers

- Lev Vygotsky & Jean Piaget (Social Influence in Developmental Psychology)
- Nancy Eisenberg & Sandra Russ (Empathy, Prosocial Behavior and Play)
- Paul B. Paulus (Group Decision-making, Brainstorming, Creativity and Innovation)
- Bernard A. Nijstad (Group Decision-making, Creativity and Innovation)
- R. Keith Sawyer (Group Collaboration, Improvisation in Jazz Music)

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Motivation

Demonstrate internal motivation to achieve a meaningful goal

Description of component
Motivation is at the core of the developmental experience and inspires children to explore and satisfy their curiosity. When individuals are internally or intrinsically motivated, acting without the promise of a reward, they are more creative. In addition to originality, creativity also requires usefulness, which includes an extrinsic motivator to discover a desired and appropriate use. When individuals are extrinsically motivated, acting for the sake of external reward, they can be less motivated to take risks and innovate. However, the push towards a goal challenges us to embrace new experiences and acquire new skills and knowledge.

Developmental emergence/trajectory of skill
One of the most noteworthy demonstrations of the benefits of intrinsic motivation was carried out by Lepper, Greene and Nesbitt (1973) in a nursery school classroom. Children’s baseline tendencies to use markers were measured, and later children were either given an award or not given an award for playing with the markers. The results showed that, several weeks later, children who did not receive the award were more likely to continue the activity. This occurred because children who received a reward believed that the activity was tied to the reward, and when there was no longer any reward, children lost interest in the activity. This study strongly suggests that intrinsic motivation can sustain children’s artistic potential, while extrinsic motivation may eliminate children’s budding creative tendencies. It is important to focus on sustaining intrinsic motivation in children’s lives, because the experience of formal schooling can undermine intrinsic motivation (Harter, 1981).

Notable studies
When children are intrinsically motivated, they try harder in the face of difficulty, which leads them to begin to understand that effort leads to achievement. This in turn leads them to adopt an incremental view of their own ability (Dweck & Leggett, 1988; Dweck, 2000). When children inevitably fail, they must reorient themselves to try harder, and they are much more likely to do so when they have arrived at that point in development due to their own efforts. As such, the intrinsic motivation to carry out pursuits such as art may build a malleable view of self and others, and this malleable view may greatly influence children’s outcomes in life.

“With the growth mindset, you are allowing yourself to be changed at all times, allowing new things to happen, and new ideas to form. It’s unsafe to some but this wondering and openness is something all of us recognize as the birthplace of creativity. New things can’t happen if you already know everything. You have to be curious—and take the risk of learning things you never anticipated.”

It is important to be intrinsically motivated and adopt the growth mindset—the belief that abilities can be developed through practice and learning. People who are only extrinsically motivated may become depleted faster (Job, Dweck, & Walton, 2010) and focus more on being seen as smart rather than viewing challenging tasks as learning experiences (Dweck & Leggett, 1988). Other reviews suggest that extrinsic motivation may lead students to study less regularly, to show less excitement about schoolwork, and to use less innovative strategies to tackle difficult material (Simons, Dewitte, & Lens, 2000).

Amabile (1985) had two groups of college students write poems after being primed with either intrinsic or extrinsic motivation. Intrinsic motivation suggests the drive to carry out a task out of personal fulfillment, while extrinsic motivation suggests that carrying out the task is contingent on external influences. The results of the study showed that the students in the intrinsic motivation condition wrote poems that were judged to be more creative by independent raters. This was a noteworthy demonstration of Amabile’s theory that creativity is best fostered by the internal drive to accomplish tasks simply for their own sake (Amabile, 1983b).

In contrast, extrinsic motivation is often associated with lower creativity. In multiple studies of the workplace, Amabile found that employees who were high in extrinsic motivation (i.e., those who only carried out their tasks because they were part of the job) took less risks in carrying out their duties (1983a, 1988, 1993). For example, they were less likely to actively seek ways of improving the way in which they carried out their daily work tasks. Independently, the employees’ immediate supervision reported on the perceived creativity of the employees’ work. It was found that as employees reported more extrinsic reasons for carrying out their duties, they were less motivated to take risks, and, to the extent that they were less motivated to take risks, they were also judged as less creative. As such, extrinsic motivation can decrease perceived performance (Dewett, 2007). Both intrinsic and extrinsic motivation play an important role in the creative process, and it is important to recognize the effort and hard work that are involved in the process that result in a positive outcome.

Key researchers
- Carol Dweck (Mindsets, Motivation and Self-regulation)
- Teresa Amabile (Individual and Team Creativity, Organizational Innovation)
- Mark Lepper (Intrinsic vs. Extrinsic Motivation)

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Description of component
Exercise and physical motion are associated with better focus, enhanced memory and greater ability to learn. Regular exercise and active exploration can act as a cognitive enhancer to promote creativity. The relationship between physical fitness and academic achievement has received increasing attention as a result of the dramatic increase of children that are overweight and unfit and the pressure on schools to meet strict academic standards (many in relation to No Child Left Behind). Conventional wisdom suggests that creative individuals sometimes engage in physical activity to help overcome mental blocks and boost their creative potential.

Developmental emergence/trajectory of skill
Developmental psychology has a long history of studying the link between infants’ motor skills and perceptual and cognitive abilities. More specifically, researchers have investigated how infants who have experience with self-locomotion (i.e., crawling) are better at spatial reasoning tasks like perceiving depth (Campos, Anderson, Barbu-Roth, Hubbard, Hettenstein, & Witherington, 2000). In addition, play researcher Stuart Brown has emphasized the many benefits of active play—often referred to as rough-and-tumble play—for children including social awareness, altruism and cooperation (Brown, 2009).

Notable studies
Research generally supports a positive relationship between physical fitness and academic achievement in elementary school through early high school students (California Department of Education [CDE], 2001; Castelli, Hillman, Buck, & Erwin, 2007; Coe, Pivarnik, Womack, Reeves, & Malina, 2006). The California Department of Education (CDE) conducted a large-scale study that examined the relationship between physical fitness and academic achievement in fifth, seventh and ninth graders (CDE, 2001). The CDE found a positive relationship between physical fitness and reading and mathematics scores from the Stanford Achievement Test for all three grade levels. That is, higher levels of fitness were associated with higher academic achievement. Furthermore, Coe et al. (2006) and Castelli et al. (2007) supported the findings of the CDE (2001) by finding a positive relationship between physical activity and higher letter grades in school and higher scores on standardized tests. In his recent book Spark, John Ratey (2008) describes a model developed by a school district in Naperville, Illinois that focuses on aerobic exercise and lifelong fitness. Middle school students engage in a wide variety of physical activities, including a mixture of traditional games and more novel play activities such as climbing walls and interactive video games that involve movement. As fitness of the students has improved, academic performances have increased dramatically.

Despite these positive associations between physical fitness and academic achievement, not all research has supported this conclusion (Tremblay, Inman, & Williams, 2000), thus emphasizing the need for further research.

“The neurons in the brain connect to one another through “leaves” on treelike branches, and exercise causes those branches to grow and bloom with new buds, thus enhancing brain function at a fundamental level.”

(Ratey, 2008, pg. 5)
More specifically, Tremblay et al. (2000) found that physical activity had a positive relationship with self-esteem and a “trivial” negative relationship with academic achievement in 12-year-old children. The researchers also suggest that for some children, physical activity may be indirectly linked to improved academic achievement by improving self-esteem.

Given the empirical support for the link between physical fitness and academic achievement, does the research literature support a similar relationship between physical activity and creativity? A limited number of studies have shown that physical activity may sometimes enhance creative thinking in adults (Blanchette, Ramocki, O’Del, & Casey, 2005; Colzato, Szapora, Pannekoek, & Hommel 2013; Gondola, 1986, 1987; Gondola & Tuckman, 1985; Oppezzo & Schwartz, 2014; Steinberg, Sykes, Moss, Lowery, LeBoutillier, & Dewey, 1997). However, these findings also suggest that the nature and consequences of the link depend on particular creativity tasks and the fitness of the individual. Gondola and colleagues conducted a series of studies that showed positive effects, varying substantially from one study to another, of both acute and long-term physical exercise on a variety of creativity measures (Gondola, 1986, 1987; Gondola & Tuckman, 1985). Colzato et al. (2013) found that acute physical exercise had a small positive effect on convergent thinking in adult athletes (compared to non-athletes). Interestingly, exercise interfered with divergent thinking in both athletes and non-athletes. Most recently, in a series of four experiments Oppezzo and Schwartz (2014) had undergraduate students walk on a treadmill or outdoors and compared their scores on divergent and convergent thinking tasks before, during and after the walking exercise. The researchers found that the creativity for almost every student increased significantly when they walked (both indoors and outside). This recent finding supports the conventional wisdom that physical movement, walking in particular, boosts creative ideation.

In a physical context that only team sports can provide, Daniel Memmert and colleagues have investigated attention and creative complexity (Memmert, 2007, 2011; Memmert & Perl, 2009; Memmert & Roth, 2007). In addition to physical fitness and coordination, collaboration and communication contribute greatly to the complexity of team sports. In an often-overlooked psychological contribution, team sports include communication that is not only verbal, but also physical in relative spacing and gesture. Memmert and colleagues (2007) have shown that attention-broadening training programs for 7-year-old children not only affect traditional creativity measures, but also the tactical creativity of those children in a team sport. Physical movement, especially through athletics, allows for enhanced creativity on both paper and on the field.

Key researchers
- Darla M. Castelli (Effects of physical activity on motor and cognitive performance in school-age children)
- Charles H. Hillman (Physical Activity and Neurocognitive Function)
- John Ratey (Brain-fitness Connection)
- Daniel Memmert (Creativity in Team Sports)

To find out more, please visit: www.centerforchildhoodcreativity.org
References

Research Framework


Imagination and Originality


Russ, S. W., & Cooperberg, M. (2003). Longitudinal prediction of creativity, coping, and depression in pretend play. Unpublished manuscript. Case Western Reserve University, Cleveland, OH.


Flexibility


References continued


Communication and Self-Expression


References continued


Collaboration


Motivation


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References continued


Action and Movement


