UCLouvain

Faculté de psychologie et des sciences
de l'éducation

Investigating the creative potential of young adults who practiced leisure activities during adolescence

Auteur : Indra Thill
Promoteur : Baptiste Barbot
Année académique 2022-2023
Master en psychologie clinique
de l'enfant, de l'adolescent et de la famille

Acknowledgments

I hereby wish to thank all the professors and assistants for sharing their knowledge and for stimulating my scientific interest and curiosity throughout my five years at the Université Catholique de Louvain-la-Neuve.

First of all, I am deeply grateful to my promotor Professor Baptiste Barbot for the unique opportunity he gave me, by providing me the means to elaborate the original research idea I had. I particularly appreciated his professionalism, his insightful comments, suggestions and motivating feedback at the right times. He gave me the freedom to work autonomously, while being there for me when needed.

I would also like to express my thanks to all the professors and assistants who have gradually led me to a level of statistical skills required for this research, and more specifically to Professor Edwards whose teachings in methodology proved in retrospect to be a perfect preparation.
My thanks also go to Professor Pinon whose course broadened my mind by encouraging to go beyond the paths taken.

A special word of thanks I wish to address to my traineeship supervisor, Ludovic Gervalle, clinical psychologist, for his unwavering support and belief in me. He not only shared his extensive knowledge and experience, but also gave me the space to turn my ideas into projects and apply them into practice.

Finally, I would like to express my gratitude to my family and friends for their understanding, support and encouragement during all stages of my studies.

Indra Thill

« *Je déclare sur l'honneur que ce mémoire a été écrit de ma plume, sans avoir sollicité d'aide extérieure illicite, qu'il n'est pas la reprise d'un travail présenté dans une autre institution pour évaluation, et qu'il n'a jamais été publié, en tout ou en partie. Toutes les informations (idées, phrases, graphes, cartes, tableaux, etc.) empruntées ou faisant référence à des sources primaires ou secondaires sont référencées adéquatement selon la méthode universitaire en vigueur. Je déclare avoir pris connaissance et adhérer au Code de déontologie pour les étudiants en matière d'emprunts, de citations et d'exploitation de sources diverses et savoir que le plagiat constitue une faute grave sanctionnée par l'Université catholique de Louvain ».*

Indra Thill

Louvain-la-Neuve, le 21 mai 2023

Abstract

Although earlier studies have highlighted the relationship between the participation to several leisure activities and creative performance, the research has generally focused on short-term effects, and a question still remains partially open regarding the sustainability of its effects on the long term.

The purpose of this thesis is to explore the contribution of leisure activities (art and sport) practiced during adolescence on the creative potential of young adults.

Methodology - This quantitative study relies on a secondary analysis of data already collected in an extensive research conducted by Barbot et al., (2021) at Pace University. The methodology is based on a survey of 129 young adults, using various instruments to measure different dimensions of leisure participation and creative potential: narrative creativity, divergent thinking (originality, flexibility, fluency), mental flexibility, and associative thinking.

Findings - The contribution of the participation to leisure activities on creative potential appeared to be rather limited in the studied sample. However, our findings revealed that scores obtained by young adults who practiced two or more forms of leisure activities for more than 3 months during adolescence, were higher than scores of those who practiced none or one activity, specifically for narrative creativity, divergent thinking (flexibility and fluency) and associative thinking. The duration of the practice of sport also emerged as a factor contributing to higher flexibility scores in divergent thinking and higher associative thinking scores.

Value - Given that creativity is a valuable asset at individual, professional and social level, this study could contribute to developing pedagogical strategies that can be used in school curricula to stimulate adolescents practicing leisure activities as a means of maintaining and developing their creativity and enhance creative potential in young adulthood.

Keywords: creativity, creative potential, divergent thinking, mental flexibility, associative thinking, narrative creativity, leisure activities, art, sport.

Table of contents

1 CREATIVITY A SOUGHT-AFTER HUMAN CHARACTERISTIC

Creativity is at the root of all progress, whether cultural, economic, social, educational or industrial (Erwin et al., 2022; Fink & Benedek, 2019). All the innovations that make our lives easier are born of a creative spirit (Forgeard & Eichner, 2014; Puccio & Cabra, 2011; Sarooghi et al., 2015). The analysis of various sectors confirms however the dramatic erosion of the ability to innovate in our world (Kozlov, 2023; Park et al., 2023), and unfortunately, studies point out that our children's education does not contribute to maintaining or developing their creative potential (Grupas 1990; Kerka, 1999; Navarro Ramón & Chacón-López, 2021; Sternberg, 2017). However, it has been shown that certain activities, such as art (Dunbar, 2008), sport (Büning et al., 2021) and video gaming (Čábelková et al., 2020), contribute to the development of creative potential at short-term. This study examines whether the practice of these leisure activities during adolescence, outside the school curriculum, can contribute to the maintenance and development of creative potential in adulthood, that is, on the longer term.

1.1 Evolution of the notion of creativity: from a gift to a multifaceted concept

The study of creativity has always been tinged with associations to mystical beliefs (Sternberg & Lubart, 1999, 2016). In antiquity, creativity was thought to be a kind of supernatural inspiration, a divine gift. One could only create what his muses dictated (Lubart et al., 2015), and even today some people still refer to their own muse as a source of inspiration (Sternberg & Lubart, 1999, 2016). Step by step, the definition of the concept of creativity evolves. It is only in the second half of the 20th century that, creativity has been a more important object of study in psychology with a fundamentally empirical approach. It follows the tradition initiated by Guilford in 1950, assessing creativity with reference to personal attributes, such as intelligence or personality (Batey & Furnham, 2006) and introducing aspects of cognition such as divergent thinking (cf. infra §1.6.1; Barbot et al., 2015). Guilford (1950) thought that creativity could be studied with a psychometric approach and proposed a paper and pencil task called the 'Unusual Uses Test', making of divergent thinking tasks the main instruments for measuring creative thinking. Based on these criteria, many researchers, starting with Guilford (1950) and

Torrance (1966), developed creativity measures and established their psychometric properties (Glăveanu, 2019). Building on Guilford's work, Torrance (1966) developed the Torrance Tests of Creative Thinking (TTCT), presenting tasks that involve divergent thinking and other problem-solving skills, and offered the possibility to score the subject for fluency, flexibility, originality, and elaboration (cf. infra § 2.2.1). These tests had an additional convenience of enabling comparison of everyday people on a standard creativity scale (Sternberg & Lubart, 1999, 2016). With and after Guilford (1950), researchers began progressively to agree with the idea of a concept of creativity relying on multiple components (Amabile, 1983, 1996; Batey & Furnham, 2006; Cropley, 1992; Eysenck, 1993, 1995; Guilford, 1950; Keegan, 1996, as cited in Kerka, 1999; Lubart et al., 2015; Mumford & Gustafson, 1988). This multivariate approach to creativity, combines individual factors such as cognitive (intelligence, knowledge), conative (style, personality, motivation), emotional factors, and environmental context, being the backbone of creative potential, a source of both stimulation (Dodds et al., 2002; Moss, 2002) and evaluation (Csikszentmihalyi, 1988, 1999, as cited in Batey & Furnham, 2006), which in turn can lead to creative production. However, "creative potential remains latent until it is called into play in a task" (Lubart et al., 2013, p.42).

1.2 Definition and components of creativity

Any assessment or measurement of a skill requires a clear definition.
It is now generally agreed, as already mentioned, that creativity is a multifaceted construct involving multiple processes and conditions (cf. infra, § 1.3; Fink & Benedek, 2019).

Creativity is commonly referred to as the ability to produce work/products[1], that are novel[2], accepted as tenable[3] and satisfying by a group at some point in time[4] (e.g., Amabile, 1983, 1996; Kaufman & Glăveanu, 2019; Kleibeuker et al., 2016; Runco & Jaeger 2012; Simonton, 2012; Sowden et al., 2015; Stein, 1953; Sternberg & Lubart 2016).

This definition contains several key criteria that need to be further clarified:

[1] Work/products are broadly defined to include any observable outcome or response (Amabile, 1983, p.357; 2012), the generation of ideas, insights, problem solutions and behaviour (e.g., Amabile, 1996; Barbot et al., 2013; Batey, 2012; Chiu, 2014; Reiter-Palmon et al., 2019, p.144; Sternberg & Lubart, 1996).

[2] Novelty must be understood as not resembling something previously known or identified, that is surprising (Glăveanu, 2019, p.227). The extent to which a work/product is novel depends on its originality or the degree of deviation from the traditional or the *status quo* (Lubart et al., 2013; Runco & Jaeger, 2012). This may well depend on the nature of the problem that is addressed, the fund of knowledge or experience that exists in the field at the time, and the characteristics of the creative individual and the persons with whom s/he is communicating (Stein, 1953, p.311).

[3] Tenability means that the product or process can be held, maintained, or defended. The outcome is also described as valuable, useful, suitable, feasible, or appropriate to the task or the domain (Glăveanu, 2019, p.227; Runco & Jaeger, 2012). Diedrich et al. (2015) pointed out that "if an idea is not novel its usefulness does not matter much, but if an idea is novel its usefulness will additionally determine its actual creativity" (p. 35).

[4] Group acceptance and time reference: "accepted as … by a group at some point in time", means that novelty and tenability/usefulness are not intrinsic to the product or process, that is, being assessed, but needs to fit in a context, both social, geographical and historical or, in other words, cultural (Dai et al., 2012; Lubart et al., 2015); it depends on what is accepted (Diedrich et al., 2015; Glăveanu, 2019, p.227; Plucker et al., 2004, p.90; Runco & Jaeger, 2012; Sowden et al., 2015; Stein, 1953, p.318). Indeed, as Stein (1953) mentions, the results of the creative process must be communicated to others, it needs "consensual validation at some point in time" (p.31).

According to Csikszentmihalyi (1990, p.198, as cited in Reid & Petocz, 2004) it is impossible to define creativity independently of judgements based on criteria that change from domain to domain and across time, implying that it is a social construction; the degree of creativity of a product being only considered as creative by people sharing the same kind of experience, norms or rules and culture or conceptions.

1.3 Conditions for the emergence of creativity

Stein (1953) states that the stage of development of a culture obviously influences the means or media available to the individual for creative progress. It is obvious that to be creative in a certain domain, the person must have some experience (e.g., a painter must know how to use pigments, charcoal, etc., or to be creative in mathematics, you need knowledge of mathematics).

Creativity also requires a specific level of intelligence and motivation, as well as a

supportive environment (Cropley & Cropley, 2008; Kaufman & Glăveanu, 2019). Though it is possible to be creative with low levels of intelligence, a minimum level of basic cognitive abilities is required to formulate an idea (Karwowski et al., 2017). Karwowski et al. (2017) were able to demonstrate that intelligence in childhood is related to creative achievement in middle age, this relationship being more specifically critical in highly cognitively demanding creativity domains, such as science, writing, and humour. Various traits have also been associated with creativity: "divergent thinking, introversion, self-esteem, tolerance for ambiguity, willingness to take risks, behavioural flexibility, emotional variability, ability to absorb imagery, and even the tendency to neurosis and psychosis" (James & Asmus as cited in Clarkson, 2005, p.6; Zenasni et al., 2008). The personality trait that most closely predicts frequency of creative behaviour and level of creative achievement is 'openness to experience' (Feist, 1998; Ivcevic & Hoffmann, 2019; Ivcevic & Mayer, 2009). It also appears that creative activities and more specifically, the number of activities, impact creativity: a study of Barbot (2008) shows that adolescents participating to two or more activities provided more and more original responses to a divergent thinking test. The investment in this type of activity encourages creativity all the more when these activities are multiple and varied (Hickey, 2002 as cited in Barbot, 2008).

1.4 Creativity is considered as a key skill in our modern world

Creativity is inherent to normal human cognitive functioning and considered one of human's most complex as well as important behaviours and form of human capital (Runco et al., 2016; Stevenson et al., 2014). "Its effects are evident and widespread, recognized in domains ranging from daily life problem solving to science and the arts" (Runco et al., 2016, p.1).

Creative thinking has been indicated as "the premier 21st century skill" (Kleibeuker et al., 2016, p.74). According to the World Economic Forum (2020) creativity, with critical thinking, tops the list of skills that employers believe will grow in prominence in the next 5 years. It is the engine of any progress in culture, for example to create new music, movies and video games (Erwin et al., 2022), science, and education, likewise in the social, economic or industrial field (Boyles, 2022; Fink & Benedek, 2019; Runco, 2004; Toynbee, 1964). Any invention or advance begins with a creative idea (Forgeard & Eichner, 2014; Puccio & Cabra, 2011).

At societal level, creativity helps people manage social conflicts and disputes (De Dreu et al., 2008 as cited in Chiu, 2014), and it is central to technological and cultural progress (Beaty et al., 2017).

At Business level, creativity is a skill that employers consider to be one of the most important in graduates (DETYA 2000, as cited in Johnstone, 2006, p.245; Reid & Petocz, 2004; Robinson et al., 2005). According to the Harvard Business School (Boyles, 2022), creativity is an in-demand skill. Top industries seek creativity to help them address complex challenges requiring novel and useful solutions to their problems and to avoid stagnation (Boyles, 2022; Stauffer, 2021). It helps people work smarter instead of harder and contributes to higher productivity and adaptability of the organisation to the changing environment and actually to business growth (Boyles, 2022; Lubart et al., 2015).

The VUCA world we live in, short for volatility, uncertainty, complexity and ambiguity (Bennett & Lemoine, 2014), is characterized by global competition and rapid emergence of new products, technologies and services. It is therefore widely agreed that creativity is an essential asset (Forgeard & Eichner, 2014) that, together with innovation and problem solving, has become a critical driver of organisational performance, adaptability and survival (Anderson et al., 2018). Many organisations provide therefore creativity training to employees to increase innovation (Birdi, 2016), since employees' idea generation and implementation has become a source of distinct competitive advantage (Anderson et al., 2014).

At individual level, creativity appears to be essential for humans, both biologically, physically and psychologically, as it contributes to growth and cultural striving (Cannatella, 2004), and is "an indispensable element for individual flexibility and adaptation" (Collins & Koechlin, 2012; Gubenko & Houssemand, 2022; Sternberg, 1999). It is currently recognised as an asset in daily problem solving and professional career, and it contributes to personal and societal development (Besançon et al., 2013; Lubart et al., 2013). Individuals value creativity as a contributor of job satisfaction (Florida, 2002), "adaptive self-expression" (Barbot & Heuser, 2017, p.88) and, according to Barbot (2008), creativity may contribute to the development of identity (Barbot, 2008; Barbot & Lubart, 2012; Barbot et al., 2021). According to Barbot & Heuser (2017), creative thinking, and its expression might help adolescents discover their own potential and uniqueness and provide them with the resources they need to grow with sufficient flexibility in their adult lives. This could be beneficial and lead to true self-transformation if it occurs in a sufficiently structured and targeted way.

As reported by Stauffer (2021), in a world of technology and race for digitisation and automation, creativity remains a skill that is better mastered by humans than machines. Being creative in the workplace is also viewed as more fun (Csikszentmihalyi, 1996), which suggests that it can positively contribute to our mental health and wellbeing, confirming Cropley's (1990, 1997) position that creativity may foster individual traits that are related to well-being such as flexibility, openness, autonomy and playfulness.

1.5 Creativity can be developed but education offers little opportunity

Generally, people think creativity is primarily associated with uniqueness or innovation or seen as an attribute belonging to 'artists' (Kerka, 1999), sustaining the popular belief that creativity is the privilege of some people received at birth. On the contrary, it is not an innate talent available to an elite (Stevenson et al., 2014). Creativity mindset and skills, a facet of human capital, can indeed be taught, developed, and nurtured (Barbot et al., 2015; Ivcevic, 2020; Sternberg, 2019).

Unfortunately, education offers little or no opportunity to learn to think creatively (Navarro Ramón & Chacón-López, 2021; Sternberg, 2017). It is even estimated that creativity diminishes by 40% between the ages of 5 and 7 (Grupas 1990; Kerka, 1999) whereas fostering creativity in education is essential for economic growth and the social good (Craft, 2003; Lerdal et al., 2019; Sowden et al., 2015; Van Geetsom, 2008). Barbot & Heuser (2017) draw our attention on the fact that creativity by adolescents is repressed rather than encouraged in educational settings, that research remains limited, and that creativity finds little or no consideration in the psychological assessment, which makes it an underestimated dimension.

Furthermore, under the influence of the social environment, many adolescents abandon this important component of themselves (Barbot & Heuser, 2017). According to the educational movement called "21st century skills" (Fadel, 2008), the school should enable children to develop creative and innovative thinking along with other key competences like critical thinking, problem solving and communication (Kleibeuker et al., 2016; Lubart et al., 2015).

1.6 Creative potential aspects examined in this study

Creative potential refers to a latent state belonging to an individual's 'human capital' (Walberg, 1988, as cited in Lubart et al., 2013) and a resource for his environment (social, professional; Lubart et al., 2013). This potential requires an opportunity to express oneself. According to the literature, it can be measured in several of its dimensions.

Creative potential can be measured through two approaches, one based on the resources or components/ingredients of creativity and the other on the process or production of creative work (Lubart et al., 2013). The components or resource-based approach to creative potential used in this study consists in presenting the individual a series of measures that have been designed to evaluate the components or resources that underpin creative work. Such an assessment covers, ideally, through tasks and questionnaires, both cognitive and conative factors (cf. supra § 1.1) aimed at defining the individual's 'profile' (Lubart et al., 2013). Since there is no direct way to measure creativity (Alhashim et al., 2020), and there has been limited consensus about the nature of creative potential (Barbot et al., 2015), creativity being a multicomponential construct (Batey & Furnham, 2006), it is recommended to multiply the assessment approaches to get a more complete picture of an individual's potential for creativity (Barbot et al., 2011; Feldhusen & Goh, 1995; Fishkin & Johnson, 1998; Han & Marvin, 2002; Hunsaker & Callahan, 1995, as cited in Barbot et al., 2015), addressing this way conceptual and methodological barriers.

Among the aspects of creative potential considered in the research of Barbot et al. (2021), four were selected as the most relevant according to the existing literature in the field of creative participation, and the respective evaluation tasks showing good psychometric properties: divergent thinking, cognitive flexibility, associative thinking and narrative creativity.
For each of them we clarify the concept hereunder. The corresponding assessment tools are described under point 2.2.

1.6.1 Divergent thinking (DT)

Since its introduction by Guilford (1950), there is a long tradition in creativity research to use divergent thinking (DT), because DT is considered as an essential component of the creative thinking process (Cropley, 2019; Erwin et al., 2022; Lubart et al., 2013; Silvia et al., 2008), as it allows to grasp the ability to create novelty (Torrance, 1966) and predicts creative achievement (Jauk et al., 2014; Plucker, 1999). DT can be defined as a

person's generative ability, starting with a singular object, idea, a given problem or prompt, to generate many novel, original and adapted ideas, alternative solutions or representations (Erwin et al., 2022; Forthmann et al., 2019; Lubart et al., 2013), which is essential for creativity expression (Lubart et al., 2011).

DT is a good indicator of the potential for creative thinking, allowing testable hypotheses (Runco & Acar, 2012) and it can be assessed in an objective and reliable way (Roberts et al., 2021, Guilford, 1950, Torrance, 1988; Runco & Acar, 2012), under specific, controlled conditions of task and stimulus (Erwin et al., 2022).

1.6.2 Cognitive flexibility

Cognitive or mental flexibility is an important potential in fostering efficient problem solving, creativity and the pursuit of complex tasks such as multitasking (switching from one task to another) and facing changing demands with novel, adaptable solutions (Ionescu, 2012). Flexibility of thought is essential to the ability to generate new and innovative ideas in highly creative people (Kenett et al., 2018).

According to Lubart et al. (2013), cognitive flexibility indicates that the individual has the capacity to switch perspectives and explore new directions during problem solving. Associated with DT, cognitive flexibility allows the individual to examine a topic from a wide perspective (Lubart et al., 2013; Takeuchi et al., 2010), moving from one line of ideas to another. "Flexibility is therefore related to cognitive mobility, a key to adopting new approaches to a problem or a task" (Lubart et al., 2013, p.45), and when task performance needs it, adaptative flexibility enables the individual to switch strategies or categories of ideas (Lubart et al., 2013), and to switch attention or mental set (Ionescu, 2012). It comprises the "ability to adapt goal-directed behaviour in response to changing environmental demands" (Garcia-Garcia et al., 2010, as cited in Ionescu, 2012, p.192).

Cognitive flexibility in creativity has been related to originality of ideas and the ability to break apart from mental fixations (Ionescu, 2012; Kenett et al., 2018; Mednick, 1962).

Cognitive flexibility can also be seen as "the ability to process information or objects in different ways given the same stimulus. Flexible thinking is especially important when logical approaches fail to produce satisfactory results" (Goff & Torrance, 2002, as cited in Bowers et al., 2014, p.324). Another characteristic of cognitive flexibility is the ability to cross-categorize (Nguyen & Murphy, 2003; Ross & Murphy, 1999), that is, when adults adapt the categories they form to the current requirements of the task or situation, or spontaneously construct ad hoc categories differing from common categories to

achieve goals (Barsalou, 1983), showing this way potential for conceptual flexibility (Nguyen & Murphy, 2003).

The organisation of an individual's associations will influence the probability and speed of attainment of a creative solution (Mednick, 1962). Cognitive flexibility emerges from efficient executive function and is generally assessed using set shifting or task switching behavioural paradigms (Dajani & Uddin, 2015).

1.6.3 Associative thinking

Associative thinking is considered as a core capability, to make connecting links, to bring together ideas (Mednick, 1962). This ability to provide associations of elements that are not commonly connected is supported by an extensive knowledge base. Associations based on common shared knowledge or suggested by other people are less likely to lead to new ideas (Lubart et al., 2013) than those based upon personal emotional, idiosyncratic experiences which appear to be especially relevant to creativity (Lubart & Getz, 1997).

A deeper dimension of associative thinking is over-inclusion. Over-inclusion can be seen as a feature of a person, that goes beyond preserving conceptual boundaries as a result of which, distantly associated, or even irrelevant ideas come to be regarded as essential parts of the concept (Barsalou, 1983). The ability to generate secondary cross-classifications in the general population appears to vary substantially and has often been considered a sign of creative ability. Indeed, the more cross-classifications a person generates, and the more novel these classifications are, the more creative this person is assessed. In general, the construction and use of ad hoc categories appears to reflect creative aspects of human intelligence (Barsalou, 1983). Overinclusive thinking tests have long been used in psychiatry. It is known that higher levels of overinclusive thinking are associated with heightened creativity (Wang et al., 2018), but also with mental disorders (Hawks, 1964; Hawks & Payne, 1971; Payne, 1962; Payne & Friedlander, 1962; Payne et al., 1972; Watson, 1967). The action of selecting items related to a visual stimulus requires either calling a 'similitude' from a common category, that is, a well-established category representation in memory, or creating an ad-hoc category (Barsalou, 1983).

A common category presents a "graded structure under the form of a continuum of category and membership, ranging from prototypical members through unclear cases to prototypical non-members" (Zadeh, 1965, as cited in Barsalou, 1983, p.212). When subjects have no recollection of an organisation (e.g., in the case of images or words that are apparently unrelated or unsimilar), they have no well-established category

representations in memory, and having less relevant structure to begin with, they experience more difficulty organizing or finding a combination. The structure they are going to use may be created, forming this way ad-hoc categories to achieve a certain goal (Barsalou, 1983).

1.6.4 Narrative creativity

Narrative creativity can be defined as a general storytelling ability (Barbot et al., 2012; Taylor et al., 2020), as a means for people to turn experiences into stories (McLean et al., 2007). As an open-ended design process, creative writing builds on creativity (Barbot et al., 2012) and can be defined as "the production of fictional narratives or written representations, to which some authors also include nonfiction" (Nettle, 2009; Root & Steinberg, 1999, as cited in Barbot et al., 2012, p.209), or as the production of an unusually original form of writing subject to appropriate structural and linguistic constraints (Sharples, 1996, as cited in Barbot et al., 2012). According to Barbot et al. (2012), creative writing involves numerous abilities (originality, selective combination, associative thinking and divergent thinking) and can therefore be considered as a more holistic approach of measuring creative potential.

It requires originality and selective combination, the ability to generate unique ideas (e.g., Alhashim et al., 2020; Dumas et al., 2020; Kim, 2006), to recombine selectively the elements of a problem in a way that it changes its representation (Pretz et al., 2003), to solve problems related to the writing process in a creative way, or to integrate original elements in the story (Barbot et al., 2012). It requires associative thinking in a way that ideas, that are not necessarily associated, are brought together (Mednick, 1962) and can generate rare and valuable ideas (Barbot et al., 2012).

Creative writing also requires divergent thinking, component of the creative thinking process (Cropley, 2019; Silvia et al., 2008…), as a process of producing a broad range of ideas in response to a particular stimulus (Barbot et al., 2012).

These elements of creative cognition (originality, associative thinking and divergent thinking), are sustained by a higher-order construct: imagination. This imagination enables the creation of novel patterns of meaning based on previous experiences and their combination in uncommon ways (Barbot et al., 2012).

1.7 Looking for a way to grow creativity on the development path to adulthood

Creativity plays an important role in people's life.

Several studies suggest a non-linear development of creativity over the course of life, including periods of stagnation but also temporary weakening of creative performance (Lau & Cheung, 2010; Rieben, 1982 as cited in Kaufman & Sternberg, 2006).

However, research shows that creativity can be developed and nurtured during one's life, and this, for instance, through reading activities and art programs (Lilly, 2014).

Adolescence is typically conceptualized as the transition phase from childhood to (emerging) adulthood, which covers the period of 10-19 years of age, a turning point in life (Lilly, 2014), during which an individual who is exposed to stimuli that nurture creative thinking, will have more opportunities to strengthen brain connections that benefit creative thinking. Adolescence is therefore considered as a critical time for the development of creativity, as the brain naturally reinforces and weakens certain synapses during adolescence (Blakemore, 2012), period of reorganisation and alignment of resources important for both creativity and identity like cognitive factors, personality traits, interests and environmental influences (Barbot, 2008; Barbot et al., 2016; Barbot & Heuser, 2017). According to Rothenberg (1990, as cited in Barbot, 2008), "the development of a specific creative identity during adolescence (investment in a creative activity) is a necessary basis for motivation and capacity to create throughout life" (p.5).

Among the many opportunities to which adolescents may be exposed, a wide range of leisure activities can be found. We want to examine more specifically whether creating recreational opportunities such as art, sport or video games can help increase the creative potential of young adults.

1.7.1 Leisure activities are linked to creative performance

Hong et al. (1993, as cited in Mareque et al., 2019) propose a definition of leisure activities as informal hobbies and activities in which the subject participates for his own pleasure and outside the educational setting or a school/university requirement. These activities may involve considerable intellectual effort, creativity, perseverance, and commitment to the tasks or other cognitive and personal-social attributes. Studies have also shown that a greater diversity of experiences contributes to creative thinking skills (Elisondo & Donolo, 2016; Memmert et al., 2010; Memmert & Roth, 2007).

Previous research has highlighted the relationship between specific leisure activities and creative performance in several scenarios. Leisure activities have an impact on both soft skills acquisition and the development of creativity (Mareque et al., 2019). According to Kurtz (2012) in two separate studies (Runco, 2004; Russ et al., 1999), participation to activities like literature, music, drama, arts, crafts, and science was "associated with creativity with statistical reliabilities over 90 per cent" (Kurtz, 2012, p.39). "Five creative leisure activities were also significantly correlated with the Emotional Creativity Inventory (ECI; Averill, 1999), specifically, writing, painting, composing music, performing drama, and do-it-yourself home improvement" (Trnka et al., 2016, p.348). School programs that combine academic development with art, music and athletics continue to nurture the creative development of their students (Lilly, 2014).

1.7.2 Leisure activities selected in this study

1.7.2.1 Art. According to Davis et al. (2014), art includes among others, literature (poetry, drama, story…), the visual, graphic and plastic arts (painting, drawing, ceramics, sculpture, photography…), the performing arts (theatre, dance, music), music, and so on. "One common claim about the effects of training in the performing art(s) is that it fosters creativity" (Dunbar, 2008**,** p.82). Art can be an effective tool to teach emotional intelligence as well as creativity, since this medium is both creative and calls for emotions (Ivcevic, 2020). According to Hickey (2002, as cited in Barbot 2008), investing in artistic creative activities enhances general creative skills.

Meltzer & Meltzer (2022) showed that arts-based learning approaches have long-term effects on creativity, contribute to lasting improvements and affect the ability to think anew in the lives of people. Their study was however based on subjects' reporting and did not include performance measurement tools.

Posner & Patoine (2009) explain that sustained training in music, dance or other arts strengthens the brain's attention system, which may improve cognition more generally.

Dunbar (2008) who studied differences between students who participated in performing arts experiences with those who did not, showed, using fMRI, that during tasks that required creative thinking, the performing arts group showed increased activity in the left frontal lobe, often associated with higher-order mental processing. He also found, using standard measures of creative thinking (Uses of Objects Task; Guilford, 1967), that students who had been engaged in the performing arts were more likely to generate creative ideas than peers who had not. Studies of neuroanatomical changes in the brain

suggest that performing arts have the potential to promote multiple, divergent solutions in problem-solving tasks (Gaxiola Tirado et al., 2019).

Visual, graphic, plastic arts and crafting

In considering all the literature and research around the topic, it could be considered possible that visual arts accommodate different educational aims, such as, socio-cultural understanding, the development of visual literacy, and encouraging critical and creative thinking (Alter, 2010). According to a qualitative study among students at the Grenoble School of Management, Coste (2008) reports that a 36-hours plastic arts course program has had an impact on participants' creativity and imagination capacity. However, it is difficult to predict positive long-term effects.

Handcraft like knitting fosters creativity and expands the imagination since this technique results in the creation of beautiful objects (Duffy, 2007).

Music

Studies show that the practice of a musical instrument promotes cognitive development (Moussard et al., 2012), as musical training contributes to brain integration, which has been linked to features such as creativity, associative thinking and imagination (Hyde et al., 2009). Learning a musical instrument can facilitate learning and improve many cognitive functions from executive control to creativity (Benz et al., 2021) and according to Gibson et al. (2009), it is possible that music training influences brain organisation in a way that the resulting cognitive system is prone to divergent thinking. A near-infrared spectroscopic study showed that the musical experience was associated with greater frontal bilateral activity in the musician, compared to the nonmusician (Benz et al., 2021), and musicians differentiate themselves from nonmusicians by generating a greater number of uses at divergent thinking tests (Gibson et al., 2009). Jonides (2008) found evidence that musicians have a greater span of verbal working memory compared to nonmusicians (Jonides, 2008; George & Coch, 2011, as cited in Benz et al., 2021). Musical practice also appears to improve semantic memory (Benz et al., 2021), supporting the idea of a more effective verbal learning mechanism among musicians (Franklin et al., 2008). In another study, Bergman Nutley et al. (2014) showed that musical practice, in addition to improving working memory, improves processing speed and reasoning ability. Musicians perform better in reasoning and verbal memory compared to nonmusicians, most likely due to changes in cortical organisation (Brandler & Rammsayer, 2003). Therefore, it seems that music training may not only increase grey

matter volumes in both hemispheres, but also may alter the connectivity of the two hemispheres (Gibson et al., 2009). In various studies, music students show higher IQ scores (Schellenberg, 2004) and fluency (Gibson et al., 2009) than did non musicians which can in turn foster convergent thinking (Lee Bae & Therriault, 2013). According to the study of Gibson et al. (2009), musicians, compared to nonmusicians, show an enhanced creative personality, they have a higher convergent and divergent thinking.

Theatre, acting

Dunbar (2008, p.93) explains that when comparing brain activity of theatre students with non-theatre students using the Alternative Uses Task (DT), they found that theatre students produce more varied and creative uses than non-arts students (strong statistical trend). Performing arts majors, unlike those who do not practice art, showed increased activation in two frontal areas: the left inferior frontal gyrus and in the left superior frontal gyrus, which suggests that they are taking a more linguistic approach to the task, whereas the non-performing arts students are taking a more perceptual approach to the task (Dunbar, 2008). Previous research led by Russ (2004) established a link between early pretend play and the enhancement of cognitive flexibility and increased divergent thinking. Individuals who had (improvisational) theatre training also tend to show more divergent thinking (Dunbar, 2008, p.97; Felsman, 2020). According to Stutesman et al. (2022), afterschool theatre classes "can be immersive ways to develop creativity and other strengths" in children and adolescents (p.23).

Reading and writing

According to McVey (2008), any kind of writing is a creative act. By writing poems on a regular basis, an adolescent develops skills related to that specific task (e.g., associative thinking) and domain (e.g., vocabulary), that are associated with underlying neuro-logical structures, and will likely demonstrate creative potential beyond situations that just require a similar combination of task-relevant skills (Barbot & Tinio, 2015).

Individuals who spend, inside or outside regular programs, more time on reading or writing, show a higher creative performance (Wang, 2012). Lilly (2014) also reports that reading specifically contributes to four aspects of divergent thinking: fluency, flexibility, originality, and elaboration. Wang (2012) explains that the strongest correlation between creativity and reading and writing lies in the ability of elaboration, that is, to enrich original ideas with details.

Dance

Dance is an aesthetic experience and a creative process (H'Doubler, 1966, as cited in Sowden et al., 2015), as it enables the expression of emotions and the creation of symbols (Hanna, 1983 as cited in Sowden et al., 2015) and through which the body, brain and personality merge to express and convey thoughts and feelings (H'Doubler, 1966 as cited in Sowden et al., 2015). Minton's (2002) study suggests that there is a possible relationship between dancing and improved ability to consider multiple perspectives. Her study shows that dance is a valid way for students to build creative thinking abilities, especially in the dimensions of elaboration, abstract thinking and originality, bringing empirical proof that dance enhances divergent thinking. According to the research led by Jaggi et al. (2016), using Figural Form A of Torrance Test of Creative Thinking (Torrance & Ball, 1984), dancers tend to show higher creativity compared to non-dancers, whether they are professional or casual dancers.

1.7.2.2 Sport. Sports offer the possibility for creative action, as it combines mental and physical skills, mind-body at play imaginatively and spontaneously (Campos, 2014). Studies have reported positive effects of physical activity on cognitive executive functions, such as inhibitory control and creativity (Büning et al., 2021). According to Bowers et al. (2014), the time that people spend in unstructured sport settings is found to be positively related to adult creativity. They showed "a direct positive relationship between time spent playing informal sports as children and levels of overall creativity, fluency, originality, elaboration, and flexibility as adults" (Richard, 2016), with the strongest relationship to the development of creative flexibility (Goff & Torrance, 2002, as cited in Bowers et al., 2014). Masley et al. (2009) demonstrated that physical exercise and more specifically aerobic exercises[1] enhances cognitive performance in a shifting-attention test and concluded that cognitive flexibility is improved. As such, cognitive flexibility becomes a specific ability in the executive function family, namely, the ability to shift (Masley et al., 2009). Convergent and divergent thinking can be found in sports respectively under the terms of 'game intelligence' and 'tactical creativity'. "Game intelligence being defined as the ability to find the best solution to a given problem", and tactical creativity being the ability to generate a variety of surprising, original and flexible options in answer to a game situation (Memmert, 2010, as cited in Zahno & Hossner, 2020, p.10; Memmert, 2011).

[1] According to the Cleveland Clinic, aerobic exercises include swimming, cycling, using an elliptical trainer, walking, rowing, running, jumping rope, performing high impact routines or step aerobics.

Other studies conducted in the world of team sport have found a link between the practice of sport (football, handball, basketball and field hockey) and divergent thinking as well as convergent thinking (game intelligence) more specifically in the case of basketball (Greco et al., 2010; Furley & Memmert, 2018; Memmert & Roth, 2007; Zahno & Hossner, 2020). According to Richard et al., (2017), the level of creativity by athletes, who practiced different sports at recreational level, was significantly higher than that of athletes who only practiced one.

1.7.2.3 Video gaming. Video gaming practice has become an important part of many people's lives. Therefore, according to Čábelková et al. (2020), the research community should, for the benefits of society, conduct more studies on the effects of video gaming on the development of interpersonal skills and creativity. Video gaming practice influences creativity and emotions (Shu-Hua Yeh, 2015), which makes it an interesting topic of research. There is however little knowledge about how 'out-of-school' effects of video game practice influences creativity and emotions (Shu-Hua Yeh, 2015). Similar to musical practice, it contributes to optimizing cognition in general (Bavelier et al., 2012). According to Green et al. (2012), video game players may also benefit from greater flexibility in resource allocation, and switch tasks more efficiently. Some types of video game programmes may enhance creativity related abilities, such as verbalisation and encoding of visual information (Clements, 1986, as cited in Shu-Hua Yeh, 2015; Rahimi & Shute, 2021) as well as divergent thinking (Benedek et al., 2006). Video game play has also been associated with a greater disposition towards creativity later in life (Clark et al., 1989; Russ et al., 1999) as well as the stimulation and development of a range of creative processes such as problem finding, framing and solving, divergent thinking, and practice with alternative solutions (Bowman et al., 2015; Russ et al., 1999). Convergent thinking appears not to be impacted by the practice according to a study of Blanco-Herrera et al., (2019).

It should be noted that not all games are favourable to the enhancement of creativity. Various types of video games can even induce harmful effects like violence, addiction, depression (Granic et al., 2014), and poorer school performance (Blanco-Herrera, 2017). The players who benefit most from the positive effects of playing video games are those who play games involving an imaginary world, role-playing, and competition. It also appears that these effects are not solely predicted by game mechanics, but also by the way the player plays (Blanco-Herrera et al., 2019).

1.7.2.4 Diversity of activities. The literature on creative participation suggests that life experience diversity and cognitive diversity, are good predictors of creative potential (Kurtz, 2012), and individuals high in 'openness to experience' often actively seek out novel and varied activities and are imaginative (Christensen et al., 2018). There is evidence suggesting that the personality trait 'openness to experience' has been strongly and consistently positively associated with creative performance (Feist, 1998; Puryear et al., 2017). According to Baer (2016), a wide range of activities in diverse domains could contribute to general improvement of creative performance. In particular, mental flexibility is linked to the diversity of activities, because as an individual acquires new skills, s/he becomes increasingly able to adapt her/his actions to the specific requirements of a given situation (Rietveld & Kiverstein, 2014). Behavioural studies show that an individual can partly transfer specific resources in one creativity domain to domains that share similar task-requirements (Baer, 1996; Barbot et al., 2013; Onarheim & Friis-Olivarius, 2013, as cited in Barbot & Tinio, 2015), and the practice in a wide range of task-specific divergent-thinking skills has been shown to have a general effect of enhancing creativity in diverse domains (Baer, 1996; Memmert & Roth, 2007; Tsung-Hsien & Han-Kuang, 2022).

1.8 Purpose of the study

Creativity being recognized as a key skill at various levels, societal, professional, individual, and given that the education world has not yet integrated this important dimension into its approach, we would therefore like to examine whether participation in specific leisure activities during adolescence could contribute to an increased level of creative potential at young adult age.

If it appeared that young adults who practiced leisure activities during adolecence have higher creativity potential than those who didn't, it would allow us to suggest that practicing one or more of these activities could contribute to higher creativity potential and adaptive abilities in the face of new situations in young adulthood. This in turn could contribute positively to the individual, professional and societal level (cf. supra § 1.4). Correspondingly, there is mounting evidence demonstrating the benefits of creativity-based interventions on multiple health outcomes (not solely identity-related), including among cancer patients (Barbot, 2021).

1.9 Hypotheses

1.9.1 Leisure activities.

Literature indicates that participating in leisure activities can have short (e.g., Kurtz, 2012; Mareque et al., 2019; Runco, 2004; Russ et al., 1999) and long-term effects (Meltzer & Meltzer, 2022) on creative performance of individuals in general. Studies have also shown that the length of the practice (Amabile 1996; Kaufman & Beghetto, 2009; Kerka, 1999) and a greater diversity of experiences (Elisondo & Donolo, 2016; Memmert et al., 2010; Memmert & Roth, 2007) contribute to creative thinking skills. We therefore hypothesise that :

H1a: Individuals who practiced at least one or more of the retained leisure activities (art, sport, video gaming) for a duration of at least 3 months during adolescence, will show, at young adult age, a higher score of creative performance in creative writing (more holistic dimension) than individuals in the control group.

H1b: The creative performance in creative writing (more holistic dimension), at young adult age, will be positively linked to the duration of the practice of one or more forms of leisure activities during adolescence.

H1c: The creative performance in creative writing (more holistic dimension), at young adult age, will be positively linked to the number of leisure activities practiced during adolescence.

More specifically, we know from previous studies (Barbot, 2008) that adolescents who invested 2 or more creative activities had a higher score in a divergent thinking test. Therefore, we hypothesise that :

H1d: Individuals who practiced two or more leisure activities (arts, sports, video gaming) for at least 3 months during adolescence, will show, at young adult age, a higher score of creative performance in creative writing (more holistic dimension) as well as in the following aspects: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, than individuals who practiced less than two activities.

1.9.2 Practice of art activities

We know that the practice of one or more forms of art can lead to short-term benefits to different aspects of creative potential: divergent thinking, mental flexibility, associative thinking (e.g., Dunbar, 2008; Gaxiola Tirado et al., 2019; Kurtz, 2012; Russ et al., 1999), and that arts-based learning approaches can produce long-term effects on creativity (Meltzer & Meltzer, 2022). We also know that the length of practice will enable the individual to attain a higher level of creativity (Amabile 1996; Kaufman & Beghetto, 2009; Kerka, 1999) and that a greater diversity of experiences contributes to creative thinking skills (Memmert et al., 2010; Memmert & Roth, 2007). We therefore hypothesise that :

H2a: Individuals who practiced one or more forms of art, for a duration of at least 3 months during adolescence, will show, at young adult age, a higher score in the following aspects of creative potential: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, than individuals in the control group, while controlling the two other categories (sport and video gaming).

H2b: The creative potential at young adult age, in the following aspects: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, will be positively linked to the duration of the practice of one or more forms of art during adolescence, while controlling the duration of the practice of one or more forms of sport and of the practice of video gaming during adolescence.

H2c: The creative potential at young adult age, in the following aspects: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, will be positively linked to the number of art activities during adolescence while controlling the number of one or more forms of sport and of the practice of video gaming during adolescence.

1.9.3 Practice of sport activities

We know that the practice of one or more forms of sport, can lead to short-term benefits to different aspects of creative potential: divergent thinking, mental flexibility and associative thinking (Bowers et al., 2014; Memmert, 2011; Zahno & Hossner, 2020), that the time that people spend in unstructured sport settings is found to be positively related to adult creativity (Bowers et al., 2014), and that the level of creativity by athletes, who practiced different sports at recreational level, was significantly higher than that of athletes who only practiced one (Richard et al., 2017). Therefore, we hypothesise that :

H3a: Individuals who practiced one or more forms of sport, for a duration of at least 3 months during adolescence, will show, at young adult age, a higher score in the following aspects of creative potential: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, than individuals in the control group, while controlling the two other categories (art and video gaming).

H3b: The creative potential at young adult age, in the following aspects: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, will be positively linked to the duration of the practice of one or more forms of sport during adolescence while controlling the duration of the practice of one or more forms of art and of the practice of video gaming during adolescence.

H3c: The creative potential at young adult age, in the following aspects: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, will be positively linked to the number of sport activities during adolescence while controlling the number of one or more forms of art and of the practice of video gaming during adolescence.

1.9.4 Practice of video gaming

Video game play has been associated with a greater disposition towards creativity later in life (Clark et al., 1989; Russ et al., 1999). We know that the practice of video gaming can lead to short-term benefits to different aspects of creative potential: divergent thinking and mental flexibility (e.g., Benedek et al., 2006; Bowman et al., 2015; Green et al., 2012; Shu-Hua Yeh, 2015). On the other hand, convergent thinking appears not to be impacted (Blanco-Herrera, 2019). We also know that the length of practice will enable the individual to attain a higher level of creativity (Amabile 1996; Kaufman & Beghetto, 2009; Kerka, 1999). Therefore, we hypothesise that :

H4a: Individuals who practiced video games for a duration of at least 3 months during adolescence, will show, at young adult age, a higher score in the following aspects of creative potential: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, than individuals in the control group, while controlling the two other categories (art and sport), and that there will be no significant difference for associative thinking.

H4b: The creative potential at young adult age, in the following aspects: verbal divergent thinking (originality, flexibility, fluency) and mental flexibility, will be positively linked to the duration of the practice of video gaming during adolescence while controlling the duration of the practice of one or more forms of art and of the practice of one or more forms of sport.

1.9.5 Practice of different categories of activities

We know that life experience diversity and cognitive diversity contribute to enhanced creativity (Kurtz, 2012), and that a wide range of activities in diverse domains could contribute to general improvement of creative performance (Baer, 2016). Therefore, we hypothesise that :

H5a: The creative potential at young adult age, in the following aspects: verbal divergent thinking (originality, flexibility, fluency), associative thinking, and more particularly mental flexibility (Rietveld & Kiverstein, 2014) will be positively linked to the number of different categories of leisure activities individuals combine during adolescence.

2 METHOD

This study is a secondary analysis based on the research of Barbot et al. (2021) at Pace University, entitled "Creative recovery: Narrative creativity mitigates identity distress among young adults with cancer", published in the Journal of Psychosocial Oncology.

2.1 Participants - Inclusion and exclusion criteria

Participants to the main study at Pace University were recruited from personal networks of the investigators, classroom settings at Pace University, as well as on-line sources, including forums geared to those who have had a history of illnesses.

They are young (emerging) adults between the ages of 18-25, male and female of diverse racial/ethnic backgrounds. The study is inclusive of participants regardless of their health statuses and health history.

The condition of inclusion for the present secondary analysis was that subjects reported the type of activity, number of activities, practice duration of the respective activities, and filled in the creativity performance-based measures. Accordingly, 32 subjects were excluded from the research database (N = 161) since they either did not complete any creativity test or for whom we did not have information about the duration of the practiced activities.

The sample presented in this study (Table 1) consists of a group of 129 young (emerging) adults whose age ranged 18-25 (M_{age} = 23,32, SD_{age} = 1.75).

Participants are both male and female of diverse racial/ethnic backgrounds (63% female, 37% male), with females and males not differing statistically with respect to age (t[127] = -.701, p = .485) (see Appendix A, Table A1).

Table 1

Case summaries: age in function of gender

Gender	N	Mean	Std. Deviation	Minimum	Maximum
Female	81	23,23	1,71	18	25
Male	48	23,46	1,82	18	25
Total	129	23,32	1,75	18	25

2.2 Creative potential assessment instruments

The participants' components of creative potential were measured using the following assessment tools:

- Verbal Divergent Thinking : three aspects: originality, flexibility, fluency, are measured by the Alternative Uses Task (AUT; Guilford - derived from Torrance, 1968) and are reported as '*DT originality', 'DT flexibility'* and *'DT fluency';*
- Mental Flexibility is measured by the Morpheus Task (Lubart et al., 2013; based on Ionescu, 2012) and reported as *'Mental flexibility';*
- Associative thinking is measured on one hand by the Compound Remote Associates Task (CRAT; Bowden & Jung-Beeman, 2003) and more specifically, visual association is measured by the Overinclusive Thinking Task (Barbot, 2021), following a similar procedure to the Alternative Categories Task (ACT; Barsalou, 1983). They are reported as *'Associative thinking RAT'* and as *'Associative thinking OV';*
- Narrative creativity more specifically creative writing is measured by the Storyboard Task (Taylor et al., 2020) and is reported as '*Creative writing'*.

All scores in this sample were standardised through conversion into z-scores.

2.2.1 The Alternate Uses Task (AUT)

DT tasks require the production of numerous solutions to an open-ended problem (Guilford, 1967, as cited in Kleibeuker et al., 2016) in a given time.

Within recent creativity research, DT tasks are by far the most widely used measures (Alhashim et al., 2020; Kleibeuker et al., 2016; Plucker & Mackel, 2010; Reiter-Palmon et al., 2019), and among them, the Alternate Uses Task (AUT; Wilson et al., 1953) has been used for assessing DT and creative ability for decades, being one of the most popular and therefore psychometrically examined by creativity researchers (e.g., Dumas et al., 2020; Gubenko & Houssemand, 2022; Puryear et al., 2017). Despite their inherent subjectivity, the originality scores rated by humans have been found most reliable at both the composite and latent factor levels (Dumas et al., 2020). According to Runco & Acar (2012), DT tests are also reasonably valid predictors of some performance criteria, which is confirmed by psychometric research suggesting that tests of divergent thinking provide useful estimates of the potential for creative thinking.

In practical terms, a common object (such as a brick, a pen, or a paperclip) is presented to the participant, with the request to generate as many alternative, original uses as

possible of this object in a given time span. Doing so, AUT enables an evaluation of the ability to produce diverging uses from a single starting point (Erwin et al., 2022). Several objects are used, one at the time, each consisting in a separate trial. Time limits and the number of trials depend on the objective of the study (Abraham, 2018, as cited in Alhashim et al., 2020). The participants to this study had about 8 minutes to complete the test. After collection, the answers of each participant are analysed and scored on creativity (Alhashim et al., 2020).

The AUT answers are generally scored by taking the four regularly used dimensions of DT into consideration: originality, fluency, flexibility and elaboration (Alhashim et al., 2020).

Originality corresponds to the number of statistically infrequent ideas, showing an ability to produce uncommon or unique responses (Alhashim et al., 2020; Kim, 2006), the originality arising from the distal-relatedness of these responses from the corresponding context or prompt (Dumas et al., 2020).

Fluency (ideational fluency) is the number of given answers that appropriately answer the prompt, regardless of novelty (Erwin et al., 2022; Alhashim et al., 2020). High fluency being important for creativity, because common, socially available ideas tend to pass first whereas more idiosyncratic, rare and unusual ideas tend to come later (Beaty & Silvia, 2012; Lubart et al., 2015). Because, "the more responses a participant generates, the more likely they include an original response", fluency affects originality (Alhashim et al., 2020, § 2.1).

Flexibility is the number of categorically different ideas (Weiss & Wilhelm, 2022), indicating the diversity of ideas (Torrance, 1972).

Elaboration refers to the level of information or the significance of the answers, that is the ability to embellish ideas with details (Goff & Torrance, 2002, as cited in Bowers et al., 2014, p.324; Torrance, 1972). This dimension was not included in the study.

2.2.2 The Morpheus Task

The Morpheus task consists of 6 sets of 15 images each. The images transform from one object to another, in progression (see Figure 1).

The subject's task is to recognize the new object or the last image in the sequence as quickly as possible, using the least intermediary images (Lubart et al., 2013).

This test being still in development phase, its reliability nor validity can be confirmed.

Figure 1

Example of item of Morpheus task on the Crealyx platform (as cited in Barbot, 2021)

2.2.3 The (Compound) Remote Associates Test (RAT) and Overinclusive Thinking Task (OV)

According to Mednick and Mednick (1967), the **Remote Associates Test (RAT)** was found to yield reliable scores (Spearman Brown .91 and .92). It evaluates individuals' creative potential and is known as a valid measure of creative convergent thinking (Chermahini et al., 2012; Mednick, 1968). It was designed with regard to Mednick's (1962) associative theory of creativity, explaining that the creative thinking process consists in "using associative elements to create new combinations which either meet specified requirements or are in some way useful" (Chermahini et al., 2012, p.177).

The RAT, developed and constructed by Mednick (1962), and RAT-like problems have been used, over the years, in numerous studies of problem solving and creative thinking by many researchers and in various languages. They are less complex as insight problems, but present properties of insight problems leading to insight solutions (Behrens & Olteţeanu, 2020; Bowden & Jung-Beeman, 2003). The RAT consists, in its college form, of 30 items (Mednick, 1968; Mednick & Mednick, 1967) to measure creative thought without requiring any specific domain knowledge (Bowden & Jung-Beeman, 2003; Chermahini et al., 2012). RAT is a tool in which the subject receives sets/items of three words drawn from mutually remote associative cluster, with the task to provide mediating links between them. It is however important that the mediating link is strictly associative rather than following elaborate rules of logic, concept formation, or problem solving.

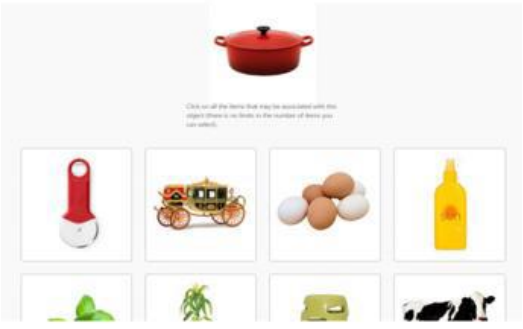
For example: 'Out-Dog-Cat' and the fourth word that can serve as an associative connective link between these disparate words is 'House' (Mednick, 1968).

According to Chermahini et al. (2012), the RAT, that is, looking for a highly constrained, single solution, corresponds quite well to Guilford's (1967) concept of convergent thinking. Despite Guilford's distinction, in many studies the RAT has been used as a test of overall creativity (Chermahini et al., 2012). The score is determined by the number of valid answers given in a particular time (Chermahini et al., 2012, Mednick, 1968). Solvers must think of more distantly related information in order to connect the three words, requiring creative thoughts to reach a solution (Bowden & Jung-Beeman, 2003). This kind of association is assumed to be familiar to a majority of individuals (Chermahini et al., 2012).

For the purpose of this study, participants filled in the **Compound Remote Associates Test** (CRAT; Bowden & Jung-Beeman, 2003, Threadgold et al., 2019), a 10 items task that measures insight and associative thinking, adapted from the original RAT version. The participants were tasked to choose one part of a compound word that correctly pairs with three provided compound word parts. Example: 'back, clip, and wall' are provided, and the correct choice is 'paper' to create a compound word with each of the three initial words that were given. The features of the CRAT present advantages over classic insight problems, due to their simplicity, unambiguity, making scoring easier, and a short time to complete (Bowden & Jung-Beeman, 2003).

Overinclusive thinking task (OV): The overinclusive thinking task evaluates participants' semantic networks and categories by presenting pictures and follows a procedure similar to the Alternative Categories Task (ACT; Barsalou, 1983). For this purpose, images were selected belonging to five categories including objects, clothes, kitchen, farm, and transportation (see Figure 2). After viewing an initial image, participants are asked to select objects that are related to that image. Items of which participants do not know the name or the use are excluded. "Participants are not limited in terms of the number of items chosen or the semantic distance to the initial object such as colour, or material" (Barsalou, 1983 as cited in Barbot et al., 2021).

Figure 2



Example of item of overinclusive thinking task on the Crealyx platform (as cited in Barbot, 2021)

2.2.4 The Storyboard Task and Consensual Assessment Technique

In order to assess creative writing abilities, participants are generally asked to provide a writing sample, most frequently a poem or short story, often in response to a specific prompt (Kaufman & Baer, 2012). For example, in the short story writing task, the participants receive an ambiguous title or a picture or image. They are asked to generate a short story within a certain time frame. The storyboard task (Taylor et al., 2020) discussed in this study is based on the presentation of a series of images, the participant being asked to create one original story, using three provided images as input (illustrating respectively the beginning, middle and end of the story; Barbot et al., 2012).

The storyboard task, as a method for assessing creative writing, demonstrated good psychometric properties, making it a valuable assessment of creative writing (Taylor et al., 2020). According to Taylor et al. (2020), the psychometric evaluation of the storyboard task suggests that it has demonstrated to be a valuable assessment of creative writing, because it shows good alternate form and delayed alternate form reliability, as well as good criterion validity with divergent thinking and self-reported ideational behaviour (Taylor et al., 2020).

The assessment of the creative writing production in the form of storyboard is carried out using a method called **Consensual Assessment Technique** (CAT; Amabile, 1982; Taylor et al., 2020), a widely used and well validated technique in creativity research that has been used in various experiments using a wide range of tasks for evaluating the level of creativity of diverse creative products. The CAT finds its roots in Amabile's (1982) social psychology of creativity. It is a method whereby judges, a group of experts familiar with a given domain, give their subjective rating for the individual outputs on their relative creativity compared to the group of outputs, following a number of guidelines or protocols (Amabile, 1982; Cseh & Jeffries, 2019; Storme et al., 2014; Taylor et al., 2020). The ratings of the judges are then analysed on the level of consensus, and with a satisfactory level of agreement the results can be distributed on a scale ranging from low to high creativity (Cseh & Jeffries, 2019). Studies may differ in how the rating of writing samples is conducted, including variations in the number of raters, their level of expertise, and the degree of rating guidance they are provided (Cseh & Jeffries, 2019). However, the CAT is known to produce high levels of inter-rater reliability of creativity scores, exceeding .70, and often ranging as high as the .90s (Amabile, 1982; Kaufman et al., 2008). This is found regardless of the specific levels of agreement which can vary according to the

domain and the level of expertise of the raters (Kaufman et al., 2008; Taylor et al., 2020). Therefore, the CAT has been called the 'gold standard' of creativity assessment (Carson, 2006, as cited in Baer & McKool, 2014), as "judgements of creative products by experts closely aligns with how real-world creative products are judged" (Taylor et al., 2020, p.3).

2.3 Participants – Leisure participation data

Respondents of Barbot et al.'s (2021) study were asked to report all informal creative and leisure activities in which they voluntarily participated at any time in their lives for at least 3 months, including the teams they participated in, the classes they took (e.g., art, dance, etc.) or the lessons or groups they joined. (e.g., music, drama, etc.).

In addition, they were asked to report the age at which they started and the age at which they stopped each activity.

Based on the information reported and previous studies dealing with this subject (cf. supra, §1.7.2; Davis et al., 2014; Mareque et al., 2019), the activities were grouped in three main categories: art, sport and video gaming.

Figure 3

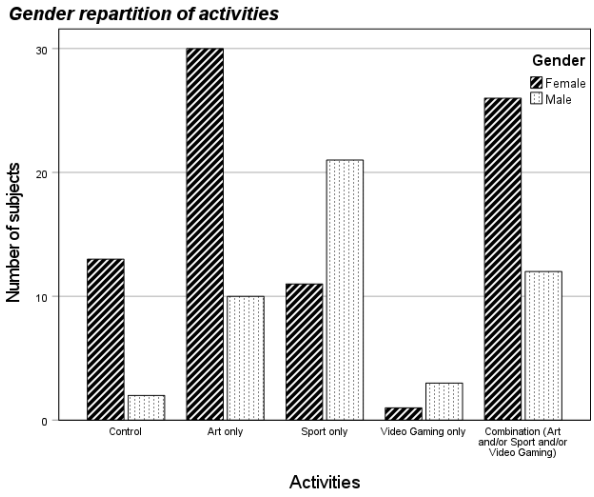


Figure 3 shows clear variations in participation and interest in different leisure activities, girls in this study having practiced three times more art activities than boys, and boys, two times more sport activities than girls. Indeed, according to Shaw et al. (1995, as cited in Barbot, 2008), boys would be inclined to participate in masculine activities, particularly sport, while girls would be less conformist in their leisure choices and invest in less traditional activities (Barbot, 2008). Gender stereotypes could be a possible explanation of this observed repartition under boys and girls (Poole, 1986 as cited in Barbot, 2008).

Participation in creative activities took place during adolescence. A minimum of 3 months of participation in a leisure activity has been set for the individual to be considered as having practiced one or more activities, since to be creative, the person must have some experience (Stein, 1953), knowledge of the subject matter and a strong bond with it, as well as intrinsic motivation (Amabile, 1996; Kerka, 1999), the length of practice enabling

the individual to attain a higher level of creativity (Kaufman & Beghetto, 2009).

The developed creativity potential could in turn be transferred to other activities/tasks (Tsung-Hsien & Han-Kuang, 2022; Memmert & Roth, 2007).

Participants started their leisure activities on average at the age of 12 (M = 12.04). The average practice duration of leisure activities, each taken separately, is around 6 years (M = 6.25). The average age of completion of activities is around 18 years (M = 18.29), to be compared with the average age of the subjects at the time of testing (M = 23.32). This gives an average term of 5 years (M = 5.03) between the end of the practice of the leisure activities and the time of passing the tests (see Table 2).

Table 2

Descriptive statistics

	Years
Mean age start	12.03
Mean duration	6.25
Mean age end	18.29
Mean age tests	23.32
Mean time btw tests and end	5.03

Participants were assigned to groups according to the hypotheses (see App. A, Fig. A0). The control group is composed of young adults who have not practiced or practiced less than 3 months one of the three main categories of activity: art, sport, video gaming, but may have participated to other activities that do not belong to the categories chosen in this study, and for which we have not found a significant link in the literature with the development of creative potential, as for example shopping, bible teaching, and so forth. All subjects may have practiced, on top of the three retained categories, other activities considered as neutral.

The duration is expressed in number of years and the total duration of activities for each category was calculated by summing the respective durations of each activity invested by each individual. This explains some of the high figures mentioned for the duration of activities: a subject who practiced four activities each for 10 years is reported as having accumulated 40 years of practice. Intensity/frequency information has not been recorded in the original study. When ‘leisure activities’ or ‘duration leisure’ are mentioned, this refers to activities falling within the three categories selected as described under point 1.7.2.

2.4 Data analytic plan

For the analysis of hypotheses, we applied the following procedures:

For hypotheses H1a, H2a, H3a we conducted for each creativity measurement an independent-samples *t* test to compare the means of the two groups. Where the underlying assumptions could not be met, we used a nonparametric Mann-Whitney *U* test (see

Appendix A). To test hypotheses H1b and H1c we proceeded by simple linear regression (see Appendix A). For hypotheses H2b, H2c, H3b and H3c, we tested the effects of duration and number of activities on the score of the creativity measurements by multiple regressions (see Appendix B). The analyses for the H4 hypothesis were carried out, but did not allow us to draw any conclusion, as the database we used did not include enough subjects (10 in total of which only 4 could be isolated who only practiced video gaming (see Appendix C). For the hypothesis H5a we proceeded by analysis of variance (ANOVA) and when the underlying assumptions could not be fulfilled, we proceeded by nonparametric Kruskal-Wallis test (see Appendix A).

All calculations reported in this document were carried out using SPSS 28.01.0., and an alpha level of $p \leq 0.05$ was adopted for all statistical tests.

3 PRELIMINARY ANALYSES

For hypotheses H2b, H3b, H2c, H3c, the underlying assumptions of the multiple linear regressions for most of the analysed dependent variables, were not fulfilled (non-normally distributed residuals). We also found out that the results were too much influenced by durations/number of activities with high observed values (based on Leverage and Cook indexes). Those influential observations have duration/number of activities values that are not well represented (few points with such values). Thus, it cannot be confirmed if it represents the real relation between duration/number variables and dependent variables or if this is only observed by chance. More evidence (more subjects with the same kind of values) would be required.

Since the linear regression was not deemed appropriate, we addressed these hypotheses (H2b, H3b, H2c, H3c) while accounting for the limitation of data and conducted ANOVA's. It was decided to have no more control for another activity (focus only on sport/art) and to rely on ANOVA to perform the test by creating groups. This would allow us to alleviate the effect of highly influential points (gathered in one group) and to carry out nonparametric tests (Kruskal-Wallis and Mann-Whitney for the multiple comparison tests) where the underlying assumptions were not all met. The analysis of the data led us to create three groups for both the duration and the number of activities in order to ensure a certain balance in the size of the groups, excluding any interference from the other categories of activities by retaining only the subjects who have practiced the category of activities mentioned in the hypothesis (see Appendix A, fig. A0).

4 STATISTICAL ANALYSIS

This study was carried out with 129 participants. Table 3 indicates that some creativity tests were not filled in by all participants, which explains the different numbers of subjects per test through the entire analysis. Standardised data are presented in Appendix A, Table A2.

Table 3

	Creative writing	DT originality	DT flexibility	DT fluency	Mental flexibility	Associative thinking RAT	Associative thinking OV
N	125	127	127	122	107	125	118

Table 3: Number of participants per dependent variable. For more details see Appendix A, table A3.

4.1 Leisure activities

Hypothesis H1a: Individuals who practiced at least one or more of the retained leisure activities (art, sport, video gaming) for a duration of at least 3 months during adolescence, will show, at young adult age, a higher score of creative performance in creative writing than individuals in the control group.

An independent-samples *t* test was performed to evaluate whether the scores of creative writing in the 'leisure' condition (M = -0,02, SD = 1,01) are higher than in the 'control' condition (M = 0,12, SD = 0,98) (see Table 4). The underlying assumptions were well fulfilled (see Appendix A, Tables A4, A6 & Fig. A1, A2).

Table 4

Zscore: Creative writing

Group	N	Mean	Std. Deviation	Variance
Leisure	110	-,0167	1,00537	1,011
Control	15	,1225	,98454	,969
Total	125	,0000	1,00000	1,000

Table 4: Summary statistics for creative writing in the two groups. The 'control group' is composed of subjects who practiced art, sport, video gaming activities for less than 3 months or practiced other activities. It shows that the 'Control' group is less represented (12%) than the 'Leisure' group (88%).

Based on the data, we could not conclude that the creative writing scores of individuals who practiced at least one or more of the retained leisure activities (art, sport, video gaming) for a duration of at least 3 months during adolescence, are higher than those of the control group (t[123] = - 0,50, p = .693) (see Appendix A, Table A6).

H1b: The creative performance in creative writing, at young adult age, will be positively linked to the duration of the practice of one or more forms of leisure activities during adolescence.

The case summaries Table 5 shows that, on average, participants practiced the leisure activities during the equivalent of 13 years (*M* = 12.96). The minimum set in the hypothesis is 3 months. The maximum cumulative total of activities goes up to 97 years (1164 months) for one subject (cf. supra §2.3).

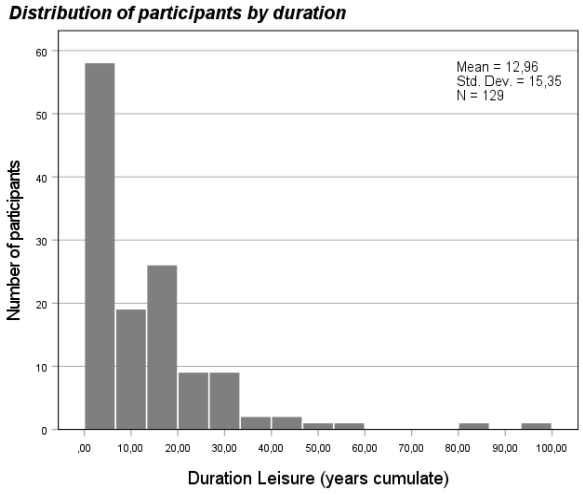
Table 5

Duration Leisure

N	Mean	Median	Minimum	Maximum	Std. Deviation	Variance
129	12,960	9,083	,00	97,00	15,350	235,626

Table 5: summary statistics of the duration of leisure activities

Figure 4



However, it is important to note that there is considerable variability (s^2 = 235.626), confirmed in the histogram (Figure 4), which indicates that this variable shows a left-skewed asymmetric distribution. A nonparametric Spearman correlation coefficient was performed to evaluate the relationship between the duration of leisure activities and the score at creative writing. The results indicated a non-significant relationship between the duration of leisure activities and the score at creative writing (*rs*[123] = .140, *p* = .119) (See Appendix A, Table A10).

In order to test the research question, a simple regression was conducted, with the duration of leisure activities (art, sport, video gaming) as the predictor, and levels of creative writing as the dependent variable. Underlying assumptions were met (see Appendix A, Table A11 & Fig. A6, A7). Overall, the results showed that the predictive model was significant (*F*[1, 123] = 7.439, R^2 = .057, *p* = .007). 5.7% of the variance of creative writing is explained by the duration of leisure activities (see Figure 5 & Appendix A, Tables A12, A13).

Table 6

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-,202	,114		-1,766	,080	-,428	,024
	Duration Leisure	,016	,006	,239	2,727	,007	,004	,028

a. Dependent Variable: Zscore: Creative writing

Table 6: Effect of leisure duration on creative writing

The results in Table 6 showed that the duration of leisure activities was a significant positive predictor of creative writing (β = 0.016, *t* = 2.727, *p* = .007).

When analysing the leverage index graph (see Appendix A, Fig. A8), four points (ID 92, 122, 31, 116) appear to be greater than 4/n (4/125 = 0.032). These points alone can bias the regression line (see Figure 5). It is important to mention that these 4 points are precisely the 4 subjects who participated in the longest duration of leisure activities (between 50 and 97 years cumulate).

Figure 5

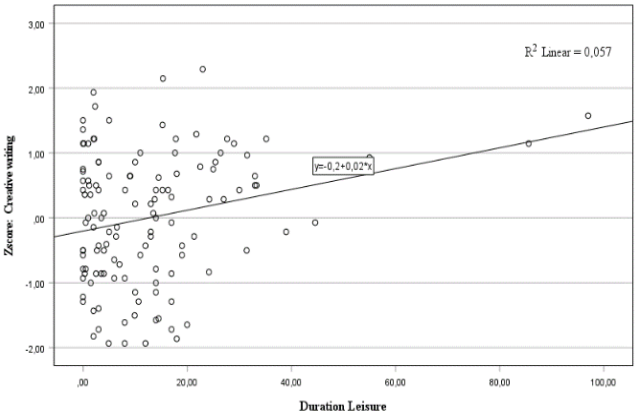


Figure 5: scatterplot shows relationship between the duration of leisure activities and creative writing.

By replicating the analysis without these subjects, we can observe that the regression line was strongly influenced going from a significant effect to a non-significant effect (β = 0.014, t = 1.594, p = .113) (see Appendix A, Tables A16-A18 & Fig. A11).

Hypothesis H1c: The creative performance in creative writing, at young adult age, will be positively linked to the number of leisure activities practiced during adolescence.

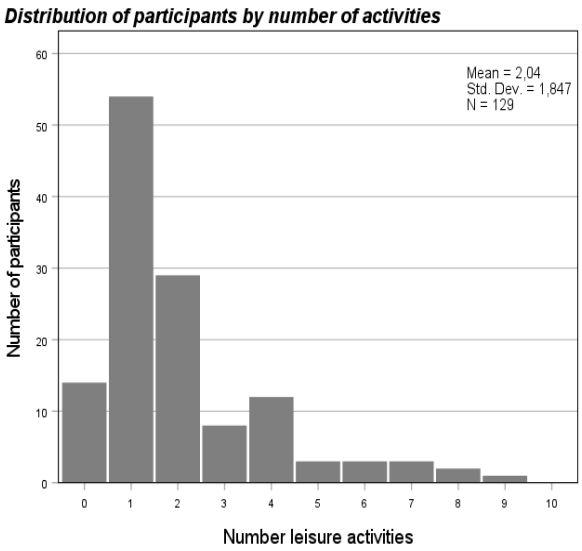
Table 7

Number of activities

N	Mean	Median	Minimum	Maximum	Std. Deviation	Variance
129	2,04	1,00	0	9	1,85	3,41

Table 7: summary statistics of the number of leisure activities

Figure 6



The case summaries Table 7 shows that the participants in this study engaged in 0 to 9 leisure activities, with an average of two activities. The majority of participants (64%) were found practicing one activity (42%) and two activities (22%). The histogram (Figure 6) shows that the data follows a left-skewed asymmetric distribution, not a normal distribution. A nonparametric Spearman correlation coefficient was performed to evaluate the relationship between the

number of leisure activities and the score at creative writing. The results indicated a significant weak relationship between the number of leisure activities and the score at creative writing (*rs*[123] = .184, *p* = .040) (see Appendix A, Table A21).

In order to test the research question, a simple regression was conducted, with the number of leisure activities (art, sport, video gaming) as the predictor, and levels of creative writing as the dependent variable. Underlying assumptions were met (see Appendix A, Table A22 & Fig. A13, A14).

Table 8

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-,224	,134		-1,667	,098	-,490	,042
	Number Leisure activities	,114	,052	,195	2,209	,029	,012	,217

[a]. Dependent Variable: Zscore: Creative writing

Table 8: Effect of the number of leisure activities on creative writing

Overall, the results showed that the predictive model was significant (*F*[1, 123] = 4.878, R^2 = .038, *p* = .029). 3.8% of the variance of creative writing is explained by the number of leisure activities (see Figure 7 & Appendix A, Tables A23, A24). The results in Table 8 showed that the number of leisure activities was a significant positive predictor of creative writing (β = 0.114, *t* = 2.209, *p* = .029).

When analysing the Leverage Index graph (see Appendix A, Fig. A15), nine points (ID 92, 122, 31, 116, 123, 22, 150, 139, 103) appear to be greater than 4/n (4/125 = 0.032). Only one point greater than 4/n (0.032) appears when analysing the Cook Index graph (ID 103) (see Appendix A, Fig. A16). These points alone can bias the regression line (see Figure 7) It is important to mention that these 9 points are precisely the 9 subjects who participated in the greatest number of leisure activities (between 6 and 9 activities). By replicating the analysis without these subjects, it can be observed that the regression line was strongly influenced, going from a significant to a non-significant effect (β = 0.116, *t* = 1.569, *p* = .119) (see Appendix A, Tables A26-A28 & Fig. A18).

Figure 7

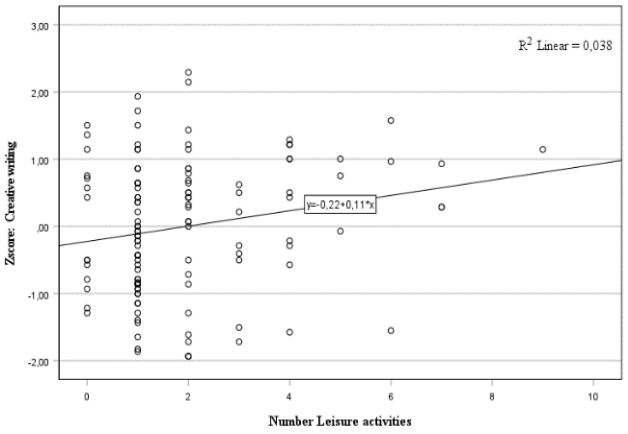


Figure 7: scatterplot shows relationship between the number of leisure activities and creative writing.

Hypothesis H1d *(see Appendix A, Tables A29-A57 and Fig. A19-A53)*

Individuals who practiced two or more leisure activities (arts, sports, video gaming) for at least 3 months during adolescence, will show, at young adult age, a higher score of creative performance in creative writing (more holistic dimension) as well as in the following aspects: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, than individuals who practiced less than two activities.

Independent-samples *t* tests and Mann-Whitney *U* tests were performed to evaluate whether the scores of creative writing, DT (originality, flexibility, fluency), mental flexibility and associative thinking (RAT & OV) are higher in the '2 or more leisure activities' condition than in the '0 or 1 leisure activity' condition (see Table 9).

Table 9

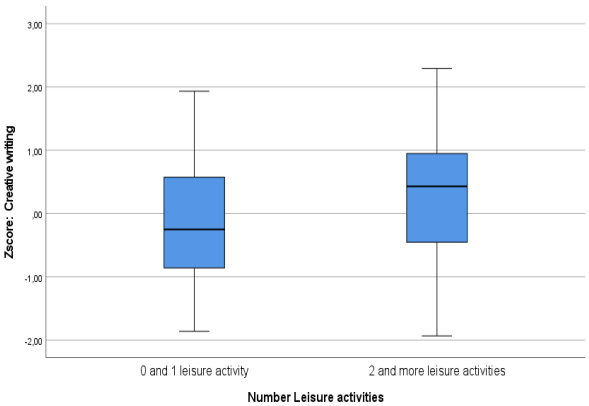
Number Leisure activities		Zscore: Creative writing	Zscore: DT originality	Zscore: DT flexibility	Zscore: DT fluency	Zscore: Mental flexibility	Zscore: Associative thinking RAT	Zscore: Associative thinking OV
0 and 1 leisure activity	N	66	67	67	64	58	64	64
	Mean	-,1535	-,1288	-,1810	-,2844	,1482	-,2274	-,1976
	Median	-,2499	-,1207	-,1823	-,6137	,1273	,0842	-,3941
	Std. Deviation	,92751	,96827	1,03708	,86220	,97549	1,20828	,82682
2 and more leisure activities	N	59	60	60	58	49	61	54
	Mean	,1717	,1439	,2021	,3138	-,1754	,2386	,2342
	Median	,4305	,2807	,3886	,1246	-,1606	,6381	,0098
	Std. Deviation	1,05689	1,02319	,92397	1,05365	1,01014	,64861	1,13660

Table 9: Descriptive statistics for each group ('0 and 1 leisure activity', '2 and more leisure activities') across the seven dependent variables of interest. The '0 and 1 leisure activity' group is composed of subjects who practiced art, sport, video gaming activities for less than 3 months or practiced other activities, and subjects who practiced one leisure activity (art, sport, video gaming) for more than 3 months. The '2 and more leisure activities' group is composed of subjects who practiced two or more leisure activities (art, sport, video gaming) for more than 3 months.

Based on the data we can conclude that the scores for young adults who practiced two or more forms of leisure activities for more than 3 months during adolescence, are higher than for those who practiced none or one activity for creative writing (z = -2.070, p = .019, d = 3.403) (see figure 8), DT flexibility (t[125] = -2.187, p = .015, d = 0.389), DT fluency (z = -3.666, $p < .001$, d = 3.415), associative thinking RAT (z = -2.241, p = .013, d = 3.421), associative thinking OV (z = -2.436, p = .008, d = 3.378). The effect size for the difference between the groups was calculated using Cohen's d (1988), indicating a small effect for DT flexibility, and a large effect for creative writing, DT fluency, associative thinking RAT and OV.

Figure 8

Boxplot : Creative writing



For the other boxplots see Appendix A Fig. A33, A38, A48, A53

On the other hand, the data did not enable to conclude that the scores for young adults who practiced two or more forms of leisure activities for more than 3 months during adolescence, are higher than for those who practiced none or one activity for DT originality (t[125] = -1.543, p = .063) and mental flexibility (t[105] = 1.682, p = . 952).

4.2 Practice of art activities

Hypothesis H2a *(see Appendix A, Tables A58-A86 and Fig. A54-A71)*

Individuals who practiced one or more forms of art, for a duration of at least 3 months during adolescence, will show, at young adult age, a higher score in the following aspects of creative potential: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, than individuals in the control group, while controlling the two other categories (sport and video gaming).

Independent-samples t test and Mann-Whitney U tests were performed to evaluate whether the scores of DT (originality, flexibility, fluency), mental flexibility and associative thinking (RAT & OV) are higher in the 'art only' condition than in the 'control' condition (see Table 10).

Table 10

Activities		Zscore: DT originality	Zscore: DT flexibility	Zscore: DT fluency	Zscore: Mental flexibility	Zscore: Associative thinking RAT	Zscore: Associative thinking OV
Control	N	15	15	15	13	14	15
	Mean	,096	-,325	-,336	,223	-,549	,039
	Median	,314	-,260	-,566	,083	,084	,026
	Std. Deviation	,898	,602	,572	,701	1,565	,852
Art only	N	39	39	37	32	38	34
	Mean	-,073	,042	,073	-,204	,070	-,125
	Median	-,102	,478	-,122	-,234	,638	-,410
	Std. Deviation	,954	1,046	1,088	,965	,869	,954

Table 10: Descriptive statistics for each group ('control' and 'art only') across the six dependent variables of interest. The 'control' group is composed of subjects who practiced art, sport, video gaming activities for less than 3 months or practiced other activities. The 'art only' group is composed of subjects who practiced one or more art activities for more than 3 months excluding sport and video gaming activities. The 'control' group is less represented than the 'art only' group.

Although mean values for DT flexibility, DT fluency and associative thinking RAT are higher in 'art only' group than in 'control group' (see Table 10), we could not conclude that the scores are significantly higher among the subjects in the 'art only' condition than among those in the 'control' condition for DT originality (t[52] = 0.595, p = .723), DT flexibility (z = -1.56, p = .060), DT fluency (z = -0.879, p = .190), mental flexibility (t[43] = 1.444, p = .922), associative thinking RAT (z = -1.55, p = .061) and associative thinking OV (z = -0.868, p = .807).

Hypothesis H2b *(see Appendix A, Tables A87-A132 and Fig. A72-A96)*

The creative potential at young adult age, in the following aspects: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, will be positively linked to the duration of the practice of one or more forms of art during adolescence, while controlling the duration of the practice of one or more forms of sport and of the practice of video gaming during adolescence.

One-way ANOVA and Kruskal-Wallis tests were performed (cf. supra §3) to compare the effect of the duration of art activities on scores of DT (originality, flexibility, fluency), mental flexibility and associative thinking RAT & OV (see Table 11).

Table 11

Duration Art		Zscore: DT originality	Zscore: DT flexibility	Zscore: DT fluency	Zscore: Mental flexibility	Zscore: Associative thinking RAT	Zscore: Associative thinking OV
0 - < 2 years - ART	N	20	20	19	17	19	19
	Mean	,093	-,258	-,323	,236	-,441	-,066
	Median	,238	-,221	-,533	,374	,084	-,081
	Std. Deviation	,863	,748	,559	,986	1,505	,800
2-10 years - ART	N	19	19	19	17	19	18
	Mean	-,065	,013	,100	-,432	,026	-,410
	Median	-,316	,064	-,190	-,396	,638	-,666
	Std. Deviation	,939	,978	1,233	,654	,921	,781
> 10 years - ART	N	15	15	14	11	14	12
	Mean	-,136	,112	,135	-,028	,203	,415
	Median	,031	,656	-,025	,250	,361	,187
	Std. Deviation	1,057	1,163	1,025	1,010	,540	1,116

Table 11: Descriptive statistics for each group ('0 - <2 years', '2 -10 years' and '>10 years') across the six dependent variables of interest. The '0 - <2 years' group is composed of subjects who practiced one or more art activities for less than 2 years cumulated, excluding sport and video gaming activities, and all subjects who did not practice any art, sport or video games. The '2 - 10 years' group is composed of subjects who practiced one or more art activities for 2 to 10 years cumulated, excluding sport and video gaming activities. The '>10 years' group is composed of subjects who practiced one or more art activities for more than 10 years cumulated, excluding sport and video gaming activities.

No significant differences were found among the three groups of participants (0 - <2 years, 2 -10 years, >10 years) excepted for mental flexibility and associative thinking OV. Based on the data we could not conclude that the duration of the practice of one or more forms of art has a significant effect on the scores of DT originality (F[2, 51] = 0.277, p = .759), DT flexibility (H[2] = 2.258, p = .323), DT fluency (H[2] =1.156, p = .561), associative thinking RAT (H[2] = 1.324, p = .516). We could thus not conclude that the creative potential at young adult age, in DT originality, DT flexibility, DT fluency and associative thinking RAT, is higher among subjects who, during adolescence, have practiced one or more forms of art for a duration of more than 10 years than among subjects with a practice duration of 2 to 10 years, and is higher among subjects with a practice duration of 2 to 10 years than among those with a practice duration of 0 to less

than 2 years, while excluding possible interference of the practice of one or more forms of sport and of the practice of video gaming during adolescence.

Kruskal-Wallis tests showed that there was a statistically significant difference in mental flexibility scores ($H[2] = 7.976$, $p = .019$) and associative thinking OV scores ($H[2] = 6.507$, $p = .039$) among the three different duration groups of art activities. Thus, groups were compared two by two using Mann-Whitney *U* tests, applying a Bonferroni correction (3 comparisons, therefore p values multiplied by 3).

Based on the multiple comparisons, we cannot conclude that mental flexibility scores at young adult age, are higher among subjects who, during adolescence, have practiced one or more forms of art for a duration of more than 10 years than among subjects with a practice duration of 2 to 10 years ($z = -2.046$, $p = .062$), nor among subjects with a practice duration of 0 to less than 2 years ($z = -.588$, $p = .165$), nor are mental flexibility scores higher among subjects with a practice duration of 2 to 10 years than among those with a practice duration of 0 to less than 2 years ($z = -2.600$, $p = .987$), while excluding possible interference of the practice of one or more forms of sport and of the practice of video gaming during adolescence.

For the associative thinking OV dimension, the data analysis showed a singular result: subjects who practiced one or more forms of art for more than 10 years have higher scores than those with a practice duration of 2 to 10 years ($z = -2.540$, $p = .017$), but show no significant difference with subjects who have practiced 0 to less than 2 years ($z = -.588$, $p = .384$), nor have subjects with a practice duration of 2 to 10 years higher scores than those with a practice duration of 0 to less than 2 years ($z = -1.489$, $p = .796$). We therefore cannot say with certainty that the score of associative thinking OV is positively linked to the duration of the practice of one or more forms of art.

This is confirmed by the analysis with multiple regression, that shows that overall, without ID92 & ID122 (most remote points in the regression model [art & sport] and showing high leverage and Cook), the results showed that the predictive model was not significant with a risk factor $\alpha = .05$ ($F[3, 112] = 1.234$, $R^2 = .032$, $p = .301$). Only 3.2% of the variance of associative thinking OV is explained by the duration of art, sport and video gaming activities. The results showed that the duration of art, was not a significant positive predictor of associative thinking OV ($\beta = 0.009$, $F = 0.790$, $p = .376$, $R^2 = .007$), while controlling for the duration of sport and the duration of video gaming (see Appendix B, Tables B71-73).

Hypothesis H2c *(see Appendix A, Tables A133-A164 and Fig. A97-A121)*

The creative potential at young adult age, in the following aspects: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, will be positively linked to the number of art activities during adolescence while controlling the number of one or more forms of sport and of the practice of video gaming during adolescence.

One-way ANOVA and Kruskal-Wallis tests were performed (cf. supra §3) to compare the effect of the number of art activities on scores of DT (originality, flexibility, fluency), mental flexibility and associative thinking RAT & OV (see Table 12).

Table 12

Number Art activities		Zscore: DT originality	Zscore: DT flexibility	Zscore: DT fluency	Zscore: Mental flexibility	Zscore: Associative thinking RAT	Zscore: Associative thinking OV
0 Art activity	N	15	15	15	13	14	15
	Mean	,096	-,325	-,336	,223	-,549	,039
	Median	,314	-,260	-,566	,083	,084	,026
	Std. Deviation	,898	,602	,572	,701	1,565	,852
1 Art activity	N	24	24	23	22	23	21
	Mean	-,103	-,006	-,141	-,159	-,108	-,268
	Median	-,276	,273	-,625	-,210	,084	-,612
	Std. Deviation	1,053	1,113	1,126	,927	1,038	,883
2+ Art activities	N	15	15	14	10	15	13
	Mean	-,026	,117	,424	-,305	,343	,107
	Median	,170	,656	,503	-,347	,638	,010
	Std. Deviation	,802	,961	,960	1,090	,412	1,053

Table 12: Descriptive statistics for each group ('0 art activity', '1 art activity' and '2+ art activities') across the six dependent variables of interest. The '0 art activity' group is composed of subjects who practiced art, sport, video gaming activities for less than 3 months or practiced other activities. The '1 art activity' group is composed of subjects who practiced one art activity for more than 3 months, excluding sport and video gaming activities. The '2+ art activities' group is composed of subjects who practiced two or more art activities for more than 3 months, excluding sport and video gaming activities.

No significant differences were found among the three groups of participants (0 art activity, 1 art activity, 2+ art activities) for the six investigated dimensions.

Based on the data we could not conclude that the number of art activities has a significant effect on the scores of DT originality (F[2, 51] = 0.204, p = .816), DT flexibility (H[2] = 2.602, p = .272), DT fluency (H[2] = 5.630, p = .060), mental flexibility (F[2, 42] = 1.111, p = .339), associative thinking RAT (H[2] = 3.665, p = .160) and associative thinking OV (H[2] = 2.296, p = .317). We could thus not conclude that the creative potential at young adult age in DT originality, DT flexibility, DT fluency, mental flexibility, associative thinking RAT and associative thinking OV, is higher among subjects who, during adolescence, have practiced two or more art activities than among those who practiced only one art activity, and is higher among subjects who practiced only one art activity than among those who practiced no art activity, while excluding possible interference of the practice of one or more forms of sport and of the practice of video gaming during adolescence.

4.3 Practice of sport activities

Hypothesis H3a *(see Appendix A, Tables A165-A188 and Fig. A122-A139)*

Individuals who practiced one or more forms of sport, for a duration of at least 3 months during adolescence, will show, at young adult age, a higher score in the following aspects of creative potential: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, than individuals in the control group, while controlling the two other categories (art and video gaming).

Independent-samples *t* test and Mann-Whitney *U* tests were performed to evaluate whether the scores of DT (originality, flexibility, fluency), mental flexibility and associative thinking (RAT & OV) are higher in the 'sport only' condition than in the 'control' condition (see Table 13).

Table 13

Activities		Zscore: DT originality	Zscore: DT flexibility	Zscore: DT fluency	Zscore: Mental flexibility	Zscore: Associative thinking RAT	Zscore: Associative thinking OV
Control	N	15	15	15	13	14	15
	Mean	,096	-,325	-,336	,223	-,549	,039
	Median	,314	-,260	-,566	,083	,084	,026
	Std. Deviation	,898	,602	,572	,701	1,565	,852
Sport only	N	32	32	30	26	31	32
	Mean	-,163	-,091	-,290	,242	,031	-,171
	Median	-,221	,025	-,567	,306	,638	-,440
	Std. Deviation	,991	1,136	,837	1,093	1,025	,825

Table 13: Descriptive statistics for each group ('control' and 'sport only') across the six dependent variables of interest. The 'control' group is composed of subjects who practiced art, sport, video gaming activities for less than 3 months or other activities. The 'sport only' group is composed of subjects who practiced one or more sport activities for more than 3 months excluding art and video gaming activities. The 'control' group is less represented than the 'sport only' group.

Based on the data we could not conclude that the scores are significantly higher among the subjects in the 'sport only' condition than among those in the 'control' condition for DT originality ($t[45] = 0.862$, $p = .804$), DT flexibility ($t[44.172] = -0.919$, $p = .182$), DT fluency ($z = -0.313$, $p = .623$), mental flexibility ($t[37] = -0.059$, $p = .477$), associative thinking RAT ($z = -1.485$, $p = .069$) and associative thinking OV ($z = -0.799$, $p = .788$).

Hypothesis H3b *(see Appendix A, Tables A189-A229 and Fig. A140-A161)*

The creative potential at young adult age, in the following aspects: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, will be positively linked to the duration of the practice of one or more forms of sport during adolescence while controlling the duration of the practice of one or more forms of art and of the practice of video gaming during adolescence.

One-way ANOVA and Kruskal-Wallis tests were performed (cf. supra §3) to compare the effect of the duration of sport activities on scores of DT (originality, flexibility, fluency), mental flexibility and associative thinking RAT & OV (see Table 14).

Table 14

Durations Sport		Zscore: DT originality	Zscore: DT flexibility	Zscore: DT fluency	Zscore: Mental flexibility	Zscore: Associative thinking RAT	Zscore: Associative thinking OV
0 - < 2 years SPORT	N	19	19	19	16	18	19
	Mean	-,093	-,301	-,221	,198	-,408	,098
	Median	,163	-,182	-,566	,188	,084	,116
	Std. Deviation	,966	,789	,768	,644	1,408	,795
2 - 10 years SPORT	N	13	13	12	11	12	13
	Mean	-,266	-,639	-,597	,299	-,193	-,496
	Median	-,136	-,888	-,747	,086	,084	-,656
	Std. Deviation	,901	1,261	,464	1,364	1,016	,429
> 10 years SPORT	N	15	15	14	12	15	15
	Mean	,096	,416	-,170	,228	,195	-,019
	Median	,270	,378	-,439	,371	,638	-,012
	Std. Deviation	1,035	,710	,900	,994	1,151	1,043

Table 14: Descriptive statistics for each group ('0 - <2 years', '2 -10 years' and '>10 years') across the six dependent variables of interest. The '0 - <2 years' group is composed of subjects who practiced one or more sport activities for less than 2 years cumulated, excluding art and video gaming activities, and all subjects who did not practice any art, sport or video games. The '2 - 10 years' group is composed of subjects who practiced one or more sport activities for 2 to 10 years cumulated, excluding art and video gaming activities. The '>10 years' group is composed of subjects who practiced one or more sport activities for more than 10 years cumulated, excluding art and video gaming activities.

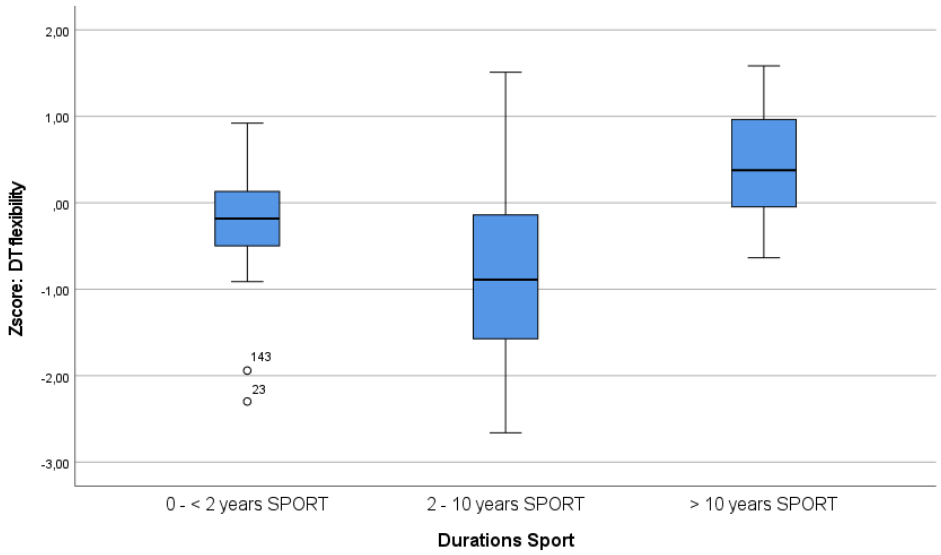
No significant differences were found among the three groups of participants (0 - <2 years, 2 -10 years, >10 years) excepted for DT flexibility and associative thinking RAT. Based on the data we could not conclude that the duration of the practice of one or more forms of sport has a significant effect on scores of DT originality (F[2, 44] = 0.487, p = .618), DT fluency (H[2] = 2.220, p = .330), mental flexibility (F[2, 36] = 0.034, p = .967) and associative thinking OV (F[2, 44] = 2.197, p = .123). We could thus not conclude that the creative potential at young adult age, in DT originality, DT fluency, mental flexibility, associative thinking OV, is higher among subjects who, during adolescence, have practiced one or more forms of sport for a duration of more than 10 years than among subjects with a practice duration of 2 to 10 years, and is higher among subjects with a practice duration of 2 to 10 years than among those with a practice duration of 0 to less than 2 years, while excluding possible interference of the practice of one or more forms of art and of the practice of video gaming during adolescence.

Kruskal-Wallis tests showed that there was a statistically significant difference in DT flexibility scores (H[2] = 8.770, p = .012) and associative thinking RAT scores (H[2] = 5.978, p = .050) among the different duration groups of sport activities.
Thus, groups were compared two by two using Mann-Whitney U tests, applying a Bonferroni correction (3 comparisons, therefore p values multiplied by 3).

Based on the multiple comparisons, we can conclude that DT flexibility scores of individuals who, during adolescence, practiced one or more forms of sport for more than 10 years, are significantly higher than scores of those who practiced 2 to 10 years (z = -2.511, p = .018, d = 3.540), and are significantly higher than scores of those who practiced 0 to less than 2 years (z = -2.341, p = .029, d = 3.394), but we could not conclude that DT flexibility scores of those with a practice duration of 2 to 10 years are significantly higher than scores of those who practiced 0 to less than 2 years (z = -1.285, p = .702) (see Figure 9). This may indicate that it takes a long practice of sport (> 10 years) to achieve a significant effect on DT flexibility scores, Cohen's d (1988) indicating a large size effect for the two significant comparisons.

Figure 9

Boxplot : DT flexibility in function of duration sport



We can conclude that associative thinking RAT scores of individuals who practiced during adolescence one or more forms of sport for more than 10 years, are significantly higher than scores of those who practiced 0 to less than 2 years (z = -2.333, p = .030, d = 3.437), Cohen's d (1988) indicating a large size effect. The associative thinking RAT scores (10 years +) are not significantly higher for subjects with a practice duration of 2 to 10 years (z = -1.889, p = .089), nor are the scores significantly higher for subjects with a practice duration of 2 to 10 years than for subjects with a practice duration of 0 to less than 2 years (z = -.265, p = 1). However, we can observe a trend in this direction when looking at the respective mean rank values (see Appendix A, Tables A218, A220, A222, A224).

Hypothesis H3c *(see Appendix A, Tables A230-A265 and Fig. A162-A186)*

The creative potential at young adult age, in the following aspects: verbal divergent thinking (originality, flexibility, fluency), mental flexibility, associative thinking, will be positively linked to the number of sport activities during adolescence while controlling the number of one or more forms of art and of the practice of video gaming during adolescence.

One-way ANOVA and Kruskal-Wallis tests were performed (cf. supra §3) to compare the effect of the number of sport activities on scores of DT (originality, flexibility, fluency), mental flexibility and associative thinking RAT & OV (see Table 15).

Table 15

Number Sport activities		Zscore: DT originality	Zscore: DT flexibility	Zscore: DT fluency	Zscore: Mental flexibility	Zscore: Associative thinking RAT	Zscore: Associative thinking OV
0 Sport activity	N	14	14	14	12	13	14
	Mean	,022	-,327	-,298	,276	-,598	,116
	Median	,238	-,221	-,549	,229	,084	,071
	Std. Deviation	,882	,624	,573	,704	1,617	,829
1 Sport activity	N	25	25	23	20	24	25
	Mean	-,185	-,267	-,460	,335	-,100	-,417
	Median	-,136	-,289	-,717	,306	,084	-,670
	Std. Deviation	1,009	1,188	,747	1,146	1,116	,616
2+ Sport activities	N	8	8	8	7	8	8
	Mean	,069	,432	,126	-,116	,430	,490
	Median	-,261	,516	-,142	,003	,638	,430
	Std. Deviation	1,020	,676	,952	,843	,412	1,049

Table 15: Descriptive statistics for each group ('0 sport activity', '1 sport activity' and '2+ sport activities') across the six dependent variables of interest. The '0 sport activity' group is composed of subjects who practiced art, sport, video gaming activities for less than 3 months or practiced other activities. The '1 sport activity' group is composed of subjects who practiced one sport activity for more than 3 months, excluding art and video gaming activities. The '2+ sport activities' group is composed of subjects who practiced two or more sport activities for more than 3 months, excluding art and video gaming activities.

No significant differences, except for associative thinking OV, were found among the three groups of participants (0 sport activity, 1 sport activity, 2+ sport activities).

Based on the data we could not conclude that the number of sport activities has a significant effect on the scores of DT originality (F[2,44] = 0.316, p = .730), DT flexibility [F[2, 44] = 1.814, p = .175), DT fluency (H[2] = 5.220, p = .074), mental flexibility (F[2, 36] = 0.561, p = .576), associative thinking RAT (H[2] = 4.123, p = .127). We could thus not conclude that the creative potential at young adult age, in DT originality, DT flexibility, DT fluency, mental flexibility and associative thinking RAT, is higher among subjects who, during adolescence, have practiced two or more sport activities than among those who practiced only one sport activity, and is higher among subjects who practiced only one sport activity than among those who practiced no sport activity, while excluding possible interference of the practice of one or more forms of art and of the practice of video gaming during adolescence.

A Kruskal-Wallis test showed that there was a statistically significant difference in associative thinking OV scores ($H[2)] = 7.933$, $p = .019$) among the three groups of participants (0 sport activity, 1 sport activity, 2+ sport activities).

Thus, groups were compared two by two using Mann-Whitney *U* tests, applying a Bonferroni correction (3 comparisons, therefore p values multiplied by 3).

Based on the multiple comparisons we can conclude that the associative thinking OV scores for individuals who practiced during adolescence two or more sport activities are higher than for those who practiced one sport activity ($z = -2.478$, $p = .020$).

This is a rather particular case, as individuals who practiced during adolescence two or more sport activities don't show significantly higher scores when compared to subjects who practiced no sport activity ($z = -.887$, $p = .563$), nor that associative thinking OV scores among subjects who practiced one sport activity are higher than among subjects who practiced no sport activity ($z = -1{,}962$, $p = .075$).

When looking at the performed multiple regression, it showed that the predictive model was significant with a risk factor $\alpha = .05$ ($F[3,114] = 9.982$, $R^2 = .208$, $p < 001$).

We find that 20.8% of the variance of associative thinking OV is explained by the number of art, sport and video gaming activities. The results showed that the number of sport activities, was a significant positive predictor of associative thinking OV ($\beta = 0.225$, $F = 8.521$, $p = .004$, $R^2 = .070$), while controlling for the number of art and video gaming activities (see Appendix B, Tables B119-121). However, the underlying assumptions are not fulfilled, and the regression is influenced by a high number of leverage and Cook points, which does not allow us to draw conclusions, even though the result goes in the expected direction (see Appendix B, Table B117 & Fig. B147-B148).

4.4 Practice of different categories of activities

Hypothesis H5a *(see Appendix A, Tables A267-A299 and Fig. A187-A210)*

The creative potential at young adult age, in the following aspects: verbal divergent thinking (originality, flexibility, fluency), associative thinking, and more particularly mental flexibility (Rietveld & Kiverstein, 2014) will be positively linked to the number of different categories of leisure activities individuals combine during adolescence.

One-way ANOVA and Kruskal-Wallis tests were performed to compare the effect of the number of different categories of leisure activities on scores of DT (originality, flexibility, fluency), mental flexibility and associative thinking RAT & OV (see Table 16).

Table 16

Number cat. Leisure activities		Zscore: DT originality	Zscore: DT flexibility	Zscore: DT fluency	Zscore: Mental flexibility	Zscore: Associative thinking RAT	Zscore: Associative thinking OV
0 cat. leisure activities	N	15	15	14	12	14	14
	Mean	,105	-,264	-,298	,276	-,509	,116
	Median	,314	-,182	-,549	,229	,084	,071
	Std. Deviation	,909	,650	,573	,704	1,589	,829
1 cat. leisure activities	N	75	75	72	63	73	71
	Mean	-,134	-,039	-,098	,023	,016	-,126
	Median	-,121	,064	-,335	,003	,638	-,392
	Std. Deviation	,946	1,065	,970	1,025	,955	,913
2 cat. leisure activities	N	36	36	35	31	37	32
	Mean	,197	,143	,309	-,111	,144	,092
	Median	,339	,360	,155	-,078	,638	-,109
	Std. Deviation	1,113	,943	1,144	1,040	,759	,962

Table 16: Descriptive statistics for each group ('0 category', '1 category' and '2 categories' of leisure activities) across the six dependent variables of interest. The '0 category' group is composed of subjects who practiced art, sport, video gaming activities for less than 3 months or practiced other activities. The '1 category' group is composed of subjects who practiced either one or more art activities, or one or more sport activities, or one or more video gaming activities for more than 3 months. The '2 categories' group is composed of subjects who practiced one or more art activities and/or sport activities and/or video gaming activities for more than 3 months.

No significant differences were found among the three groups of participants:
'0 category', '1 category' and '2 categories' of leisure activities for DT originality *(F*[*2, 123*] = *1.469, p* = .234*)*, DT flexibility (*H*[2]= 2.346, *p* = .309), DT fluency (*H*[2] = 4.758, *p* = .093), mental flexibility *(F*[*2, 103*] = *0.655, p* = .522*)*, associative thinking RAT (*H*[2] = 2.047, *p* = .359) and associative thinking OV (H[2] = 3.156, *p* = .206).
We cannot conclude that the creative potential in the following aspects at young adult age: verbal divergent thinking (originality, flexibility, fluency), mental flexibility and associative thinking (RAT & OV) is positively linked to the number of different categories of leisure activities individuals combine during adolescence.

5 DISCUSSION AND LIMITATIONS OF THIS STUDY

We formulated 5 hypotheses that dealt with artistic, sport and video gaming activities outside the educational setting and their influence on the long term (5 years on average, cf. supra §2.3) on the creative potential of the people who practice them. Unfortunately, the video gaming category (H4) had to be removed from the analysis because of a too small sample and no information about the type of video game. That leaves an open avenue for further research, given that the literature suggests positive effects of video gaming on creativity, but long-term effects are still to be confirmed, that is, at young adult age when practicing during adolescence (Rahimi & Shute, 2021; Shu-Hua Yeh, 2015).

Starting from the scientific literature in this field, which establishes a link on the short-term between the practice of certain leisure activities and a higher creative potential (e.g., Davis et al., 2014; Mareque et al., 2019), we hypothesized that these activities could have a longer-term effect and thus confirm the very few studies in this direction (Meltzer & Meltzer, 2022; Richard, 2016).

Overall, it could not be shown that practicing leisure activities during adolescence has a positive effect on the creative potential in adulthood, since the average score of creative writing was not higher than the one of the control group (H1a). However, these conclusions are not generalizable given the strong under-representation of the control group (n = 15 or 12%) in comparison to the leisure group (n = 110 or 88%) (cf. supra § 4.1 - Table 4). Similar results were observed when focusing on a group of subjects who practiced one or more forms of art (H2a), and on a group of subjects who practiced one or more forms of sport (H3a). When comparing the control group for each of the six aspects of creativity (DT originality, DT flexibility, DT fluency, mental flexibility and associative thinking RAT & OV), to the ‘only art’ group, as well as to the ‘only sport’ group, the scores of these two conditions did not prove to be higher than those of the control group. Here too, the control group was under-represented in relation to the different conditions (art & sport) (cf. supra § 4.2 - Table 10 and § 4.3 - Table 13).

These results are in contradiction with previous research in the field of arts which reported positive effects on several dimensions of creative potential (Dunbar, 2008; Ivcevic, 2020, Meltzer & Meltzer, 2022) as well as in the field of sports (Greco et al., 2010; Furley & Memmert, 2018; Masley et al., 2009; Memmert & Roth, 2007; Zahno & Hossner, 2020). Reproducing this study with a better design, taking into account a more extensive control group, allowing a more robust comparison, could offer a future research perspective.

On the other hand, we can conclude that the scores of young adults who practiced two or more forms of leisure activities for more than 3 months during adolescence, are significantly higher than the scores of those who practiced none or one activity specifically for creative writing, DT flexibility, DT fluency, associative thinking RAT and associative thinking OV (H1d).

It appears that practicing at least two activities (art and/or sport) has an effect on the creative potential. This reinforces the existing theoretical findings of the positive impact of these activities on some aspects of creativity, and more specifically on associative thinking in addition to divergent thinking already previously identified (Barbot, 2008). Nevertheless, based on the results of this study, it seems that to maintain the longer-term effect, the practice of at least two activities would be required.

In addition to large size effects (Cohen, 1988; Lenhard & Lenhard, 2016), Table 9 (§ 4.1) shows that the sizes (number of subjects) of both groups (0-1 activity and 2 & more activities) are larger and better balanced than for the other hypotheses, which gives us more confidence in the conclusions from the tests.

When we deepen our investigation, to see if the scores in the six measured aspects are higher for subjects who practiced two or more art activities, than for those who practiced only one, and are higher for those who practiced one than for those who didn't practice any, we do not find similar results as no significant differences were found among the three groups of participants (0 art activity, 1 art activity, 2+ art activities) (H2c). When conducting the same analyses for the number of sport activities, we were also unable to detect any effect as significant (H3c). This is not in line with the findings (higher level of creativity) reported by Richard et al. (2017).

In terms of the effect of the duration of activities, contrary to expectations, the analysis could not show that subjects who, during adolescence, have practiced one or more forms of art for a duration of more than 10 years, have higher scores than subjects with a practice duration of 2 to 10 years, and that subjects with a practice duration of 2 to 10 years have higher scores than those with a practice duration of 0 to less than 2 years, as no significant differences were found among the three groups of participants (0 - <2 years, 2 -10 years, >10 years) in the six measured aspects of creativity (H2b). This turns out to be inconsistent with the assertions of Kaufman & Beghetto (2009) that the length of practice is related to creativity.

Similar results were found for the duration of sport activities, except for two aspects, more precisely: DT flexibility and associative thinking RAT. In both cases, it seems that it is

necessary to practice, for at least 10 years, one or more forms of sport activities for a better score in DT flexibility and associative thinking RAT in adulthood (H3b). These findings are to a certain extent in line with the research of Bowers et al. (2014) and Goff & Torrance (2002, as cited in Bowers et al., 2014), suggesting a positive relationship between the time spent practicing sport and the level of creativity and especially for DT flexibility. This certainly opens up a path of research on these two aspects of creative potential with a greater number of subjects with a better distribution of durations and especially by collecting key information on the intensity and frequency of these activities. It may even be that, taking into account these factors (duration distribution, intensity, frequency), the practice of artistic and/or sporting activities could allow subjects to obtain more advantageous scores in the six dimensions of creative potential presented in this study.

When focusing our attention on the effect of the variety/diversity of activities (H5a), we were not able to conclude that the creative potential was positively linked to the number of different categories of leisure activities individuals combine during adolescence in any of the six creativity dimensions, being in contradiction with the results of research by Baer (2016) and Kurtz (2012) suggesting a positive contribution of the diversity of domains of activities. Though this test showed several limitations since it did not consider the number of activities, the duration of these activities (number of years of practice), their frequency (how many times per week/month/year), and intensity (duration of each practice).

Overall, we could not demonstrate an effect of the duration of the practice (H1b) nor of the number of leisure activities (H1c) on creative writing, but this needs to be qualified:

For H1b, we found that the regression became insignificant by removing the subjects (n = 4) who had a great leverage, which at the more detailed analysis, turned out to be those with the longest duration of leisure activity practice. However, the result of the regression including these subjects, went in the direction suggested in the literature (improvement of creativity with the duration of leisure activities; Amabile 1996; Kaufman & Beghetto, 2009; Kerka, 1999). It could be assumed that these subjects with higher scores would be representative of subjects who practiced leisure activities for a longer time. This indicates a research avenue including a greater number of subjects who have a longer duration of practice.

For H1c, we also found that the regression became insignificant by removing the subjects (n = 9) who had a great leverage and Cook index which turned out to be those with the highest number of leisure activities. Again, the result of the regression including these subjects was in line with the theoretical expectation outlined above (improvement of creativity with the number of leisure activities; Hickey, 2002 as cited in Barbot, 2008; Memmert et al., 2010; Memmert & Roth, 2007). One could assume that these higher-scoring subjects would be representative of people who have practiced a greater number of leisure activities. This suggests a line of research that includes a larger number of subjects who have practiced a greater number of leisure activities.

Information on personality traits was not available in this study. However, we know that studies have found that the personality domain of openness to experience is positively associated with creative performance (Christensen et al., 2018; Feist, 1998; Ivcevic, & Mayer, 2009; Puryear et al., 2017). Openness has also more specifically been related to the number of creative activities in a study by King et al. (1996). It is not excluded that the subjects in this study, who practiced a greater number of activities, are precisely those who have higher openness to experience. Further research taking this trait into account could allow for a more accurate analysis of the results, making it possible to distinguish the respective effects of openness to experience and participation in leisure activities.

Memory biases could have occurred and compromised the accuracy of the reporting, particularly for the reporting phase of practiced activities and their duration. This may partially account for the absence of significant effects when comparing the activity groups to the control group.

Another more transversal issue and unaccounted-for variable that could have negatively influenced the expression of creative potential are the testing conditions (e.g., laboratory environment, experimenter attitude, exam-like conditions).

However, this methodological barrier is not inherent to this research in particular (Batey & Furnham, 2006).

6 CONCLUSIONS

We investigated the creative potential of young adults who practiced leisure activities during adolescence. Scores obtained by young adults who practiced two or more forms of leisure activities for more than 3 months during adolescence, have been found to be higher than scores of those who practiced none or one activity specifically for the general measure of creative writing (z = -2.070, p = .019, d = 3.403) as well as for DT flexibility (t[125] = -2.187, p = .015, d = 0.389), DT fluency (z = -3.666, p < .001, d = 3.415), associative thinking RAT (z = -2.241, p = .013, d = 3.421) and associative thinking OV (z = -2.436, p = .008, d = 3.378), partially confirming our hypothesis H1d. The duration of the practice of sport also emerged as a factor contributing to higher scores (H3b) in DT flexibility (z = -2.511, p = .018, d = 3.540) and associative thinking RAT (z = -2.333, p = .030, d = 3.437), though a practice duration of at least 10 years seems to be required. As far as creative writing is concerned, it might be affected both by the duration (H1b) and the number (H1c) of activities. These significant results obtained should however be relativised because other tested dimensions and hypotheses did not reveal any significant effect of the practice, the duration, the number and diversity of activities on our various measures of creative potential. As discussed earlier, this research was based on a sample presenting several limitations: the unequal distribution of participation duration and number of activities, the absence of information on the intensity and frequency of the practiced activities, and the generally small size of the control group. This research, however, raises a path for future research that would integrate these missing dimensions. This study complements the limited research on the long-term impacts of participation in leisure activities, digging more deeply on one hand in specific aspects like duration and number and on the other hand considering a more extensive range of dimensions of creative potential. It shows that encouraging participation to leisure activities in adolescence can contribute to greater creative potential in adulthood. This in turn could contribute positively to individual well-being and beyond, to a more successful and effective social and professional life. Even more that this approach to develop one's creative potential can be a fun and attractive way to grow creativity on the development path to adulthood. It could even be suggested to integrate this opportunity of participation in activities more extensively at the level of school curricula making it more accessible to more adolescents so that it does not remain the privilege of those surrounded by a supportive environment.

7 BIBLIOGRAPHY

Alhashim, A. G., Marshall, M., Hartog, T., Jonczyk, R., Dickson, D., van Hell, J., Okudan-Kremer, G. E., & Siddique, Z. (2020). WIP: Assessing creativity of alternative uses task responses: A detailed procedure. *ASEE Annual Conference and Exposition,* Conference Proceedings, 2020-June, [1656]. Retrieved from https://par.nsf.gov/servlets/purl/10205616

Alter, F. (2010). Using the visual arts to harness creativity. *Unesco Observatory, Faculty of Architecture, Building And Planning, The University of Melbourne Refereed e-Journal, vol 1.* Issue 5. April 2010. Retrieved from https://www.unescoejournal.com/wp-content/uploads/2020/01/1-5-2-alter-paper.pdf

Amabile, T. M. (1982). Social psychology of creativity: A consensual assessment technique. *Journal of Personality and Social Psychology, 43*(5), pp. 997-1013. https://doi.org/10.1037/0022-3514.43.5.997

Amabile, T. M. (1983). The Social Psychology of Creativity: A Componential Conceptualization. *Journal of Personality and Social Psychology, 45*,(2), pp. 357-376.

Amabile, T. M. (1996). *Creativity in context: Update to the social psychology of creativity.* Boulder, CO: Westview Press. ISBN 9780813330341.

Amabile, T. M. (2012). Componential Theory of Creativity. Harvard Business School. http://hbswk.hbs.edu/. Retrieved from https://www.hbs.edu/ris/Publication%20Files/12-096.pdf

Anderson, N., Potočnik, K., & Zhou, J. (2014). Innovation and creativity in organizations: A state-of-the-science review, prospective commentary, and guiding framework. *Journal of Management, 40*(5), pp. 1297-1333. https://doi.org/10.1177/0149206314527128

Anderson, N., Potočnik, K., Bledow, R., Hülsheger, U., & Rosing, K. (2018). Innovation and creativity in organizations. In Ones, D. S., Anderson, N., Viswesvaran C., & Sinangil H. K. (eds). *Handbook of Industrial, Work & Organizational Psychology: Managerial Psychology and Organizational Approaches. vol. 3*, 8, SAGE Publications Ltd, pp. 161-186.

Averill, J. R. (1999). Individual differences in emotional creativity: Structure and correlates. *Journal of Personality, 67*, pp. 331-371. DOI:10.1111/1467-6494.00058

Baer, J. (1996). The effects of task-specific divergent thinking training. *Journal of Creative Behaviour, 30*, pp. 183-187. https://onlinelibrary.wiley.com/doi/epdf/10.1002/j.2162-6057.1996.tb00767.x

Baer, J. (2016). Domain Specificity and the Limits of Creativity Theory. *The Creativity Post* - February 02, 2016. Retrieved from https://www.creativitypost.com/article/domain_specificity_and_the_limits_of_creativity_theory

Baer, J., & McKool, S. S. (2014). The gold standard for assessing creativity. *International Journal of Quality Assurance in Engineering and Technology Education, 3*, pp. 81-93. http://dx.doi.org/10.4018/ijqaete.2014010104

Barbot, B. (2008). Structures identitaires et expression créative à l'adolescence. *L'orientation scolaire et professionnelle, 37* (4), pp. 483-507. https://www.researchgate.net/publication/30466090_Structures_identitaires_et_expression_creative_a_l'adolescence_Identity_structures_and_creative_expression_in_adolescence http://journals.openedition.org/osp/1772 ; DOI : https://doi.org/10.4000/osp.1772

Barbot, B., Besançon, M., & Lubart, T. I. (2011). Assessing Creativity in the Classroom. *The Open Education Journal 4* (1), pp. 58-66. DOI: 10.2174/1874920801104010058

Barbot, B., Besançon, M., & Lubart, T. (2015). Creative potential in educational settings: its nature, measure, and nurture, *Education 3-13*, 43:4, pp. 371-381. https://doi.org/10.1080/03004279.2015.1020643

Barbot, B., & Heuser, B. (2017). Creativity and Identity. Formation in Adolescence: A Developmental Perspective. In *Explorations in Creativity Research, The Creative Self.* Academic Press, 2017, pp. 87-98. ISBN 9780128097908. http://dx.doi.org/10.1016/B978-0-12-809790-8.00005-4.

Barbot, B., & Lubart, T. (2012). Adolescence, créativité et transformation de Soi. *Enfance, 3,* pp. 299-312. https://doi.org/10.3917/enf1.123.0299. https://www.researchgate.net/publication/256439206_Adolescence_creativite_et_transformation_de_Soi

Barbot, B., Lubart, T., & Besançon, M. (2016). Peaks, Slumps, and Bumps: Individual Differences in the Development of Creativity in Children and Adolescents. *New Directions for Child and Adolescent Development, Wiley, 2016, 151* pp. 33 - 45. https://doi.org/10.1002/cad.20152

Barbot, B., Piering, K., Horcher, D., & Baudoux, L. (2021). Creative recovery: Narrative creativity mitigates identity distress among young adults with cancer. *Journal of Psychosocial Oncology 40*:3, pp. 315-330. https://doi.org/10.1080/07347332.2021.1907498

Barbot, B., Randi, J., Tan, M., Levenson, C., Friedlaender, L., & Grigorenko, E. L. (2013). From perception to creative writing: A multi-method pilot study of a visual literacy instructional approach. *Learning and Individual Differences, Volume 28*, 2013, pp. 167-176. ISSN 1041-6080, https://doi.org/10.1016/j.lindif.2012.09.003. https://www.sciencedirect.com/science/article/pii/S1041608012001288

Barbot, B., Tan, M., Randi, J., Santa-Donato, G., & Grigorenko, E. L. (2012). Essential skills for creative writing: Integrating multiple domain-specific perspectives. *Thinking Skills and Creativity*, *7*(3), pp. 209-223. https://doi.org/10.1016/j.tsc.2012.04.006

Barbot, B., & Tinio, P. P. L. (2015). Where is the "g" in creativity? A specialization–differentiation hypothesis. *Front. Hum. Neurosci., 13*. Sec. Cognitive Neuroscience - Volume 8 - 2014 | https://doi.org/10.3389/fnhum.2014.01041

Barsalou, L. W. (1983). Ad hoc categories. *Memory & Cognition, 11*(3), pp. 211-227. https://doi.org/10.3758/BF03196968

Batey, M. (2012). The Measurement of Creativity: From Definitional Consensus to the Introduction of a New Heuristic Framework. *Creativity Research Journal, 24*(1), pp. 55-65. https://doi.org/10.1080/10400419.2012.649181

Batey, M., & Furnham, A. (2006). Creativity, Intelligence, and Personality: A Critical Review of the Scattered Literature. *Genetic, Social, and General Psychology. Monographs, 132*(4), pp. 355-429. https://doi.org/10.3200/MONO.132.4.355-430

Bavelier, D., Green, C. S., Pouget, A., & Schrater, P. (2012). Brain Plasticity Through the Life Span: Learning to Learn and Action Video Games. *Annual Review of Neuroscience, 35*(1), pp. 391-416. doi:10.1146/annurev-neuro-060909-152832

Beaty, R. E., & Silvia, P. J. (2012). Why do ideas get more creative across time? An executive interpretation of the serial order effect in divergent thinking tasks. *Psychology of Aesthetics, Creativity, and the Arts, 6*(4), pp. 309-319. https://doi.org/10.1037/a0029171

Beaty, R. E., Kenett, Y. N., Christensen, A. P., Rosenbergd, M. D., Benedek, M., Chenf, Q., Finke, A., Qiuf, J., Kwapil, T. R., Kane, M. J., & Silvia, P. J. (2017). Robust prediction of individual creative ability from brain functional connectivity. *PNAS, vol. 115* no. 5, January 30, 2018, pp. 1087-1092. www.pnas.org/cgi/doi/10.1073/pnas.1713532115

Behrens, J. P., & Olteţeanu, A.-M. (2020). Are All Remote Associates Tests Equal? An Overview of the Remote Associates Test in Different Languages. *Front. Psychol. 11*:1125. DOI: 10.3389/fpsyg.2020.01125

Benedek, M., Fink, A., & Neubauer, A. C. (2006). Enhancement of ideational fluency by means of computer-based training. *Creativity Research Journal, 18*(3), pp. 317-328. http://dx.doi.org/10.1207/s15326934crj1803_7.

Bennett, N., & Lemoine, G. J. (2014). What a difference a word makes: Understanding threats to performance in a VUCA world. Strategic Planning. *Harvard Business Review, issue 92*(1/2), Jan-Feb 2014. Retrieved from https://www.researchgate.net/publication/263926940_What_VUCA_really_means_for_you

Benz, S., Sellaro, R., Hommel, B., & Colzato, L. S. (2021). La musique fait tourner le monde : L'impact de la pratique musicale sur les fonctions cognitives non associées à la musique - Une revue. *Déméter: Theories & Pratiques Artistiques Contemporaines, 6* (2021). Retrieved from https://hdl.handle.net/1887/3249388

Bergman Nutley, S., Darki, F., & Klingberg, T. (2014). Music practice is associated with development of working memory during childhood and adolescence. *Frontiers in Human Neuroscience, 2014 Jan 7*;7:926. DOI: 10.3389/fnhum.2013.00926

Besançon, M., Lubart, T., & Barbot, B. (2013). Creative giftedness and educational opportunities. *Educational and Child Psychology 30*(2), pp. 79-88. DOI: 10.53841/bpsecp.2013.30.2.79

Birdi, K. S. (2016). Creativity Training. In: Sparrow, P., Shipton, H., Budhwar, P. & Brown, A., (eds.). *Human Resource Management, Innovation and Performance.* Palgrave, Macmillan, pp. 298-312. ISBN 9781137465184 https://doi.org/10.1057/9781137465191

Blakemore, S.-J. (2012). The Mysterious Workings of the Adolescent Brain. *http://www.ted.com/talks/sarah_jayne_blakemore_the_mysterious_workings_of_the_a olescent_brain.html*.

Blanco-Herrera, Jorge A.; Gentile, Douglas A.; Rokkum, Jeffrey N. (2019). Video Games can Increase Creativity, but with Caveats. *Creativity Research Journal, 31*(2), pp. 119–131. doi:10.1080/10400419.2019.1594524

Bowman, N. D., Kowert, R., & Ferguson, C. J. (2015). Chapter 2 - The Impact of Video Game Play on Human (and Orc) Creativity. *Video Games and Creativity*, Academic Press, 2015, pp. 39-60. ISBN 9780128014622. https://doi.org/10.1016/B978-0-12-801462-2.00002-3. Retrieved from https://www.sciencedirect.com/science/article/pii/B9780128014622000023

Bowden, E. M., & Jung-Beeman, M. (2003). Normative data for 144 compound remote associate problems. *Behavior Research Methods, Instruments & Computers 35*, pp. 634-639. https://doi.org/10.3758/BF03195543

Bowers, M. T., Green, B. C., Hemme, F., & Chalip, L. (2014). Assessing the Relationship Between Youth Sport Participation Settings and Creativity in Adulthood. *Creativity Research Journal, 26*:3, pp. 314-327 DOI: 10.1080/10400419.2014.929420

Boyles, M. (2022). The importance of creativity in business. *Harvard Business School Online's Business Insights Blog,* 25 jan 2022. https://online.hbs.edu/blog/post/importance-of-creativity-in-business

Brandler, S., & Rammsayer, T. H. (2003). Differences in Mental Abilities between Musicians and Non-Musicians. *Psychology of Music, 31*(2), pp. 123-138. https://doi.org/10.1177/0305735603031002290

Büning, C., Jürgens, L., & Lausberg, H. (2021). Divergent learning experiences in sports enhance cognitive executive functions and creativity in students. *Physical Education and Sport Pedagogy*, *26*(4), pp. 402-416. https://doi.org/10.1080/17408989.2020.1812056

Čábelková, I. C., Strielkowski, W., Rybakova, A., & Molchanova, A. (2020). Does Playing Video Games Increase Emotional Creativity? *Int. J. Environ. Res. Public Health*, *17*(7):2177. https://doi.org/10.3390/ijerph17072177

Campos, D. G. (2014). On Creativity in Sporting Activity: With Some Consequences for Education, Fair Play. *Revista de Filosofía, Ética y Derecho del Deporte*, *2*:2, pp. 40-68. https://raco.cat/index.php/FairPlay/article/view/281987/369844

Cannatella, H. (2004). Embedding Creativity in Teaching and Learning. *The Journal of Aesthetic Education 38*(4), pp. 59-70. DOI:10.1353/jae.2004.0032.

Chermahini, S. A., Hickendorff, M., & Hommel, B. (2012). Development and validity of a Dutch version of the Remote Associates Task: An item-response theory approach. *Thinking Skills and Creativity Vol.7*, pp. 177-186. https://doi.org/10.1016/j.tsc.2012.02.003.

Chiu, F.-C. (2014). Improving your creative potential without awareness: Overinclusive thinking training, *Thinking Skills and Creativity, Volume 15*, 2015, pp. 1-12. ISSN 1871-1871, https://doi.org/10.1016/j.tsc.2014.11.001. https://www.sciencedirect.com/science/article/pii/S187118711400056X

Christensen, A. P., Cotter, K. N., & Silvia, P. J. (2018). Reopening Openness to Experience: A Network Analysis of Four Openness to Experience Inventories. *Journal of Personality Assessment*, *101*:6, pp. 574-588. https://doi.org/10.1080/00223891.2018.1467428

Clark, P. M., Griffing, P. S., & Johnson, L. G. (1989). Symbolic play and ideational fluency as aspects of the evolving divergent cognitive style in young children. *Early Child Development and Care, 51,* pp. 77-88. https://doi.org/10.1080/0300443890510107

Clarkson, A. (2005). Educating the Creative Imagination: A course design and its consequences. *Jung: the e-Journal of the Jungian Society for Scholarly Studies.* Retrieved on June 9, 2006 from http://www.thejungiansociety.org/Jung%20Society/ejournal/Volume1/Clakson-2005.html.

Cleveland Clinic (2019). Retrieved from *https://my.clevelandclinic.org/health/articles/7050-aerobic-exercise*

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2. Auflage).* Hillsdale, NJ: Erlbaum.

Collins, A., & Koechlin, E. (2012). Reasoning, learning, and creativity: frontal lobe function and human decision-making. *PLoS Biol. 10*: e1001293. DOI: 10.1371/journal.pbio.1001293 Retrieved from https://www.researchgate.net/publication/223987263_Reasoning_Learning_and_Creativity_Frontal_Lobe_Function_and_Human_Decision-Making

Coste, D. (2008). L'apport de l'art plastique dans la pédagogie d'une Ecole de Management. *Humanisme et Entreprise*, *287*, pp. 37-53. https://doi.org/10.3917/hume.287.0037

Craft, A. (2003). Creativity and Possibility in the Early Years. Retrieved from *https://tactyc.org.uk/pdfs/Reflection-craft.pdf*

Cropley, A. J. (1990). Creativity and mental health in everyday life. *Creativity Research Journal, 13* (3), pp. 167-178. Retrieved from https://www.academia.edu/9571760/Creativity_and_mental_health_in_everyday_life

Cropley, A. J. (1992). Creativity as an element of giftedness. *International Journal of Educational Research, 19*, pp. 17-30.

Cropley, A. J. (1997). Creativity: A bundle of paradoxes. *Gifted and Talented International, 12*, 1997, pp. 9-15. https://doi.org/10.1080/15332276.1997.11672859

Cropley, A. J, & Cropley, D. H. (2008). Resolving the paradoxes of creativity: An extended phase model *Cambridge Journal of Education*, 2008, *38*, pp. 355-373. DOI:10.1080/03057640802286871

Cropley, D. H. (2019). Measuring Creativity. In *Homo Problematis Solvendis – Problem- solving Man: A History of Human Creativity*, pp. 9–12. Springer Singapore. https://doi.org/10.1007/978-981-13-3101-5_2

Cseh, G. M., & Jeffries, K. K. (2019). A scattered CAT: A critical evaluation of the consensual assessment technique for creativity research. *Psychology of Aesthetics, Creativity, and the Arts, 13*, pp. 159-166. http://dx.doi.org/10.1037/aca0000220

Csikszentmihalyi, M. (1996). *Flow and the psychology of discovery and invention*. New York: Harper Collins. (pp. 107-126 plus Notes)

Dai, D. Y., Tan, X., Marathe, D., Valtcheva, A., Pruzek, R. M., & Shen, J. (2012). Influences of social and educational environments on creativity during adolescence: Does SES matter? *Creativity Research Journal, 24*(2-3), pp. 191-199. https://doi.org/10.1080/10400419.2012.677338

Dajani, D. R., & Uddin, L. Q. (2015). Demystifying cognitive flexibility: Implications for clinical and developmental neuroscience. *Trends Neurosci. 2015 Sep;38*(9), pp. 571-8. DOI: 10.1016/j.tins.2015.07.003 PMID: 26343956.

Davis, L. N., Hoisl, K., & Davis, J. (2014). Spanning the Creative Space between Home and Work: Leisure Time, Hobbies and Organizational Creativity. *Paper presented at The DRUID Society Conference 2014*. http://druid8.sit.aau.dk/druid/registrant/index/login/cid/15

Diedrich, J., Benedek, M., Jauk, E., & Neubauer, A. C. (2015). Are creative ideas novel and useful? *Psychology of Aesthetics, Creativity, and the Arts 9*(1), pp. 35-40. http://dx.doi.org/10.1037/a0038688

De Dreu, C. K. W., Baas, M., & Nijstad, B. A. (2008). Hedonic tone and activation level in the mood-creativity link: Toward a dual pathway to creativity model. *Journal of Personality and Social Psychology, 2008 May; 94*(5), pp. 739-756. DOI: 10.1037/0022-3514.94.5.739. PMID: 18444736.

De Dreu, C. K. W., Nijstad, B. A., Baas, M., Wolsink, I., & Roskes, M. (2012). Working memory benefits creative insight, musical improvisation, and original ideation through maintained task-focused attention. *Pers Soc Psychol Bull. 2012 May;38*(5), pp. 656-669. DOI: 10.1177/0146167211435795

Dodds, R. A., Smith, S. M., & Ward, T. B. (2002). The use of environmental clues during incubation. *Creativity Research Journal, 14*, pp. 287-304. https://doi.org/10.1207/S15326934CRJ1434_1

Duffy, K. (2007). Knitting through recovery one stitch at a time: Knitting as an experiential teaching method for affect management in group therapy. *Journal of Groups in Addiction & Recovery, 2*(1), pp. 67-83. https://doi.org/10.1300/J384v02n01_04

Dumas, D., Organisciak, P., & Doherty, M. (2020). Measuring Divergent Thinking Originality with Human Raters and Text-Mining Models: A Psychometric Comparison of Methods. *Psychology of Aesthetics Creativity and the Arts.* DOI:10.1037/aca0000319

Dunbar, K. N. (2008). Arts education, the brain, and language. In: Asbury, C., Rich, B. (eds.). *Learning Arts and the Brain: The Dana Consortium Report on Arts and Cognition*, pp. 81-92. The Dana Foundation.

Elisondo, R. C., & Donolo, D. (2016). Creativity, Involvement, and Leisure Time: The More, the Better. *Business Creativity and the Creative Economy. 2*, pp. 102-109. doi:10.18536/bcce.2016.10.2.1.10

Erwin, A. K., Tran, K., & Koutstaal, W. (2022). Evaluating the predictive validity of four divergent thinking tasks for the originality of design product ideation. *PLoS ONE 17*(3): e0265116. https://doi. org/10.1371/journal.pone.0265116

Eysenck, H. J. (1993). Creativity and personality: Suggestions for a theory. *Psychological Inquiry, 4*, pp. 147–178. Published By: Taylor & Francis, Ltd. https://www.jstor.org/stable/1448958 https://doi.org/10.1207/s15327965pli0403_1

Eysenck, H. J. (1995). Genius: The natural history of creativity. *New York: Cambridge University Press.* Retrieved from https://pdfcoffee.com/qdownload/geniusthe-natural-history-of-creativety-eysenck-hans-j-pdf-free.html

Fadel, C. (2008). How to Build a Student for the 21st Century. *TIME Magazine, December 18, 2006.* www.p21.org. https://www.oecd.org/site/educeri21st/40756908.pdf

Feist, G. J. (1998). A Meta-Analysis of Personality in Scientific and Artistic Creativity. *Personality and Social Psychology Review, 2*, pp. 290-309. http://dx.doi.org/10.1207/s15327957pspr0204_5

Felsman, P., Gunawardena, S., & Seifert, C. M. (2020). Improv experience promotes divergent thinking, uncertainty tolerance, and affective well-being. *Thinking Skills and Creativity, 35.* https://doi.org/10.1016/j.tsc.2020.100632

Fink, A., & Benedek, M. (2019). "The Neuroscience of Creativity". *Neuroforum 2019 vol.25*(4), pp. 231-240. https://doi.org/10.1515/nf-2019-0006.

Florida, R. (2002). The rise of the creative class. *Washington Monthly*. Why cities without gays and rock bands are losing the economic development race. Retrieved from https://washingtonmonthly.com/2002/05/01/the-rise-of-the-creative-class/

Forgeard, M. J. C., & Eichner, K. V. (2014). Creativity as a target and tool for positive interventions. In A. C. Parks & S. M. Schueller (Eds.), *The Wiley Blackwell handbook of positive psychological interventions - First edition*, pp. 137-154. Wiley Blackwell. https://doi.org/10.1002/9781118315927.ch7

Forthmann, B., Wilken, A., Doebler, P., & Holling, H. (2019). Strategy induction enhances creativity in figural divergent thinking. *The Journal of Creative Behavior, 53*(1), pp. 18-29. https://doi.org/10.1002/jocb.159

Franklin, M. S., Sledge Moore, K., Yip, C.-Y., Jonides, J., Rattray, K., & Moher, J. (2008). The effects of musical training on verbal memory. *Psychology of Music, 36*, pp. 353-365. DOI:10.1177/0305735607086044

Furley, P., & Memmert, D. (2018). Can creative role models prime creativity in soccer players? *Psychology of Sport and Exercise, 37*, pp. 1–9. https://doi.org/10.1016/j.psychsport.2018.03.007

Gaxiola Tirado, J. A., Colverson, A., & Moreno, S. (2019). Do, Re, Mi, and EEG: An Analysis of Imagined and Performed Musical Settings. Music, social engagement and AD. In Contreras-Vidal J. L., Robleto, D., Cruz-Garza, J. G., Azorín J. M., & Nam, C. S. (eds.; 2019). *Mobile Brain-Body Imaging and the Neuroscience of Art, Innovation and Creativity*. *Springer Series on Bio- and Neurosystems, vol. 10*, p.204. https://doi.org/10.1007/978-3-030-24326-5 doi:10.1007/978-3-030-24326-5_18. Retrieved from https://www.researchgate.net/publication/337280490_Do_Re_Mi_and_EEG_An_Analysis_of_Imagined_and_Performed_Musical_Settings - in Contreras-Vidal, J.L.

Gibson, C., Folley, B. S., & Park, S. (2009). Enhanced divergent thinking and creativity in musicians: a behavioral and near-infrared spectroscopy study. *Brain Cogn. Feb. 2009 Volume 69*, Issue 1, pp. 162-169. https://doi.org/10.1016/j.bandc.2008.07.009. https://www.sciencedirect.com/science/article/pii/S0278262608002303

Glăveanu, V. P. (2019). Measuring creativity across cultures: Epistemological and methodological considerations. *Psychology of Aesthetics, Creativity, and the Arts, American Psychological Association 2019, Vol. 13*, No. 2, pp. 227-232. https://doi.org/10.1037/aca0000216

Granic, I., Lobel, A., & Engels, R. C. M. E. (2014). The benefits of playing video games. *American Psychologist, 69*(1), pp. 66-78. https://doi.org/10.1037/a0034857

Greco, P., Memmert, D., & Morales, J. C. P. (2010). The effect of deliberate play on tactical performance in basketball. *Percept. Mot. Skills 110*, pp. 849-856. DOI: 10.2466/PMS.110.3.849-856

Green, C. S., Sugarman, M. A., Medford, K., Klobusicky, E., & Bavelier, D. (2012). The effect of action video game experience on task-switching. *Comput Human Behav. 2012 May;28*(3), pp. 984-994. doi: 10.1016/j.chb.2011.12.020.

Grupas, A. (1990). "Creative Problem-Solving." *Paper presented at the Annual Meeting of the Missouri Association of Community and Junior Colleges*, November 15-17, 1990. (ED 343 813). https://files.eric.ed.gov/fulltext/ED343813.pdf

Gubenko, A., & Houssemand, C. (2022). Alternative Object Use in Adults and Children: Embodied Cognitive Bases of Creativity. *Front Psychol. 2022 Sep 2;*13. https://doi.org/10.3389/fpsyg.2022.893420

Guilford, J. P. (1950). Creativity. *American Psychologist, 5*(9), pp. 444-454 https://doi.org/10.1037/h0063487

Hawks, D. V. (1964). The clinical usefulness of some tests of overinclusive thinking in psychiatric patients. *British Journal of Social and Clinical Psychology, 3*, pp. 186-195. https://doi.org/10.1111/j.2044-8260.1964.tb00428.x

Hawks, D. V., & Payne, R. (1971). Overinclusive Thought Disorder and Symptomatology. *British Journal of Psychiatry, 118*(547), pp. 663-670. DOI: https://doi.org/10.1192/bjp.118.547.663

Hyde, K. L., Lerch, J., Norton, A., Forgeard, M., Winner, E., Evans, A. C., & Schlaug, G. (2009). Musical training shapes structural brain development. *The Journal of neuroscience : the official journal of the Society for Neuroscience*, *29*(10), pp. 3019-3025. https://doi.org/10.1523/JNEUROSCI.5118-08.2009. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2996392/pdf/zns3019.pdf

Ionescu, T. (2012). Exploring the nature of cognitive flexibility. *New Ideas in Psychology*, *30*(2), pp. 190-200. https://doi.org/10.1016/j.newideapsych.2011.11.001

Ivcevic, Z. (2020). Creativity Can Be Taught. Research reveals new ways to teach creativity to children and adults. *Psychology Today.* https://www.psychologytoday.com/us/blog/creativity-the-art-and-science/202006/creativity-can-be-taught

Ivcevic, Z., & Hoffmann, J. (2019). Emotions and Creativity: From Process to Person and Product. In J. Kaufman & R. Sternberg (Eds.), *The Cambridge Handbook of Creativity* (Cambridge Handbooks in Psychology, pp. 273-295). Cambridge University Press. DOI:10.1017/9781316979839.015

Ivcevic, Z., & Mayer, J. D. (2009). Mapping dimensions of creativity in the life-space. *Creativity Research Journal, 21*(2-3), pp. 152-165. https://doi.org/10.1080/10400410902855259

Jaggi, P., Gupta, V., & Shree, R. (2016). Effects of Dancing on Creativity and Self-Esteem in Young Adults. *International Journal of Humanities and Social Sciences - IJHS, Vol.2* Issue. 1, Jan-Mar 2017, pp. 1-27. www.ijhs.net.in 1

Jauk, E., Benedek, M., & Neubauer, A. C. (2014). The road to creative achievement: A latent variable model of ability and personality predictors. *European Journal of Personality*, *28*(1), pp. 95-105. https://doi.org/10.1002/per.1941

Johnstone, M. N. (2006). Augmenting Postgraduate Student Problem-Solving Ability by the Use of Critical Thinking Exercises. *Edith Cowan University, Australia.* https://ro.ecu.edu.au/ceducom/81

Jonides, J. (2008). Musical Skill and Cognition. In: Asbury, C., Rich, B. (eds.) *Learning Arts and the Brain: The Dana Consortium Report on Arts and Cognition*, pp. 11-16. The Dana Foundation. http://w.aems-edu.org/PDFs/Learning_Arts_and_the_Brain.pdf#page=21

Karwowski, M., Kaufman, J. C., Lebuda, I., Szumski, G., & Firkowska-Mankiewicz, A. (2017). Intelligence in childhood and creative achievements in middle-age: The necessary condition approach. *Intelligence, 64*, pp. 36-44. https://doi.org/10.1016/j.intell.2017.07.001

Kaufman, J. C. (2016). *Creativity 101* (2nd Edition). New York: Springer.

Kaufman, J. C., & Baer, J. (2012). Beyond new and appropriate: Who decides what is creative? *Creativity Research Journal, 24*(1), pp. 83-91. https://doi.org/10.1080/10400419.2012.649237.

Kaufman, J. C., Baer, J., Cole, J. C., & Sexton, J. D. (2008). A comparison of expert and nonexpert raters using the consensual assessment technique. *Creativity Research Journal, 20*(2), pp. 171-178. https://doi.org/10.1080/10400410802059929.

Kaufman, J. C., & Beghetto, R. (2009). Beyond Big and Little: The Four C Model of Creativity. *Review of General Psychology 13*. https://doi.org/10.1037/a0013688

Kaufman, J. C., & Glăveanu, V. (2019). A Review of Creativity Theories: What Questions Are We Trying to Answer? In J. Kaufman & R. Sternberg (Eds.), *The Cambridge Handbook of Creativity*, pp. 27-43. https://doi.org/10.1017/9781316979839.004

Kaufman, J. C., & Sternberg, R. T. (2006). *The International Handbook of Creativity*. Cambridge University Press. ISBN-13 978-0-511-14619-0.

Kenett, Y. N., Levy, O., Kenett, D. Y., Stanley, H. E., Faust, M., & Havlin, S. (2018). Flexibility of thought in high creative individuals represented by percolation analysis. *Proceedings of the National Academy of Sciences. 115*(5). pp. 867-872. https://doi.org/10.1073/pnas.171736211

Kerka, S. (1999). Creativity in Adulthood. *On Adult, Career, and Vocational Education*. Distributed by ERIC Clearinghouse. https://eric.ed.gov/?id=ED429186

Kim, K. H. (2006). Can We Trust Creativity Tests? A Review of the Torrance Tests of Creative Thinking (TTCT). *Creativity Research Journal, 18*:1, pp. 3-14. DOI: 10.1207/s15326934crj1801_2

King, L. A., McKee Walker, L., & Broyles, S. J. (1996). Creativity and the Five-Factor Model. *Journal of research in personality 30*(2), pp. 189–203. https://doi.org/10.1006/jrpe.1996.0013

Kleibeuker, S. W., De Dreu, C. K. W., & Crone, E. A. (2016). Creativity development in adolescence: Insight from behavior, brain, and training studies. In B. Barbot (Ed.), *Perspectives on creativity development. New Directions for Child and Adolescent Development, 151,* pp. 73-84. DOI: 10.1002/cad.20148 https://brainanddevelopment.nl/wp-content/uploads/2019/08/Kleibeuker_et_al_2016_Creativity_Development_In_Adolescence.pdf

Kozlov, M. (2023). 'Disruptive' science has declined — and no one knows why. *Nature Jan. 2023.* Retrieved from https://www.nature.com/articles/d41586-022-04577-5

Kurtz, T. E. (2012). Thinking About Thinking: Enhancing Creativity and Understanding in Operational Planners. United States Army. *https://publicaccess.dtic.mil*

Lau, S., & Cheung, P. C. (2010). Developmental trends of creativity: What twists of turn do boys and girls take at different grades? *Creativity Research Journal, 22*(3), pp. 329-336. https://doi.org/10.1080/10400419.2010.503543

Lee Bae, C. S., & Therriault, D. (2013). The Cognitive Underpinnings Of Creative Thought: A Latent Variable Analysis Exploring The Roles Of İntelligence And Working Memory İn Three Creative Thinking Processes. *Intelligence, 41*, pp. 306-320. DOI:10.1016/j.intell.2013.04.008

Lenhard, W. & Lenhard, A. (2016). Computation of effect sizes. Retrieved from: Computation of different effect sizes like d, f, r and transformation of different effect sizes: Psychometrica. *Psychometrica.* DOI: 10.13140/RG.2.2.17823.92329

Lerdal, K., Surovek, A. E., Cetin, K. S., Cetin, B., & Ahn, B. (2019). Tools for Assessing the Creative Person, Process, and Product in Engineering Education. *American Society for Engineering Education*, Paper ID #25315. doi:10.18260/1-2--33445. https://www.researchgate.net/publication/344792129_Tools_for_Assessing_the_Creative_Person_Process_and_Product_in_Engineering_Education

Lilly, F. R. (2014). Creativity in Adolescence. *In book: Encyclopedia of Primary Prevention and Health Promotion (pp. 1057-1065). Project: Encyclopedia of Creativity.* DOI:10.1007/978-1-4614-5999-6_219 Retrieved from https://www.researchgate.net/publication/304094397

Lubart, T. I., Besançon, M., & Barbot, B. (2011). *Évaluation du potentiel créatif* (EPoC). Paris : Hogrefe France.

Lubart, T. I., & Getz, I. (1997). Emotion, metaphor and the creative process. *Creativity Research Journal, 10*(4), pp. 285-301. https://doi.org/10.1207/s15326934crj1004_1

Lubart, T. I., Mouchiroud, C., Tordjman, S., & Zenasni, F. (2015). *Psychologie de la créativité*. 2ème édition. Armand Colin.

Lubart, T. I., Zenasni, F., & Barbot, B. (2013). Creative Potential and its Measurement. *International Journal for Talent Development and Creativity 1*, pp. 41-50. https://www.researchgate.net/publication/264618782_Creative_Potential_and_Its_Measurement

Mareque, M., de Prada Creo, E., & Gonzalez-Sanchez, M. B. (2019). Fostering creativity and communicative soft skills through leisure activities in management studies. *Education + Training, Vol. 61* No. 1, pp. 94-107. Emerald Insight. http://dx.doi.org/10.1108/ET-07-2018-0149

Masley, S., Roetzheim, R., & Gualtieri, T. (2009). Aerobic Exercise Enhances Cognitive Flexibility. *J Clin Psychol Med Settings 16*, pp. 186-193. https://doi.org/ 10.1007/s10880-009-9159-6

McLean, K. C., Pasupathi, M., & Pals, J. L. (2007). Selves creating stories creating selves: A process model of self-development. *Personality and Social Psychology Review*, *11*(3), pp. 262-278. https://doi.org/10.1177/1088868307301034

McVey, D. (2008). Why all writing is creative writing. *Innovations in Education & Teaching International, Vol. 45* No. 3, pp. 289-294. DOI:10.1080/14703290802176204

Mednick, S. A. (1962). The associative basis of the creative process. *Psychological Review*, *69*(3), pp. 220-232. https://doi.org/10.1037/h0048850

Mednick, S. A. (1968). The Remote Associates Test. *The Journal of Creative Behavior, 2,* pp. 213-214. https://doi.org/10.1002/j.2162-6057.1968.tb00104.x

Mednick, S. A., & Mednick, M. T. (1967, 1971). *Examiner's manual, Remote Associates Test: College and adult forms 1 and 2.* Boston: Houghton Mifflin.

Meltzer, C., & Meltzer, S. (2022). The power of art: Examining the long-term effect of arts-based interventions in education and working life. *Organizational Aesthetics 11*(1): 120-141. Retrieved from https://www.researchgate.net/publication/358830511_The_power_of_art_Examining_the_long-term_effect_of_arts-based_interventions_in_education_and_working_life

Memmert, D. (2011). "Sports and creativity," in *Encyclopedia of Creativity, 2nd ed., Vol. 2*, eds M. A. Runco and S. P. Pritzker (San Diego, CA: Academic Press), pp. 373-378. DOI: 10.3389/fpsyg.2015.00115. Retrieved from https://www.dshs-koeln.de/fileadmin/redaktion/Institute/Kognitions-_und_Sportspielforschung/Publikationen/Paper/Memmert_2011_Sports-and-creativity.pdf

Memmert, D., Baker, J., & Bertsch, C. (2010). Play and practice in the development of sport-specific creativity in team ball sports. *High Ability Studies, 21*(1), pp. 3-18. https://doi.org/10.1080/13598139.2010.488083

Memmert, D., & Roth, K. (2007). The effects of non-specific and specific concepts on tactical creativity in team ball sports. *Journal of Sports Sciences, 25*(12), pp. 1423-1432. DOI: 10.1080/02640410601129755

Minton, S. (2002). Assessment of High School Students' Creative Thinking Skills: A Comparison of the Effects of Dance and Non-dance classes. In R. J. Deasy (Ed.) *Critical Links: Learning in the Arts and Student Academic and Social Development*, pp. 19-20. Washington, DC: Arts Education Partnership. https://www.govinfo.gov/content/pkg/ERIC-ED466413/pdf/ERIC-ED466413.pdf

Moss, S. A. (2002). The impact of environmental clues in problem solving and incubation: The moderating effect of ability. *Creativity Research Journal, 14(2)*, pp. 207-211. DOI: 10.1207/S15326934CRJ1402_7

Moussard, A., Rochette, F., & Bigand, E. (2012). La musique comme outil de stimulation cognitive. *L'Année psychologique, 112,* pp. 499-542. https://doi.org/10.3917/anpsy.123.0499

Mumford, M. D., & Gustafson, S. B. (1988). Creativity syndrome: Integration, application, and innovation. *Psychological Bulletin, 103*(1), pp. 27-43. https://doi.org/10.1037/0033-2909.103.1.27

Navarro Ramón, L., & Chacón-López, H. (2021). The impact of musical improvisation on children's creative thinking. *ScienceDirect - Thinking Skills and Creativity, Volume 40,* 2021,100839, ISSN 1871-1871, https://doi.org/10.1016/j.tsc.2021.100839. https://www.sciencedirect.com/science/article/pii/S1871187121000547

Nguyen, S. P., & Murphy, G. L. (2003). An apple is more than just a fruit: cross-classification in children's concepts. *Child Development, 2003 Nov-Dec; 74* (6) pp. 1783-1806. https://doi.org/10.1046/j.1467-8624.2003.00638.x

Olteţeanu, A. M., & Zunjani, F. H. (2020). A Visual Remote Associates Test and Its Validation. *Front Psychol. 2020 Jan 28;11*(26). DOI: 10.3389/fpsyg.2020.00026.

Park, M., Leahey, E., & Funk, R. J. (2023). Papers and patents are becoming less disruptive over time. *Nature 613,* pp. 138-144. https://doi.org/10.1038/s41586-022-05543-x

Payne, R. W. (1962). An object classification test as a measure of overinclusive thinking in schizophrenic patients. *British Journal of Social and Clinical Psychology*, *Volume 1*, Issue 3, pp. 213-221. https://doi.org/10.1111/j.2044-8260.1962.tb00702.x

Payne, R., & Friedlander, D. (1962). A Short Battery of Simple Tests for Measuring Overinclusive Thinking. *Journal of Mental Science, 108*(454), pp. 362-367. DOI:10.1192/bjp.108.454.362

Payne, R. W., Hawks, D., Friedlander, D., & Hart, D. (1972). The Diagnostic Significance of Overinclusive Thinking in an Unselected Psychiatric Population. *British Journal of Psychiatry, 120*(555), pp. 173-182. DOI:10.1192/bjp.120.555.173

Plucker, J. A. (1999). Is the proof in the pudding? Reanalyses of Torrance's (1958 to present) longitudinal data. *Creativity Research Journal, 12*(2), pp. 103-114. https://doi.org/10.1207/s15326934crj1202_3

Plucker, J. A., Beghetto, R., & Dow, G. (2004). Why Isn't Creativity More Important to Educational Psychologists? Potential, Pitfalls, and Future Directions in Creativity Research. *Educational Psychologist, 39*, pp. 83-96. http://dx.doi.org/10.1207/s15326985ep3902_1

Plucker, J. A., & Makel, M. C. (2010). Assessment of creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity.* Pp. 48-73. Cambridge University Press.

Posner, M. L., & Patoine, B. (2009). How arts training improves attention and cognition. *Cerebrum*, pp. 2-4. Retrieved from https://dana.org/article/how-arts-training-improves-attention-and-cognition/

Pretz, J. E., Naples, A. J., & Sternberg, R. J. (2003). Recognizing, defining, and representing problems. In J. E. Davidson, & R. J. Sternberg (Eds.), *The psychology of problem solving*, pp. 3-30. Cambridge University Press. https://doi.org/10.1017/CBO9780511615771.002

Puccio, G. J., & Cabra, J. F. (2011). Idea generation and idea evaluation: Cognitive skills and deliberate practice. In M. D. Mumford's (Ed.), *Handbook for Organizational Creativity*, pp. 187-213. Elsevier. DOI:10.1016/B978-0-12-374714-3.00009-4

Puryear, J. S., Kettler, T., & Rinn, A. N. (2017). Relationships of personality to differential conceptions of creativity: A systematic review. *Psychology of Aesthetics, Creativity, and the Arts, 11*(1), pp. 59-68. https://doi.org/10.1037/aca0000079

Rahimi, S., & Shute, V. (2021). The Effects of Video Games on Creativity: A Systematic Review. In S. Russ, J. Hoffmann, & J. Kaufman (Eds.), *The Cambridge Handbook of Lifespan Development of Creativity* (Cambridge Handbooks in Psychology, pp. 368-392). Cambridge: Cambridge University Press. doi:10.1017/9781108755726.021

Reid, A., & Petocz, P. (2004). Learning domains and the process of creativity. The *Australian Educational Researcher, Vol. 31*(2), pp. 45-62. https://doi.org/10.1007/BF03249519

Reiter-Palmon, R., Forthmann, B., & Barbot, B. (2019). Scoring divergent thinking tests: A review and systematic framework. *Psychology of Aesthetics, Creativity, and the Arts, 13*(2), pp. 144-152. https://doi.org/10.1037/aca0000227

Richard, V. (2016). *Le rôle de la créativité dans le développement de l'expertise sportive*. [Doctorate thesis. Université de Montréal]. https://papyrus.bib.umontreal.ca/xmlui/handle/1866/16396

Richard, V., Abdulla, A. M., & Runco, M. A. (2017). Influence of skill level, experience, hours of training, and other sport participation on the creativity of elite athletes. *Journal of Genius and Eminence, 2* (1), pp. 65-76. DOI:10.18536/jge.2017.04.02.01.07

Rietveld, E., & Kiverstein, J. (2014). A rich landscape of affordances. *Ecol. Psychol. 26*, pp. 325-352. https://doi.org/10.1080/10407413.2014.958035

Roberts, A. M., Sternberg, R. J., Runco, M. A., Acar, S., Ward, T. B., Kolomyts, Y., & Kaufman, J. C. (2021). Creativity and Cognition, Divergent Thinking, and Intelligence. DOI:10.1017/9781108776721.008 Retrieved from https://www.researchgate.net/publication/349412524_Creativity_and_Cognition_Divergent_Thinking_and_Intelligence

Robinson, M. A., Sparrow, P. R., Clegg, C., & Birdi, K. (2005). Design engineering competencies: Future requirements and predicted changes in the forthcoming decade. *Design Studies, 26*(2), pp. 123-153. DOI: 10.1016/j.destud.2004.09.004

Ross, B. H., & Murphy, G. L. (1999). Food for thought: cross-classification and category organization in a complex real-world domain. *Cognitive Psychology, 38*, pp. 495-553. DOI: 10.1006/cogp.1998.0712

Runco, M. A. (2004). Creativity. *Annual Review of Psychology, 55*, pp. 657-687. https://www.annualreviews.org/doi/abs/10.1146/annurev.psych.55.090902.141502

Runco, M. A., Abdulla, A. M., Paek, S. H., Al-Jasim, F. A., & Alsuwaidi, H. N. (2016). Which Test of Divergent Thinking Is Best? *Creativity. Theories – Research - Applications, vol.3*, no.1, 2016, pp. 4-18. https://doi.org/10.1515/ctra-2016-0001 https://www.researchgate.net/publication/313284609_Which_Test_of_Divergent_Thinking_Is_Best

Runco, M. A, Acar, S. (2012). Divergent thinking as an indicator of creative potential. *Creat Res J. 2012; 24*: pp. 66-75. https://doi.org/10.1080/10400419.2012.652929

Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity Research Journal, 24*(1), pp. 92-96. https://doi.org/10.1080/10400419.2012.650092

Russ, S. W. (2004). *Play in child development and psychotherapy: Toward empirically supported practice.* Lawrence Erlbaum Associates Publishers.

Russ, S. W., Robins, A. L., Christiano, B. A. (1999). Pretend Play: Longitudinal Prediction of Creativity and Affect in Fantasy in Children. *Creativity Research Journal, 12*(2), pp. 129-139. DOI: 10.1207/s15326934crj1202_5

Sarooghi, H., Libaers, D., & Burkemper, A. (2015). Examining the relationship between creativity and innovation: A meta-analysis of organizational, cultural, and environmental factors. *Journal of Business Venturing, 30*(5), pp. 714-731. doi:10.1016/j.jbusvent.2014.12.003. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0883902614001098

Schellenberg, E. G. (2004). Music Lessons Enhance IQ. *Psychological Science, 15*(8), pp. 511-514. https://doi.org/10.1111/j.0956-7976.2004.00711.x

Shu-Hua Yeh, C. (2015). Exploring the effects of video game play on creativity performance and emotional responses. *Computers in Human Behavior, Volume 53,* 2015, pp. 396-407. https://doi.org/10.1016/j.chb.2015.07.024

Silvia, P. J., Winterstein, B. P., Willse, J. T., Barona, C. M., Cram, J. T., Hess, K. I., Martinez, J. L., & Richard, C. A. (2008). Assessing creativity with divergent thinking tasks: Exploring the reliability and validity of new subjective scoring methods. *Psychology of Aesthetics, Creativity, and the Arts, 2*(2), pp. 68-85. https://doi.org/10.1037/1931-3896.2.2.68

Simonton D. K. (2012) Quantifying creativity: can measures span the spectrum? *Dialogues in Clinical Neuroscience, 14*:1, pp. 100-104. DOI: 10.31887/DCNS.2012.14.1/dsimonton

Sowden, P., Clements, L., Redlich, C., & Lewis, C. (2015). Improvisation Facilitates Divergent Thinking and Creativity: Realizing a Benefit of Primary School Arts Education. *Psychology of Aesthetics, Creativity, and the Arts. 9* (2), pp. 128-138. DOI: 10.1037/aca0000018. Retrieved from https://psycnet.apa.org/record/2015-21002-004

Stauffer, B. (2021). What Are the 4 C's of 21st Century Skills? *AES – Applied Educational Systems*. Retrieved from https://www.aeseducation.com/blog/four-cs-21st-century-skills

Stein, M. I. (1953). Creativity and Culture. *Journal of Psychology, 36,* pp. 311-322. http://dx.doi.org/10.1080/00223980.1953.9712897

Sternberg, R. J. (1999). *Handbook of creativity.* Cambridge University Press.

Sternberg, R. J. (2017). Teaching for creativity. In R. A. Beghetto, & J. C. Kaufman (Eds.), *Nurturing creativity in the classroom* (2nd ed, pp. 355–380). New York: Cambridge University Press.

Sternberg, R. J. (2019). Enhancing people's creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity*, pp. 88–103. Cambridge University Press. https://doi.org/10.1017/9781316979839.007

Sternberg, R. J., & Lubart, T. I. (1996). Investing in creativity. *American Psychologist, vol. 51*, 7, pp. 677-688. https://doi.org/10.1037/0003-066X.51.7.677

Sternberg, R. J., & Lubart, T. I. (1999, 2016). The concept of creativity: Prospects and paradigms. In R. J. Sternberg (Ed.), *Handbook of creativity*, pp. 3-15. Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511807916.003

Stevenson, C. E., Kleibeuker, S. W., De Dreu C. K. W., & Crone, E. A. (2014). Training creative cognition: Adolescence as a flexible period for improving creativity. *Frontiers in Human Neuroscience, vol. 8*; Art 27. DOI: 10.3389/fnhum.2014.00827. Retrieved from https://www.researchgate.net/publication/268451050_Training_creative_cognition_Adolescence_as_a_flexible_period_for_improving_creativity#fullTextFileContent

Storme, M., Myszkowski, N., Çelik, P., & Lubart, T. (2014). Learning to judge creativity: The underlying mechanisms in creativity training for non-expert judges. *Learning and Individual Differences, 32*, pp. 19-25. https://doi.org/10.1016/j.lindif.2014.03.002

Stutesman, M. G., Havens, J., & Goldstein, T. R. (2022). Developing creativity and other 21st century skills through theater classes. *Translational Issues in Psychological Science*, *8*(1).

Takeuchi, H., Taki, Y., Sassa, Y., Hashizume, H., Sekiguchi, A., Fukushima, A., & Kawashima, R. (2010). White matter structures associated with creativity: evidence from diffusion tensor imaging. *NeuroImage, 51*, pp. 11-18. DOI: 10.1016/j.neuroimage.2010.02.035

Taylor, C. L., Kaufman, J., & Barbot, B. (2020). Measuring Creative Writing with the Storyboard Task: The Role of Effort and Story Length. *The Journal of Creative Behavior*. *55*. https://doi.org/10.1002/jocb.467

Threadgold, E., Marsh, J. E., McLatchie, N., & Ball, L. J. (2019). Background music stints creativity: Evidence from compound remote associate tasks. *Applied Cognitive Psychology*, *33*(5), pp.873–888. doi:10.1002/acp.3532

Torrance, E. P. (1966, 1974, 1990). *Torrance tests of creative thinking. Norms-technical manual. Research edition. Verbal tests, forms A and B. Figural tests, forms A and B.* Princeton: Personnel Press.

Torrance, E. P. (1972). Predictive validity of the Torrance Tests of Creative Thinking. *The Journal of Creative Behavior, 6(*4), pp. 236-252. https://doi.org/10.1002/j.2162-6057.1972.tb00936.x

Torrance, E. P. (1988). The nature of creativity as manifest in its testing. In R. J. Sternberg (Ed.), *The nature of creativity: Contemporary psychological perspectives*. Pp. 43–75. Cambridge University Press.

Torrance, E. P., & Ball, O. E. (1984). *Torrance Test of Creative Thinking Streamlined Scoring Workbook, Figural A.* Bensenville, IL: Scholastic Testing Service.

Toynbee, A. (1964). Is America neglecting her creative minority? In C. W. Taylor (Ed.), *Widening horizons in creativity: The proceedings of the Fifth Utah Creativity Research. Conference*, pp. 3-9. New York: Wiley.

Trnka, R., Zahradnik, M., & Kuška, M. (2016). Emotional Creativity and Real-Life Involvement in Different Types of Creative Leisure Activities. *Creativity Research Journal*. *28*(3), pp. 348-356. DOI:10.1080/10400419.2016.1195653

Tsung-Hsien, K., & Han-Kuang, T. (2022). Mechanisms of Learning Transfer in *Creativity Training Journal of Workplace Learning, v34* n7, pp. 609-627. http://dx.doi.org/10.1108/JWL-08-2021-0107

Van Geetsom, N. (2008). *Creatief denken in het (secundair) onderwijs: krachtige werkvormen als basis voor de ontwikkeling van innovatief talent*. Academia Press. ISBN : 9789038213460

Wang, A. Y. (2012). *Exploring the relationship of creative thinking to reading and writing, 7*(1), pp. 38-47. https://doi.org/10.1016/j.tsc.2011.09.001

Wang, L., Long, H., Plucker, J. A., Wang, Q., Xu, X., & Pang, W. (2018). High Schizotypal Individuals Are More Creative? The Mediation Roles of Overinclusive Thinking and Cognitive Inhibition. *Front. Psychol. 9*:1766. DOI: 10.3389/fpsyg.2018.01766

Watson, C. G. (1967). Interrelationships Of Six Overinclusion Measures. *Journal of Consulting Psychology, 31*(5), pp. 517-520. https://doi.org/10.1037/h0024980

Weiss, S., & Wilhelm, O. (2022). Is Flexibility More than Fluency and Originality? *Journal of Intelligence, 10*. 96. 10.3390/jintelligence10040096

Wilson, R. C., Guilford, J. P., & Christensen, P. R. (1953). The measurement of individual differences in originality. *Psychol Bull. 1953 Sep;50*(5), pp. 362-370. DOI: 10.1037/h0060857.

World Economic Forum (2020). These are the top 10 job skills of tomorrow – and how long it takes to learn them. *Future of Jobs Report. The Jobs Reset Summit*. https://www.weforum.org/agenda/2020/10/top-10-work-skills-of-tomorrow-how-long-it-takes-to-learn-them/

Zahno, S., & Hossner, E.-J. (2020). On the Issue of Developing Creative Players in Team Sports: A Systematic Review and Critique From a Functional Perspective. *Frontiers in Psychology, 11*. https://doi.org/10.3389/fpsyg.2020.575475

Zenasni, F., Besançon, M., & Lubart, T. (2008). Creativity and tolerance of ambiguity: An empirical study. *J Create Behav. 2008; 42*, pp. 61-73. https://doi.org/10.1002/j.2162-6057.2008.tb01080.x

Summary

Creativity is a highly sought-after human skill, an essential asset better mastered by humans than machines, contributing to organisational performance, adaptability, survival (Anderson & al., 2018), innovation, and progress (Forgeard & Eichner, 2014; Puccio & Cabra, 2011). The good news is that creativity can be taught, developed, and nurtured (Barbot et al., 2015; Ivcevic, 2020; Sternberg, 2019; Stevenson et al., 2014). However, educational settings are more likely to repress creativity than encourage it (Barbot & Heuser, 2017). Adolescence, age of reorganisation and alignment of resources, is considered as a critical period in the development of creative potential (Barbot, 2008; Barbot et al., 2016; Barbot & Heuser, 2017; Blakemore, 2012). Earlier studies have highlighted the relationship between several leisure activities and creative performance (Mareque et al., 2019), but although effects could be demonstrated on the short term, the question still remains partially open as to the sustainability of its effects on the long term. This quantitative study is based on data collected in a research by Barbot et al., (2021) at Pace University among young adults (n = 129). Creativity being a multifaceted concept, several measures of creativity dimensions (divergent thinking, mental flexibility, associative thinking and narrative creativity) were used for the sake of this research. Various hypotheses have been tested, general and more specific, such as the effects of art, sport and variety. We also investigated the impact of the duration and number of activities. Our findings pointed out that scores obtained by young adults who practiced two or more forms of leisure activities for more than 3 months during adolescence, were higher than scores of those who practiced none or one activity specifically for creative writing (z = -2.070, p = .019, d = 3.405), DT flexibility (t[125] = -2.187, p = .015, d = 0.389), DT fluency (z = -3.666, p < .001, d = 3.415), associative thinking RAT (z = -2.241, p = .013, d = 3.421), and associative thinking OV (z = -2.436, p = .008, d = 3.378). The duration of the practice of sport also emerged as a factor contributing to higher scores in DT flexibility (z = -2.511, p = .018, d = 3.540) and associative thinking RAT (z = -2.333, p = .030, d = 3.437), though a practice duration of at least 10 years seems to be required. This research was based on a sample presenting several limitations: the unequal distribution of participation duration and numbers of activity, the absence of information on the intensity and frequency of the practiced activities, and the generally small size of the control group. However, given the promising results, this investigation raises a path for future research that would integrate these missing dimensions.

UNIVERSITE CATHOLIQUE DE LOUVAIN
Faculté de psychologie et des sciences de l'éducation
Place Cardinal Mercier,10 bte L3.05.01. 1348 Louvain-la-Neuve. Belgique | www.uclouvain.be/psp