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Cognitive, personality, and emotional factors involved in creativity: from childhood to adulthood

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Summary

The analysis of cognitive, personality, and emotional factors and their interactions in human performance represents one of the core challenges for psychological research and neuroscience. Understanding the responsible mechanisms, even a partial and flawed understanding, can serve as a valuable guide to further articulate the account for the individual differences underpinning human behaviour.

Studies addressing individual differences in human creativity has surprisingly gained interest recently. Notably, the percentage of articles dealing with creativity in psychological abstracts has grown from .002 % in the 1920s to approximately .01 % in the 1980s. Furthermore, from the late 1960s until 1991, almost 9,000 "creativity" references have been added to the literature. This remarkable interest in creativity makes perfect sense given its role in human development and its application in different domains, including art and science as well as education, business and society as a whole. However, what does it mean creativity? There is general agreement in the literature that creativity concerns a wide range of human activities, from exceptional results to ordinary activities, and depicts the ability to produce outcomes (ideas or actual productions), which must satisfy the criteria of originality and appropriateness. Creativity allows people to access the fullness of available information and limit the risk of being locked into old concepts and stereotypes. For this reason, creativity has been defined as one of the four major skills in the 21st century, along with critical thinking, communication, and collaboration, and one of the most prominent and in-demand skills of the future.

Although the pivotal role of creativity in human activities and evolution seems to be well-acknowledged, the debate on the role of different cognitive and extra-cognitive factors in creativity continues to loom large, making the research on individual

differences profoundly meaningful for psychological research. For instance, the role of executive functioning (e.g., reasoning, problem-solving, and planning), cognitive styles (e.g., field dependence independence), personality traits (e.g., big five and trait emotional intelligence), as well as emotions and language abilities on creativity remains still understated.

The current dissertation aims to deepen the role of cognitive, personality, and emotional factors as well as their interactions in creativity at different developmental stages. Specifically, the first chapter provides an overview of the recent literature on creativity, considering two theoretical frameworks: the process-oriented and product-oriented approaches. The second chapter describes the literature on cognitive and extra-cognitive factors implicated in this work. The research topics were:

- Evaluating the association between Field Dependence Independence cognitive style (FDI) and creativity;
- Analysing the association between fluid intelligence and creativity, also testing the involvement of FDI in children, adolescents, and young adults;
- Exploring the involvement of youth personality traits in the association between planning and creativity;
- Evaluating the impact of youth trait emotional intelligence on creative production through the effect of both divergent thinking and convergent thinking;
- Providing a new perspective of adolescents' divergent thinking as a precious weapon for countering the wicked problems related to the battle against the environmental crisis.

The third chapter describes the seven studies of the thesis, which are briefly summarised below.

Study 1 – This research is a systematic review aiming to deepen the association between FDI and creativity, considering creative process (e.g., divergent and convergent thinking) and creative production (actual inventions). Eight studies have been selected using the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) rules. Results revealed that a consistent number of studies focused on the creative process mainly in terms of divergent thinking instead of convergent thinking, also providing misleading results. Furthermore, only two studies focused on creative production, revealing that field independents provided high creativity. The mixed results of the systematic review, and overall, the paucity of the studies, led to conclude that albeit the association between FDI and creativity represents a fascinating research field, it needs to be further investigated by more accurate empirical explorations.

Study 2 – Given the findings of Study 1, this second research touches on the association between FDI and creative production by the Visual Creative Synthesis Task (VCST), a product-oriented task that requires creating objects belonging to pre-established categories, starting from triads of visual components. Sixty young adults took part in the experiment. Results showed that field independents outperformed field dependents in the VCST scores, showing higher levels of creativity. Results of this study were discussed considering the better competencies of field independents in mental imagery and mental manipulation of abstract objects during complex tasks that require creativity.

Study 3 – The research looks at the debate about the intelligence-creativity link, examining the effect of fluid intelligence (Gf) on creativity in terms of both creative potential and real-world creative production, taking into account the role of FDI. Specifically, in a sample of young adults, the research advances two models in which FDI mediates the interplay between Gf and creativity in terms of creative potential and production. It also advances two models in which FDI was a moderator of the same

association. Results revealed only a mediating role of FDI in the Gf-creativity association (in both creative potential and production). Analyses showed a positive indirect effect, supporting that the individual predisposition toward field independence could play a key role in the interplay between Gf and creativity.

Study 4 – By two experiments, Study 4 seeks to extend the evidence about the mediating role of FDI on the association between Gf and creativity. In this research, creativity is evaluated in terms of creative potential by the Alternative Uses Task, a widely used assessment of divergent thinking, which requires finding as many alternative uses as possible for ordinary objects, such as a brick. Research supports the findings provided by Study 4, also revealing that even though the individual disposition toward field dependence independence tends to evolve across the life span (greater field independence with age), FDI seems to affect creativity from childhood to adulthood permanently.

Study 5 – The study addresses, in a sample of 83 young adults, the interplay amongst planning, personality, and creative production, assuming the Big Five personality dimensions as moderator variables. The research relies on an interactionist approach in which cognitive processes and personality traits are jointly involved in people's ability to generate creative inventions. Results show that planning was positively related to creative production, whilst agreeableness, at low-middle levels, represented the only personality dimension moderating the planning-creativity link. These findings suggest that the individual tendency to be less agreeable, which implies a reduced disposition to be compliant and less caring about others' opinions, ideas, and judgments, brings people to use their own ability to plan in order to promote creativity.

Study 6 – Like Study 5, this research conceptualised creativity as a blend of interacting individual resources. It investigates, in a sample of 63 young adults, the extent to which

creative production is supported by trait Emotional Intelligence (EI) through the effect of both divergent thinking (DT) and convergent thinking (CT). To this aim, the study hypothesises a parallel mediation model, in which trait EI is the independent variable, creative production is the dependent variable, while DT and CT represent the mediators. Results highlight that only DT fully mediated the relationship between trait EI and creative production. These findings suggested that trait EI, encompassing well-being, self-control, emotionality, and sociability, involves a better DT ability, which, in turn, increases the likelihood of producing a creative invention.

Study 7 – The study examines the mediating role of DT in the association between the Big Five personality traits and Pro-Environmental Behaviour (PEB) in a sample of 146 adolescents. The focus is late adolescence since this developmental stage involves different crucial facets for PEB, such as civic engagement, responsibility toward the community, moral reasoning, and future orientation. A path analysis suggests that Openness, Extraversion, and Agreeableness are indirectly associated with PEB through the mediation of DT. This study improves the knowledge on the impact of the Big Five dimensions on adolescents' PEB, also suggesting that youth must invest in and increase their DT competencies to enhance their own disposition to behave pro-environmentally.

In the last chapter, the main hypotheses of the seven studies were summarised and discussed, stressing the idea of creativity as the result of the multiplicative interaction amongst different individual cognitive and extra-cognitive resources. Finally, the dissertation ends with an accurate examination of limits and future research directions.

Chapter 1 - Creativity: An Introduction

1.1 What does it mean creativity?

The human ability to be creative is a true marvel of nature: people experience creativity in their daily lives in a multitude of forms, joying its fruition as both agents and recipients (Abraham, 2018). Creativity is often heralded as the epitome of human abilities, allowing a great deal of achievement in people's daily lives across all walks of life, also playing an essential role in human development and progress at every level, from individual to societal domains (Abraham, 2018).

Several instances of creative achievement can be easily recognised across different fields of human enterprise. In the scientific domain, different scientists have broken down the theories of the time, advancing brilliant and creative ideas and discoveries due to careful observation, experimentation, and introspection. For instance, Mary Curie was the only person who won the Nobel Prize twice in different science domains such as physics and chemistry for her contribution to radioactivity research and in discovering radium and polonium. Charles Darwin and Sigmund Freud reached their prestige for formulating the Theory of Evolution and Psychosexual Development that had a colossal resonance in the field of biology and psychology, respectively. In the art domain, Paul Cézanne is considered the father of modern art since his opera determined the nexus between Impressionism and the later art movements such as Cubism and Fauvism. Besides, the trumpeter Miles Davis is widely considered a great innovator of jazz through his unconventional approach, realising minimalism in composition. This distinction in creativity domains can be acknowledged in psychology research. Previous studies found that highly creative people usually show greater openness to novel experiences, a more disposition toward complexity, and a higher aesthetic sensibility

(e.g., Silvia et al., 2009). However, the analysis of the individual features of creative people is more complex than we can imagine. Note that creativity depicts a small set of cognitive capacities that differentiate human beings from other species (Ward & Kolomyts, 2010). This implies that creativity concerns a wide range of domains of human activities, which includes not only exceptional results in science and art (e.g., scientific discoveries or artworks) but also everyday activities such as finding new and useful solutions to everyday problems or thinking away from the ordinary way of though. This is why creativity is also considered one of the four major skills in the 21st century, along with critical thinking, communication, and collaboration and one of the most prominent and in-demand skills of the future (World Economic Forum, 2020).

Despite the relevance of creativity for humans, the path for its scientific conceptualisation has been not straightforward. Early definitions of creativity widely varied across scientific fields, generating misperceptions and making creativity an inaccessible entity to the mass (Plucker et al., 2004). Historically, creativity was mainly related to arts: for instance, early studies stressed that creativity was genetic, not learnable, and unmeasurable. Previous researchers also stated that creative skills were fixed and reserved only for nonconformist and reclusive people (Baer, 2012). Furthermore, within the research in psychology, creativity has been conceptualised as a motivation (Kris, 1952), a form of thought (Dollinger et al., 2004), an ability useful to discover novel problems (Csikszentmihalyi, 1988), a complex phenomenon, which determine the passage from an idea to a product (Mumford, 2003), a cognitive ability (Ward et al., 1999), and so forth.

However, the psychological research on creativity has converged over the past decades, and myths and stereotypes about definitions of creativity were debunked (Patson et al., 2021; Puryear & Lamb, 2020). In this vein, by reviewing the definitions of creativity,

Walia (2019) provided a "working" definition, revealing that creativity lays on four main features: 1) creativity represents a key ability of humans; 2) creativity presumes an intentional creative process activity; 3) the creative process occurs in different contexts; 4) the creative process entails the production of creative outcomes (either in tangible or intangible form), which must satisfy specific criteria (e.g., originality or novelty/unconventionality and appropriateness or usefulness).

Given Walia's conceptualisation of creativity (2019), two different but not fully separate approaches can be recognised: the process-oriented approach and the product-oriented approach. Whereas the former refers to the individual *potentiality* or *possibility* to generate an outcome, which could or could not be creative, the latter describes an approach mainly focused on *what* people *actually* realised (Guilford, 1950).

1.2 Defining and evaluating creativity by the process-oriented approach

The process-oriented approach investigates two main themes: the stages characterising the creative process and the components of such a process. This implies the analysis of different factors, including the role of individual prior knowledge, the differences between creative and non-creative thoughts, and the impact of conscious and unconscious operations (Kozbelt et al., 2010).

Wallas (1926) proposed one of the first models of creativity, providing a 4-stage model, in which creative process could be disentangled as follows: 1) *Preparation phase* is a stage requiring an intensively and extensively evaluation of the problem that requires an original solution; 2) *Incubation phase* is a stage of engagement with the problem through unconscious efforts; 3) *Illumination phase*, characterised by the emergence of the solution in a sudden flash of insight; and 4) *Verification phase,* in which people process the solution deliberately. Although Wallas' 4-stage model marks the beginning

of the creative process analysis, Guilford's seminal work on the Structure of the Human Intellect (Guilford, 1950; 1967) dominated the research about the creative process. This model was a catalyst for further theories about both creative process and creative production and described three different cuboid structures of the human intellect, namely operations (e.g., divergent thinking, convergent thinking), content properties (e.g., symbolic, semantic, behavioural), and products (e.g., relations, transformations, and implications). According to Guilford, divergent thinking represents the core of creative thinking. Specifically, it was conceived as a spontaneous and free-flowing form of thought, representing the ability to find many new solutions to an open-ended problem. Besides divergent thinking, also labelled divergent production, relies on four main factors, including fluency (the ability to produce a wide number of ideas in a short period), flexibility (the ability to generate ideas belonging to different conceptual categories), originality (the ability to produce infrequent ideas) and elaboration (the ability to generate detailed ideas). Divergent thinking was considered a reliable and acceptable indicator of creative potential insofar as it moderately predicts creative achievement and creative production in everyday life (Runco & Acar, 2012). It seems to emerge from the earliest stages of life: one-year-old children can already think divergently performing non-verbal and non-imitative divergent thinking tasks (Hoicka et al., 2016), even though an early peak in divergent thinking seems to appear around the age of 5 years. Research also underlined a slump at around the fourth grade (see for a review Said-Metwaly et al., 2020), probably due to cognitive and environmental changes. However, the fourth and fifth-grade children seem to be equally able to produce more original and appropriate ideas, even though they provide a larger number of ideas, without considering their quality (Claxton et al., 2005). Notably, in terms of developmental trends, adolescence represents another critical period: on the one hand,

neurodevelopmental changes in adolescence have a significant impact on cognitive processes, including divergent thinking (Barbot & Heuser, 2017), on the other hand, adolescents are more susceptible to social, emotional, and relational experiences, which can promote or suppress youth's creative identity (van der Zanden et al., 2020). Even though the pivotal role of divergent thinking in creativity seems to be well established, researchers questioned the potential role of other mental operations such as convergent thinking. According to Guilford's Model on the Structure of Intellect (1967), convergent thinking exemplifies the ability to find a single, right, and ready-made solution to a clearly defined problem. It lays on logical reasoning, speed, accuracy and focuses on recognising the familiar, reapplying set techniques and previous information (Cropley, 2006). Notably, Guilford noticed that divergent production emerged mainly in creative people, leading further studies to depict divergent thinking as a manifestation of creativity at the expanse of convergent thinking. Previous empirical evidence confirmed the view that divergent thinking was the core of creativity, showing its predicting role in a multitude of creative achievements (e.g., Kim, 2008) and their quality (e.g., Beaty et al., 2013). This scenario brought to evaluate divergent and convergent thinking as two conflicting or competing processes (Cropley, 1999; Getzels & Jackson, 1962). Some authors recently stressed that although convergent thinking has been often depicted as an uncreative process, this conceptualisation was mistaken (Zhu et al., 2019). According to this perspective, convergent thinking is integrally embedded within the creative process: whereas divergent thinking leads to generating as many ideas as possible, convergent thinking facilitates the evaluation and selection of such ideas (Cropley, 2006). In this way, convergent thinking applies specific criteria and constraints to divergent thinking to find the best idea to pursue.

In terms of measures, even though different test batteries exist, the evaluation of divergent and convergent thinking mainly relies on two process tasks: the Alternative Uses Task - AUT (Guilford, 1967) and the Remote Associates Test - RAT (Mednick & Mednick, 1967), respectively. The AUT requires to come up with many alternative uses as possible for everyday objects such as a cardboard box, brick, newspaper, shoe and the like. The generated uses are usually scored in terms of fluency (number of uses), flexibility (number of categories of uses), originality (degree of novelty), and elaboration (degree of detail with the uses generated). Different versions of the AUT can be distinguished in literature, which can be appreciated in terms of task duration (brief times, lengthy times, and untimed) and the number of trials (usually ranging from 1 to 5). Notably, choosing a version rather than another depends on the researcher's aim and the research context. Specifically, lengthy durations or untimed tasks are often used in clinical or atypical populations (Abraham et al., 2007), whereas unconstrained versions are more useful to tick originality during the idea generation (Plucker & Renzulli, 1999). Besides, different scoring methods for originality can be acknowledged in literature: 1) evaluating extreme scores, that is, those uses generated by 1-5% of the sample and disregarding the rest; 2) judge-based evaluation of uses provided by at least two trained judges; 3) the proportional weighting of each use by the frequency of its occurrence; 4) asking participants to select amongst their generated uses the top two, which are further evaluated.

Concerning convergent thinking, albeit different convergent tasks can be found (e.g., the analogical reasoning task, conceptual expansion task, semantic association task), the RAT represents the most widely used convergent thinking task. This measure relies on Mednick's perspective (Mednick, 1962), according to which creative process involves generating new and useful combinations from associative elements, requiring a single

solution. Specifically, in this task, participants are given a list of unrelated word triads and asked to find a fourth word by which they must form a compound association. For instance, in the Italian version of the RAT (Salvi et al., 2020), the triad “cottura” (cooking), “spigolo” (corner) and “retto” (right) is related to the word, “angolo” (corner) creating a compound word “angolo-cottura” (kitchenette), a synonymous (“spigolo”=”angolo”) and a semantic association “angolo retto” (right angle). Note that although the RAT is not free of limits, since it requires (as indeed all convergent tasks) a single solution, its scoring method is extremely simple compared to divergent measures.

1.3 Defining and evaluating creativity by the product-oriented approach

In his seminal work, Guilford (1950) differentiated between creative potential (e.g., DT) and production. Following this view, the product-oriented approach focuses on the extent to which people differ from each other in making ideas embodied into a tangible form within real-world contexts. In other words, this perspective pays attention to the people’s act of creating and what originated from it. In line with this perspective, everyday creativity or real-world creativity could be described as the ability to produce an outcome that is original (novel) and appropriate (useful) according to a particular context or goal (Sternberg et al., 2002). Originality exemplifies the ability to produce something new, making an outcome unique and unusual compared to other inventions (Abraham, 2018). It, therefore, implies a deviation from what is generally considered canonical and familiar. By contrast, appropriateness is closely related to the outcome's level of usefulness and effectiveness, exemplifying how the product fits and has meaning within a specific context. In this vein, appropriateness represents a function of people’s evaluation and more specifically of experts within a specific domain (Walia,

2019). Originality and appropriateness are multiplicative, such that if the outcome is very original but not at all appropriate or very appropriate but not at all original, then it is definitely not creative (Patson et al., 2021). Note that even though other additional criteria of creativity have been proposed, such as high quality (Niu & Sternberg, 2002; Sternberg & Lubart, 1995), surprise (Boden, 2004), non-obviousness (Simonton, 2012), aesthetic, genuineness (Kharkhurin, 2014) and so forth, originality and appropriateness represent undoubtedly the most used in psychology literature of creative production (see for a review of the definition of creative production Walia, 2019). According to Ilha Villanova and Pina e Cunha (2020), real-world creative production can be defined as "a phenomenon in which a person habitually responds to daily tasks in an original and meaningful way […]. Everyday creativity can be either a creative product, which is communicated to and assessed by the creator's immediate society or a creative experience that is often personal and assessed by only the individual" (Ilha Villanova & Pina e Cunha, 2020, p. 19). To sum up, we can frame creativity as follow:

$$\text{Creativity} = [\text{Originality x Appropriateness}]_{\text{context}}$$

In terms of developmental trends, Kaufman and Beghetto's work (e.g., Kaufman & Beghetto, 2009) provided by the Four C Model of Creativity (Kaufman & Beghetto, 2009) provided an overview of the development of creative expression. In their work, the authors argued that research on creative production could be divided into two main paths: studies on genius or people who were renowned for their exceptional work and results within a field and studies focusing on everyday or real-world creativity, that is, creative activities, in which ordinary people are usually involved, including decorating a family room, combining Italian and Chinese food to generate a new culinary fusion, or finding a solution to a challenging problem at work.

According to the Four C Model of Creativity (Kaufman & Beghetto, 2009), real-world creativity and its development could be conceptualised through four levels, including mini-c, little-c, Pro-c, and Big-c.

Every human being begins their creativity development at mini-c level, which is inherent in learning processes and subjective self-discoveries and relies on a novel and personally meaningful interpretation of experience, actions, and events (Beghetto & Kaufmann, 2007). At this level, creativity relies on an individual's creative process of constructing personal knowledge and accommodating new information to produce new understanding. This perspective of creativity aligns with Piaget's theory of cognitive development, according to which people build new forms of knowledge by re-organising existing mental schemas. Typically, mini-c develops in childhood or when adults begin to take up a new interest (e.g., an adult having no musical experience who begins piano lessons). Such domain-specific knowledge and skills develop through formal and informal learning, practice and maturation. Mini-c is also evident during adulthood when people take up a new hobby or make experimental attempts to repair or improve something they do not know much about (e.g., a computer programmer who spends the weekend updating the backsplash in the kitchen). In terms of outcomes, inventions might not be revolutionary at this level, but they can be considered new and meaningful by the authors, regardless of social recognition. This highlights the essential role of the dynamic and interpretative process of personal knowledge and understanding: people's creativity starts with an "internalisation or appropriation of cultural tools and social interaction…not just copying but rather a transformation or reorganisation of incoming information and mental structures based on the individual's characteristics and existing knowledge" (Moran et al., 2003, p. 63). With appropriate feedback, creative outcomes at little-c levels might be valuable to other people. In this

vein, for most ordinary people, creativity shows itself in the forms of mini-c or little-c, but even though these two types of creativity refer to real-world production in routine situations, little-c requires recognition by others. In contrast, mini-c is often related to self-exploration and self-enjoyment, and it is free from the evaluation of other people. For instance, people show little-c creativity when they solve a complex problem at work, spend their weekends painting landscapes, creating photographs, and exhibiting them on a website. Instead, school-age children show their little-c creativity when they engage in purposeful practice in a specific area or sport: for instance, when they compose a poem or a short story, create a song during music practice, and so forth. The Pro-c creativity regards people generating creative outcomes within all professional areas but who have not reached an eminent status of creativity. The notion of Pro-c creativity is in line with the concept of expertise, according to which only by practice, formal training, experimentation, and exploration people can reach prominence within a field. Finally, the Big-c creativity involves creative inventions that will be remembered in the history books. Specifically, Big-c creativity refers to major breakthroughs and revolutionary changes in various domains that lead to a significant contribution to the world: monumental and lasting scale operas like Picasso's *Les Demoiselles d'Avignon*, fall into this Big-c creativity.

An alternative way to analyse creative production was provided by Finke and colleagues' Geneplore Model (Finke et al., 1992). It focuses on generating creative inventions, describing a cyclic motion between two different phases, namely the generative and the explorative phases. During the generative phase, retrieval information, association, and combination of ideas contribute to produce pre-inventive structures, which represent internal precursors of creative productions. Instead, in the explorative phase, people continuously elaborate, evaluate, and modify such pre-

inventive structures to find possible limits and future and potential implications of the final outcome. Given the circular nature of the Geneplore Model, people can switch from one phase to another depending on environmental and contextual requests giving rise to a generation-elaboration cycle (Finke et al., 1992)

Finally, a further influential theoretical framework on creative production is the Investment Theory of Creativity (e.g., Sternberg & Lubart, 1991), which aims to cohesively understand the foundation of creativity. Specifically, this model has sought to identify which individual resources lead to success in the "creative marketplace" and how they interact to prompt creativity. In this vein, the Investment Theory of Creativity provided an alternative perspective of creative production, differently from theories postulating that creativity resulted from the effect of a unitary individual source or determinant. For instance, the Investment Theory of Creativity differed from: 1) psychoanalytic theories, in which creativity relies on the individual ability to regress or access preconscious primary-process thinking and synthesise it through a conscious secondary-process form of thought (e.g., Arieti, 1976); 2) divergent thinking theories stressing divergent thinking as the core of creativity (e.g., Guilford, 1967); 3) environmental creativity theories emphasising the pivotal role of surrounding environment influences (e.g., Simonton, 1975). In this vein, the Investment Theory of Creativity provides a knitted perspective of creativity, in which creative inventions result from the confluence of six different interacting individual resources, namely intelligence, knowledge, intellectual style, personality, motivation, and environment. According to this model, these six resources represent the individual income stream that can be channelled into creative performance mainly by interactions. As reported by Sternberg and Lubart (1991), “high intelligence in the absence of motivation, or extensive knowledge in the absence of the intellectual ability to understand and utilise

that knowledge, will lead to, at most, modest levels of creative performance" (Sternberg & Lubart, 1991, pp. 4-5). Besides, the authors underlined that one resource (e.g., personality) could compensate for the weakness of another resource (e.g., intelligence). Therefore, interactions amongst individual resources may occur at different levels, for instance, between high or low levels of factors, giving rise multiplicatively to high or modest creativity, respectively.

Concerning measures, although product-oriented tasks are generally described as time-consuming and difficult to administer with larger samples, the Consensual Assessment Technique – CAT developed by Amabile (Amabile, 1982). It is widely used in evaluating creative products in different domains (e.g., art, painting, poetry, collage, and so forth) and well-validated in creativity research. This assessment method relies on Amabile's hypothesis, according to which "a product or response is creative to the extent that appropriate observers independently agree it is creative" (Amabile, 1982, p. 100). The CAT asks participants to generate some kind of invention and then have a panel of experts who independently evaluate such inventions. For instance, in one study, participants "were given a line drawing of a girl and a boy [and] asked to write an original story in which the boy and the girl played some part" (Baer, 1994 p. 39). After this phase, a panel of expert judges were asked to evaluate the degree of creativity of the stories provided by participants following a scale ranging from 1 to 5, considering their own expert sense. Judges were asked to evaluate, and no explanation and defence of their evaluations were needed. An example of instruction given to the judged is:

> *"There is only one criterion in rating these tests: creativity. I realise that creativity doesn't exist in a vacuum, and to some extent creativity probably overlaps other criteria one might apply – aesthetic appeal, organisation, richness of imagery, sophistication of expression, novelty of word choice,*

appropriateness of word choice, and possibly even correctness of grammar, for example – but I asked you to rate the stories solely on the basis of your thoughtful-but-subjective opinions of their creativity. The point is, you are the expert, and you need's defend your choices or articulate a definition of creativity. What creativity means to you can remain a mystery – what I want you to do is use that mysterious expert sense to rate the stories for creativity" (Baer, 1994 pp. 39-40).

Chapter 2 – Study variables: cognitive, personality, and emotional factors

2.1 Executive functions: fluid intelligence and planning

Executive Functions (EFs) can be conceptualised as a set of higher-order regulatory processes that subserve goal-directed activity across time and task demands (e.g., Daucourt et al., 2018). There is a general agreement that EFs are essential for mental and physical health as well as psychological development from early childhood to adulthood (Diamond, 2013). Besides, previous research found that EFs predict autonomy in daily performance (e.g., Rosenberg, 2015), social-emotional competencies (e.g., Riggs et al., 2006), and academic success (e.g., Borella et al., 2010). Although the role of EFs is well defined, its nature is still a matter of debate: some authors operationalised executive functioning as a uniform mechanism (e.g., Duncan, 1995), whereas others as a set of separate but interdependent cognitive processes (e.g., Diamond, 2013). According to this latter view, Diamond's hierarchical framework (2013) identified fluid intelligence (Gf) and planning as two of the main components of EFs, classifying them in a unique block labelled as High-Order Executive Functions.

Gf has been conceptualised from different theoretical perspectives, being the Cattel and Horn Model (e.g., Cattel, 1971) the most accepted in the scientific community. According to this framework, Gf is a hereditary factor that allows humans to reason and understand the relationships amongst concepts regardless of previously acquired knowledge and skills (Jaeggi et al., 2008). It also plays an essential role in allowing people to flexibly adapt their thinking to new problems or situations (de Abreu et al., 2010). As stated by Cattell (1971), Gf is "an expression of the level of complexity of relationships which an individual can perceive and act upon when he does not have recourse to answers to such complex issues already sorted in memory" (Cattell,1971, p.

99). The development of Gf has been a matter of interest in psychology research, and the dynamic system perspective represents one of the most popular. According to this view, the Investment Theory (Cattel, 1971) stated that children "invest" their Gf to generate new crystallised abilities, which, in turn, enable them to face new situations. Similarly, the Mutualism model (Van der Maas et al., 2006) underlines that children's Gf development emerges as a consequence of a multitude of interactions amongst cognitive processes (e.g., reading/mathematics), which develop further over the lifespan (Van der Maas et al., 2006). Besides, according to the Dickens-Flynn Model (Dickens & Flynn, 2001), the development of Gf is dynamic: it is characterised by bi-directional relations with the surrounding environment, which determine an enhancement or a decrement of Gf. In terms of measures, Gf is usually evaluated by non-verbal and relatively culture-free tasks, including, for instance, Raven's Progressive Matrices, in which participants have to analyse geometrical problems and provide the solution through reasoning with new and abstract material.

The ability to plan has been conceptualised from different perspectives: 1) as a hierarchical process that controls the order in which a sequence of operations or actions should be performed by an online comparison of the individual's present state and desired state (Miller et al., 1960); 2) as a mental activity involving the identification and organisation of subtasks that people need in problem-solving activities, which affects the likelihood of success of the action planned (Chaiklin, 1984); 3) as a goal-directed process playing a pivotal role not only in selecting and organising actions (e.g., Read, 1987) but also in simulating methods to achieve a goal (e.g., Simons & Galotti, 1992). Albeit all these theories differ from each other, the main attribute that characterised and joined all of them concerns the involvement of mental simulation of purposeful and future actions within the planning process (Mumford et al., 2001). These simulations of

future actions are crucial in healthy development and adaptation, also showing a crucial role in a significant number of everyday life activities from childhood to adulthood (e.g., Eichmann et al., 2019). In terms of development trends, prior research revealed that rudimentary planning skills arise at the age of 3-4 years (Miyata et al., 2009), whilst the first turning point in development occurs at the age of five, when children show better flexibility competencies as well as a better ability to reason about causal relations amongst future events (e.g., McColgan & McCormack, 2008). Notably, the age of nine represents a second turning point, which brings children to show prominent planning ability (e.g., De Luca et al., 2003), which can be considered fully mature at the age of fifteen (Ballhausen et al., 2017). From a neural perspective, planned simulations are subserved by the activities of the prefrontal cortex (Romine & Reynolds, 2004) and the interplay of frontoparietal and frontostriatal networks (Owen et al., 2005). Concerning measures, planning assessment can be distinguished into "low structure" tasks, evaluating planning actions within everyday contexts such as visiting different places in a natural environment or planning a strategy in an imagined space (Kaller et al., 2004) and "high structure" tasks, characterised by a single goal, a clear and well-defined initial state, and immediate feedback such as the Tower of London (ToL). The latter is widely employed in research and clinical contexts in both children and adults and requires participants to answer the minimum number of steps needed to move three different coloured balls to a target position.

2.2 Cognitive styles: field-dependence-independence

Cognitive style, also known as thinking style, is not an ability itself but rather a preferred way of using abilities to approach different tasks or situations (Sternberg & Lubart, 1991). Overall, cognitive styles refer to how people acquire, organise, and use information (Riding & Rayner, 2013). They are usually conceptualised as bipolar,

prevalent and relatively stable over time, corresponding to a critical dimension of the individual functioning and behaving. Amongst all cognitive styles, Field Dependence Independence (FDI) has generated an extensive amount of research, representing the most studied and popular cognitive style in the psychology literature (Mefoh & Ezeh, 2017). Indeed, no one can provide a full account of the empirical evidence on cognitive styles without mentioning Witkin's theory of psychological differentiation (Witkin et al., 1948), in which FDI reflects "the extent to which the person perceives part of a field as discrete from the surrounding field as a whole, rather than embedded in the field" (Witkin et al., 1977, p.6-7). More in detail, such a cognitive style describes a stable and habitual tendency (Zhang, 2017) characterised by two different poles: field dependence and field independence. Unlike field dependent subjects, field independents usually show less difficulty in separating information from the surrounding context (Zhang, 2004) and are generally more focused on relevant information, inhibiting attention to irrelevant information coming from the environment (Guisande et al., 2007). Although FDI is sometimes described in more perceptual ways, it is also conceptualised in cognitive terms, given its association with global and local processing (e.g., Chamberlain et al., 2017), spatial thinking (e.g., Rémy & Gilles, 2014), spatial orientation (e.g., Boccia et al., 2016), and general cognitive functioning (e.g., Miyake et al., 2001). These associations have led to a lack of clarity about what FDI actually represents (Evans et al., 2013). However, Witkin and colleagues in their seminal works (e.g., Witkin et al., 1962), were more interested in conceptualising FDI as a cognitive style, that is, a set of general strategies of representing and processing information that people apply consistently across cognitive, perceptual, and even personality systems (Witkin et al., 1977). For instance, considering personality, a consistent number of studies have shown that FDI is closely interlocked with personality functioning and

individual differences (e.g., Zhang, 2004). Field independents are generally defined as more flexible, analytic, reflective, open-minded, intrinsically motivated, capable of breakdown the routine, and independent in working than field dependents. By contrast, field dependents show a higher preference for social interactions and cooperative working (Witkin & Goodenough, 1977).

In terms of cognitive underpinnings of FDI, previous research revealed that FDI reflects the efficiency of different controlled mental processes, including not only the Core Executive Functions, made up of working memory, inhibitory control, and cognitive flexibility (e.g., Brosnan et al., 2002; Miyake et al., 2001) but also the Higher-Order Executive Functions, which, as reported above, include both Gf and planning (e.g., Duncan, 2013; Huygelier et al., 2018). Notably, these individual differences in terms of dependence *vs* independence can be found in the early stages of life. For instance, previous research revealed that when parents encourage their children to behave independently, children tend to be field independent, whereas when they are encouraged to conform to authority, children tend to be more field dependent. Besides, in educational contexts, field independent students are less concerned about interpersonal relationships with teachers, also showing less disposition and preference for cooperative learning (e.g., Dublin, 1993). Field independent students from higher education instructions also seem to select primary science and math courses, whereas field dependent students are more inclined to select human services, including teaching and social work. Altogether these findings support the view that FDI plays a crucial role in different facets of human life from the early stage of human development, involving not only individual differences in perception but also in personality, intelligence, and behaviour (Saracho, 2001). In terms of developmental trends, previous research showed greater field independence with age (e.g., Akshoomoff & Stiles, 1996; Amador-Campos

& Kirchner-Nebot, 1997) even though such a trend is not necessarily linear. For instance, no significant differences were found between age groups of 5-6 and 6-7 years, whilst a greater significant difference was shown between age groups of 7-8 and 8-9 years (e.g., Bigelow, 1971), and performance in FDI tasks tend to plateau around the age of 17 years (e.g., Amador-Campos & Kirchner-Nebot, 1997; Booth, 2006; Witkin et al., 1967). However, note that performance in these tasks tends to be stable over time in adulthood (e.g., Kepner & Neimark, 1984), whilst some decline occurs over around 60 years (e.g., Ronnlund & Nilsson, 2006). FDI is usually evaluated by the Embedded Figure Test (EFT), in which participants have to find a simple black and white target figure within a complex and coloured one. Note that there are several variants of the EFT, including the Group Embedded Figure Test (GEFT), which is a pen and pencil measure that is used in a group situation, and the Children's Embedded Figure Test (CEFT), which consists of coloured meaningful figures and only two simple target shapes. Note that recently, further versions have been provided, such as the Leuven Embedded Figure Test (LEFT), which evaluates the effects of a number of lines forming the target shape outline, the number of lines shared with the background, and target shape symmetry.

2.3 Personality: big five and trait emotional intelligence

The Big Five or Five-Factor Model (FFM; McCrae & Costa, 1987) represents one of the most popular taxonomies proposed throughout the history of personality research. This model depicts the basic structure of personality by five superordinate factors, including Openness, Extraversion, Neuroticism (Emotional Stability), Conscientiousness, and Agreeableness. Openness refers to an individual's predisposition toward open-mindedness, intellectual curiosity, aesthetics, imagination, and originality (Feist, 1998).

Extraversion reflects the tendency to be energetic, active, ambitious, and assertive (Feist, 1998), whilst Neuroticism represents a generalised predisposition to emotional instability, which brings people to be anxious, insecure and fearful (Goldberg, 1990), avoiding situations where the risk of failure is very high. In turn, Conscientiousness corresponds to the individual predisposition to work hard and persistently achieve a specific goal (Goldberg, 1993) and Agreeableness captures the individual tendency toward affiliative, cooperative, supportive, and warm behaviours (Feist, 1998). Although the FFM has been widely employed in adult personality literature, research has demonstrated that the five factors are already present in childhood (e.g., Digman & Inouye, 1986). For instance, Kohnstamm and colleagues (1998) found that over 75% of parents' free descriptions of children aged between 3 and 12 years could be traced back to the Big Five traits. Similar results have also been found by Mervielde and colleagues' work, in which children's (aged between 4 and 12 years) Big Five personality features were evaluated by teachers (Mervielde et al., 1995) and peer's nominations (Mervielde et al., 2000). Notably, by prospective analyses, research has demonstrated that the Big Five judgments are fairly stable over time regardless of the employment of different measures and the age of children. Furthermore, results on children have also been extended and confirmed by further studies involving adolescents, in which the substantial genetic core of personality was provided (e.g., Bates et al., 2010). Altogether these results show the rank-order consistency of the Big Five taxonomy over time as people move from childhood to adulthood, passing through adolescence (Vazsonyi et al., 2015). Big Five personality traits are usually evaluated by self-report questionnaires, including the Big Five Questionnaire or the NEO Five-Factor Inventory.

Another personality taxonomy has been proposed in the last years as providing specific advantages in social contexts: Emotional Intelligence (EI). Previous research suggests

that EI plays an adaptive role since it provides abilities useful in situations where an effective way of managing emotions and social relationships is more important than the use of brute force for achieving a goal (Alegre et al., 2019). In this vein, several studies revealed that emotional abilities allow individuals to act more adequately within the environment, providing, in this way, evolutionary advantage (de Waal, 2011). Evidence on the pivotal role of emotions in human evolution has also been provided by studies on brain activity and emotion recognition (e.g. Fischman, 1993; Kret et al., 2018). Overall, EI refers to an individual's ability to identify, process, and handle emotions in both themselves and others (Freudenthaler & Neubauer, 2005). It represents one of the most debated and criticised constructs in the academic community (Matthews et al., 2004), involving two prevalent views: one relies on EI as an ability, whereas the other defines EI as a trait. Ability EI is usually depicted as one's actual capability to manage emotions, whereas trait EI (or trait emotional self-efficacy) refers to a set of affective predispositions related to emotional self-perceptions and emotional self-efficacy. Note that the distinction between trait EI and ability EI can also be found in assessment: whereas trait EI is usually evaluated by self-report questionnaire, ability EI's evaluation mainly relies on performance tasks (Petrides, 2011).

Petrides and Furnham (2001) proposed one of the most comprehensive frameworks of trait EI, according to which it depicts a constellation of emotion-related, self-perceptions and dispositions, which lay at the lower levels of personality hierarchies (Carroll, 1993; Petrides & Furnham, 2001; Petrides et al., 2007). Trait EI relies on four subdimensions, namely well-being (based on trait happiness, optimism, and self-esteem), self-control (which involves stress management, low impulsiveness, and emotion regulation), emotionality (defined as the perception and expression of emotions and subsequently use of them to create and maintain social relationships), and

sociability (which involves behaviours in social contexts such as listening, communication, emotion management, assertiveness, social awareness, and self-esteem). Correlational studies showed that overall trait EI is closely associated with Big Five personality traits and mainly with Neuroticism and Extraversion (Siegling et al., 2015), also playing a crucial role in life satisfaction, rumination, and coping strategies (Petrides et al., 2007). Note that research on trait EI mainly relies on adults or adolescents, whilst fewer studies can be found with children. However, in order to fill this gap, Mavroveli and colleagues (2008) advanced a model in which children's trait EI can be divided into nine different facets, including adaptability, affective disposition, emotion expression, emotion regulation, low impulsivity, peer relations, self-esteem, and self-motivation). The authors developed the Trait Emotional Intelligence Questionnaire for children from this model, which showed satisfactory reliability and validity in children between 8 and 12 years. Notably, further studies explored the role of trait EI in different children's domains, showing that it affects children's academic achievement and school behaviour (e.g., Mavroveli et al., 2011), bullying (Peacher et al., 2017), and peer relations at school (Mavroveli et al., 2009).

Chapter 3 – Experimental contributions

3.2 Do cognitive styles and fluid intelligence contribute to children, adolescents, and youth creativity?

Studies in the following paragraphs explore the impact of field dependence independence cognitive style (FDI) and fluid intelligence (Gf) on creativity, taking into account different stages of life. Specifically, Study 1 (see paragraph 3.2.1) is a systematic review summarising the literature the relationships between FDI and creativity, considering both creative process and creative production approaches. The Study 2 (see paragraph 3.2.2) addresses the FDI-creativity link through the lens of the Geneplore model in a sample of youth. Study 3 evaluates the mediating role of FDI in the association between Gf and creativity in youth. Note that Study 4 extends the findings provided by Study 3 addressing the mediating effect of FDI in Gf-creativity link in children (Experiment A) and adolescents (Experiment B).

3.2.1 Study 1 - Field dependent-independent cognitive style and creativity from the process and product-oriented approaches: a systematic review.

Introduction

The pivotal role of creativity in human activities has been widely recognised across years in psychological research (Simonton, 2000). The phenomenon of creativity seems to affect different domains of human endeavours, including not only art and science (Batt et al. 2010) but also everyday problem solving (Cropley, 1990; Kaufman & Beghetto, 2009), social behaviours (Fancourt & Steptoe, 2019) and well-being (Arbuthnott & Sutter, 2019). Given that, creativity has been described as one of the four

major skills in the 21st century along with critical thinking, communication, and collaboration (Qian et al., 2019), representing "a key human attribute that pushes our civilisation forward" (Acar et al., 2020, p.1).

Although previous research has sought to verify the impact of different individual cognitive and extra-cognitive resources underpinning creativity (e.g., Benedek et al., 2014; Chávez-Eakle, 2012; Fink & Woschnjak, 2011; Frith et al., 2020; Giancola et al., 2021; Palmiero et al., 2019; Palmiero et al., 2020), the debate on *which* resources and *how* they interact in order to promote or inhibit creative potential and production is still open. Notably, fruitful findings in this area have been provided by studies on the impact of cognitive styles (e.g., Martinsen, 1997; Palmiero et al., 2016). The latter refers to the individual predisposition to acquire, organise, and use information across situations (Kozhevnikov et al., 2005). Besides, cognitive styles are conceived as bipolar (e.g., visualiser vs verbaliser; holistic vs analytic), relatively stable over time, representing a pivotal dimension of the individual functioning (Sternberg & Grigorenko, 1997). Amongst all cognitive styles, the Field Dependence-Independence (FDI) has attracted a great deal of empirical attention, generating a significant amount of research since the Witkin and colleagues' work (e.g., Witkin & Asch, 1948; Witkin et al., 1977). Specifically, the interplay between FDI and creativity has been long discussed until around 1980, when the attention and popularity of such a cognitive style drastically decreased. However, since the 2000s, a new wave of interest has characterised the research on the FDI-creativity link. Even though reviews on this topic can be found in literature (e.g., Bloomberg, 1967; Zhang, 2017), no systematic reviews have been carried out to date. Therefore, the current study aims to summarise the literature on the relationships between FDI and creativity, taking into account both creative process and creative production approaches. This dual perspective allows identifying, on the one

hand, studies on the interplay between FDI and the individual disposition to think or act creativity (evaluated by creative potential measures such as DT and CT) and, on the other hand, studies on the role of FDI in the ability to generate actual real-world creative inventions.

Method

Literature search strategy

Three researchers conducted the online search independently, which was done through three different electronic datasets (Pubmed, Web of Science, and Scopus) in accordance with Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines. In order to identify the articles that showed the association between FDI and both creative process and creative product the following keywords were used: "Creativity", "Creative Thinking", "Divergent Thinking", "Convergent Thinking", "Creative Process", "Creative Product", "Art", "Field Dependent", "Field Independent", "Field Dependence", "Field Independence", "Cognitive Style", "Intellectual Style". The systematic search ended on June 30, 2020.

Inclusion and exclusion criteria

To explore the direct relationships between FDI and creativity (process or product), studies were selected if they met the following criteria: a) peer-reviewed journal articles published in English; no reviews, meta-analyses, case reports, letters to the editor, conference articles or book chapters; b) studies using creative process or creative product based on performance tasks and including measures of originality, appropriateness or creativity; no study based on merged scores of creative process and creative product (e.g., divergent thinking, plus creative preference assessed by

performance tasks, plus creative personality assessed by a questionnaire - Bloomberg, 1971), self-report creativity (Fergusson, 1992; 1993), and based on non-creativity measures (e.g., technical proficiency, such as occlusion, base line, perspective - Riding & Pearson, 1987); c) studies using FDI standardised measures (e.g., the Embedded Figure Test); no study based on composite measures of FDI (e.g., the Group Embedded Figure Test plus the Hidden Pattern Test plus the SOI Learning Abilities Test - Borland, 1988 or mobility-fixity measures - Niaz et al., 2000; Noppe, 1985); d) studies on differences between expert (e.g., artists) and non-expert; e) studies on healthy subjects, regardless of the age; no study based on clinical samples.

Study selection and data collection

First, literature was evaluated, by the three authors, considering duplicates followed by a screening of titles and abstracts. After that, results were screened in full text if considered eligible and for each included research, the following data were extracted: 1) research design; 2) statistical analyses; 3) sample characteristics including size, age, and gender; 4) type of FDI measures; 5) type of creativity measures, 6) focus on creativity (process vs product), and 7) findings.

Results

Number of selected studies

Duplicates were removed from 17638 initial records, leading to 9088 remaining records, which were screened by titles and abstracts. A total of 9067 records were excluded, and 21 articles were assessed for eligibility and screened by full text. Thirteen articles were excluded (see reasons for discarding full text in Figure 1), and 8 papers were considered

suitable for this systematic review. Figure 1 shows the flow diagram of the extracted articles by the selection process.

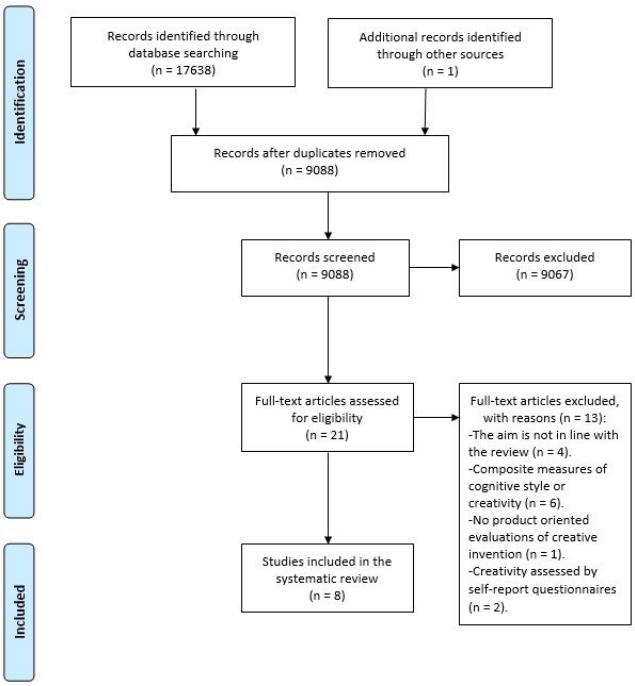

Figure 1. Flow diagram of the extracted studies.

Study design and sample characteristics

Table 1 synthesises the main characteristics of the studies included in this systematic review. All the 8 articles selected for this systematic review hypothesised a relation between FDI and creativity and they were published from 1967 to 2020. Of the 8 articles, 4 employed a between study design (Lei et al., 2020; Li et al., 2020; Miller, 2007; Saracho, 1992), 3 a correlational study design (Baranovska et al., 2017; Fergusson, 1992; 1993; Saurenman & Michael, 1980), and 1 used both between and correlational research designs (Noppe & Gallagher, 1977). A total of 1145 participants (402 males and 466 females) were enrolled in these 8 studies, and the range of participants was from 40 to 300 subjects. The sample mean age varied from 3 to 32 years. Three studies did not report some socio-demographic information such as gender

(Saurenman & Michael, 1980), mean age (Baranovska et al., 2017), and range and mean age (Noppe & Gallagher, 1977; Spotts & Mackler, 1967). One study (Spotts & Mackler, 1967) indicated that the sample was composed of undergraduate students and 1 study (Noppe & Gallagher, 1977) by education majors. In addition, one study reported only the percentage of gender (Lei et al., 2020). Only one study involved children (Saracho, 1992), 1 pre-adolescents (Saurenman & Michael, 1980), 2 adolescents (Baranovska et al., 2017; Lei et al., 2020), 3 young adults (Miller, 2007; Noppe & Gallagher, 1977; Spotts & Mackler, 1967), whereas 1 study focused on both adolescents and young adults (Li et al., 2020).

Authors (years)	Research design	Statistical analyses	Sample characteristics	FDI measures	Creativity measures	Focus on creativity	Findings
Spotts & Mackler (1967)	Correlational	Pearson product-moment correlation	N = 138 (138 M) Range = N.D. Mean = N.D. SD = N.D. Undergraduate students	EFT - Jackson Short Form Apparatus: 1 test trial of 12 items Scoring: Time to locate the simple figure within the complex design. Rapid solutions = FI Slow solutions = FD HFT Apparatus: 16 complex designs with a simple figure embedded in each design. Scoring: Accuracy High score = FI Low score = FD	Ask and Guess test Parameters: Fluency, adequacy, and flexibility Tin Cans test Parameters: Flexibility, fluency, and originality Circles test Parameters: Fluency, flexibility, elaboration, and originality Decorations test Parameters: Fluency, flexibility, elaboration, and originality	Creative process	The EFT negatively correlated with originality and elaboration of the Circles test; fluency, flexibility, and originality of the Decoration test. The HFT positively correlated with fluency and flexibility of the Ask and Guess test; elaboration of the Circles test; fluency, flexibility, and originality of the Decorations test; fluency and originality of the Tin Cans test. In addition, the HFT negatively correlated with originality of the Circles test.
Noppe & Gallagher (1977)	Between model Correlational	T test Pearson product-moment correlation	N = 45 (9 M; 36 F) Range = N.D. Mean = N.D. SD = N.D. Education majors	GEFT Apparatus: I part = 7 items (practice) II part = 18 items (test) Total items = 25 Scoring: Accuracy Median split	RAT 30 items Parameters: Accuracy	Creative process	Field independents attained significant higher RAT scores than field dependents. In addition, the GEFT positively correlated with the RAT score.
Saurenman & Michael (1980)	Correlational	N.D.	N = 96 (gender: N.D.) Range = 9.6-12.4 Mean = 10.9 SD = 3.8 Low Achievement N=48 High Achievement	GEFT Apparatus: I set = 7 items (practice) II part= 9 items (test) III part= 9 items (test) Total items=25 Scoring: Accuracy	DFC Parameters: Total score DSU Parameters: Total score	Creative process	Dividing the sample in children with low and high achievement, the GEFT positively correlated with DFC and DSU in the low achievement subsample.

			N=48				
Saracho (1992)	Between model	MANOVA	N=300 (150 M; 150 F) Range = 3-5 Mean = N.D. SD = N.D. Group 1 (3 years old): N = 100 (50M; 50F) Group 2 (4 years old): N = 100 (50M; 50F) Group 3 (5 years old): N = 100 (50M; 50F)	PEFT (preschool eft) Apparatus: 24 items Scoring: Group 1: ≤ 4 = FD ≥ 5 = FI Group 2: <10 = FD >10 = FI Group 3: <10 = FD >10 = FI	PRS Parameters: Creativity in communicating ideas, Frequency of play, Social play, and Dramatic play assessed by three graduate students in early childhood education. Average inter-rater reliability = .94	Creative product	Considering the total sample, field independents were better in PRS creative communication ideas score.
Miller (2007)	Between model	ANCOVA	N = 90 (30 M; 60 F) Range = 18-32 Mean = 19.74 SD = N.D.	GEFT Apparatus: I set = 7 items (practice) II part= 9 items (test) III part= 9 items (test) Total items=25 Scoring: Accuracy	Collage-making task Parameters: Creativity Score assessed by a set of independent judges following the Consensual Assessment Technique. Inter-rater reliability is not reported.	Creative product	Field independents outperform field dependents: the higher the GEFT score, the higher the creativity score. No significant effect of expected evaluation, probably due to the extrinsic motivation effect.
Baranovska et al. (2017)	Correlational	Spearman's correlation	N =148 (53M; 95F) Range = 18-19 Mean = N.D. SD = N.D.	GEFT Apparatus: I set = 7 items (practice) II part= 9 items (test) III part= 9 items (test) Total items=25 Scoring: Accuracy	Torrance's test of figural creativity - Circles task Parameters: Fluency, flexibility, originality, and elaboration	Creative process	Positive and significant correlation between the GEFT score and Elaboration score of the Figural form of the TTCT (Circles ask). No significant correlations were found amongst GEFT scores and the other TTCT parameters.
Lei et al. (2020)	Study 1: Between	Study 1: MANOVA	Study 1: N = 89 (46,2 %	Study 1: EFT	Study 1: TTCT - The unique use of cans	Creative process	Study 1: Significant main effect of

	model		M; 53.8 % F) Range = N.D. Mean = 16.31 SD = .59	Apparatus: N.D. Scoring: T scores T scores less than 50 = FD T scores above than 50 = FI	Parameters: Fluency, flexibility, and originality		FDI on fluency and originality (FD > FI). No significant main effect of FDI on flexibility. FDI moderates the interplay between expected evaluation and DT performance: FD produced more original ideas than FI with expected evaluation than those without evaluation.
	Study 2: Between model	Study 2: MANOVA	Study 2: N = 92 (59.8% M; 40.2% F) Range = N.D. Mean = 16.03 SD = .67	Study 2: EFT Apparatus: N.D. Scoring: Total score = N.D. T scores: T scores less than 50 = FD T scores above than 50 = FI	Study 2: TTCT - The unique use of cans Parameters: Fluency, flexibility and originality		Study2: Significant main effect of FDI on fluency and originality (FI > FD). No significant main effect of FDI on flexibility. No moderation effect of FDI on the relation of evaluation type and DT in terms of fluency, flexibility, and originality.
Li et al. (2020)	Study 1: Between model	Study 1: ANOVA	Study 1: N = 40 (7 M; 33 F) Range = 17-24 Mean = 20.20; SD = 1.60	Study 1: EFT Apparatus: I part = 9 items (practice) II part = 10 items (test) III part = 10 items (test) Total items = 29 Scoring: I part = 0 points II part = 12 points III part = 12 points Total score = 24 points Top 30% (≤ 13.50 points) = FD	Study 1: Brainstorming Tasks: 1) Scientific Task - What would the world be like without gravity? Parameters: Fluency, flexibility and novelty 2) Social Task - How can we make our school (university) better? Parameters: Fluency, flexibility and novelty	Creative process	Study 1: In both Scientific and Social tasks, the main effect of FDI was significant. Field independents outperformed field dependents in fluency, flexibility and novelty.

				Bottom 30% (≥17.50) = FI			
	Study 2: Between model	Study 2: ANOVA	Study 2: N = 107 (15 M; 92 F) Range = N.D. Mean = 20.23 SD = 1.92	Study 2: EFT Apparatus: I part = 9 items (practice) II part = 10 items (test) III part = 10 items (test) Total items = 29 Scoring: I part = 0 points II part = 12 points III part = 12 points Total score = 24 points Top 30% (≤ 13.50 points) = FD Bottom 30% (≥ 17.50) = FI	Study 2: Brainstorming Tasks: 1) Scientific Task Parameters: Fluency, flexibility and novelty		Study 2: Field independents outperformed field dependents in Scientific Task fluency, flexibility and novelty, confirming the findings of the Experiment 1. Moreover, in the absence of environmental cues the novelty score was higher in field independents than field dependents, In the presence of environmental cues field dependents and field independents produced equally novel ideas. No significant results were found for fluency and flexibility.

Table 1. The main characteristics of the studies included in the systematic review. EFT = Embedded Figure Test; HFT = Hidden Figure Test; FI = Field Independence; FD = Field Dependence; GEFT = Group Embedded Figure Test; RAT = Remote Associates Test; DFC = Divergent Production of Figural Classes; DSU = Divergent Production of Symbolic Units; PEFT = Pre-school Embedded Figure Test; PRS = Play Rating Scale; TTCT = Torrance Test of Creative Thinking.

Instruments and scoring methods

One study evaluated FDI using the Pre-school Embedded Figure Test (PEFT) (Saracho, 1992), a test suitable for administration to children between the ages of 3 and 5 years. The PEFT consists of 24 items, in which children were requested to find a simple figure embedded in familiar objects. A low number of correct responses reflects the children predisposition toward field dependence, whereas a high number of correct responses is related to field independence. Two studies evaluated FDI through the Embedded Figure Test - EFT (Lei et al., 2020; Li et al., 2020). In Lei and colleagues' study (2020), the authors used only the EFT and categorised participants by T score of the test. Participants with T scores below 50 were field dependent, whereas participants with T scores above 50 were categorised as field independent. In Li and colleagues' study (2020), the EFT consisted of three parts: 1 practice (9 items), 2 test (10 items for each part), in which participants had to locate and outline a simple figure embedded within complex figures using a pen. The individual predisposition toward field dependence or field independence was evaluated, ranking the correct responses provided by participants from low EFT score to high EFT score and selecting the top 30% (field dependent group) and bottom 30% (field independent group) of participants. One study (Spotts & Mackler, 1967) evaluated the FDI by the Jackson Short Form of the EFT, which consisted of one test trial of 12 embedded figures used in the EFT and the Hidden Figure Test (HFT), in which participants were requested to find a simple figure within 16 different complex designs. Finally, four studies used the Group Embedded Figure Test (GEFT) (Baranovska et al., 2017; Noppe & Gallagher, 1977; Saurenman & Michael, 1980; Miller, 2007), in which subjects were requested to find a shape hidden within a complex geometric design by three sets: 1 practice set (7 items) and 2 test sets (9 items for each set).

Regarding creativity, six studies focused on creative process, whereas only two papers evaluated the individual creative production (see Table 1). Concerning creative process measures, one study (Noppe & Gallagher, 1977) used the Remote Associates Test - RAT (30 items), a convergent tool in which subjects had to associate a word with other three unrelated words. The number of correct responses was used as the accuracy parameter, and no time limit was reported. Five studies used divergent measures. In one study, Spotts and Mackler (1967) evaluated DT in verbal and visual domains. Specifically, the DT verbal domain was evaluated by the Ask and Guess test, in which the focus was to write about possible causes and events concerning a tale, the Mother Goose story, in a time limit of 15 minutes (parameters: fluency, adequacy, and flexibility); and the Tin Cans test in which subjects were requested to find unusual uses of tin cans in 5 minutes (parameters: flexibility, fluency, and originality). The DT visual domain was evaluated using the Circles and Decorations tests. Whereas in the former, subjects were requested to see how many objects they can from 36 circles placed in 6 different rows in 10 minutes (parameters: fluency, flexibility, elaboration, and originality), in the latter, participants had to decorate objects in any way they wished in a time limit of six minutes (parameters: fluency, flexibility, elaboration, and originality). One study (Saurenman & Michael, 1980) used two measures of DT: the Divergent Production of Figural Classes (DFC), in which subjects were given information in concrete forms (e.g., capital letters) and were instructed to generate conceptual classes grouping this information by common properties; the Divergent Production of Symbolic Units (DSU), in which participants were given information in the form of denotative signs (letters, numbers, musical notations, codes, and words), and had to generate conceptual units. Two studies used two different subtests of the Torrance Test of Creative Thinking (TTCT). Specifically, one study (Baranovska et al., 2017) used the

Circles task of the Torrance Test of Figural Creativity, in which participants were requested to use 30 circles in a time limit of 10 minutes for drawing anything they wished. The subjects' responses were evaluated in terms of fluency, flexibility, and originality. One study (Lei et al., 2020) used the unique use of cans, in which participants had to list as many unusual uses as possible. No time limit was used. Each unusual use in the list provided by the participants was evaluated in terms of fluency, flexibility, and originality. Finally, in the first experiment, Li et al. (2020) used the scientific task and the social task, in which participants had to think independently of as many ideas as possible and save them into a Word document. The time limit was 15 minutes for each task, and ideas were evaluated in terms of fluency, flexibility, and novelty. In the second experiment, the authors used the scientific task only but in two different conditions: without environmental cues (the same condition of the first experiment) and with environmental cues in which participants used a group chat in which they could save, send, and view their own and other's ideas. The same time limit and parameters of the first experiment were used. Regarding creative production measures, 1 study (Saracho, 1992) used the Play Rating Scale, in which three observers evaluated children's behaviours in terms of creativity in communicating ideas, whereas 1 study (Miller, 2007) used the Collage-making task, evaluating participants' collages in terms of creativity, according to the consensual assessment technique (Amabile, 1982).

Findings

Six studies evaluated the relationship between FDI and creative process. Regarding DT, Spotts and Mackler (1967) found that the EFT score negatively correlated to visual DT in terms of originality and elaboration of the Circles test in terms of fluency, flexibility, and originality of the Decoration test. No significant correlations were found

in fluency and flexibility of the Circles test. In addition, EFT did not significantly correlate with all verbal DT measures. Spotts and Mackler (1967) also found that HFT scores positively correlated with verbal DT: the HFT positively correlated with fluency and flexibility of the Ask and Guess test and elaboration of the Circles test. No significant correlations were found considering the other verbal DT parameters. Positive correlations were also found between HFT and visual DT in terms of fluency, flexibility, and originality of the Decoration test and in terms of fluency and originality of the Tin Cans test. No other significant correlations were found. Considering the logic underpinning the two FDI tests (for EFT, the lower the execution time, the more the individual predisposition toward the field independence; for HFT, the more the accuracy score, the more the individual predisposition toward field independence), these findings showed a relevant interplay between field independence and DT. However, in this study, a significant and negative correlation between HFT and originality of the Circles test was also found. Partial significant results were found by further studies. For instance, Saureman and Michael (1980) found only in children with low achievement the interplay between the GEFT and both DFC and DSU. In addition, evaluating visual DT, Baranovska and colleagues (2017) found that the GEFT correlated only positively only to the elaboration score of the Torrance Test of Figural Creativity. The main effect of FDI evaluated by EFT and verbal DT was found in fluency and originality but not flexibility (Lei et al., 2020). Moreover, field independents outperformed field dependents during brainstorming tasks, including scientific and social tasks in terms of fluency, flexibility, and novelty (Li et al., 2020), but in the presence of environmental cues field dependent and independent subjects produced equally novel ideas. Only one study evaluated the interplay FDI and CT, showing a positive correlation between the GEFT and the accuracy score of the RAT (Noppe & Gallagher, 1977). Regarding

creative production, both studies found that field independents were more creative than field dependents (Miller, 2007; Saracho, 1992).

Discussion

This systematic review sought to explore the current literature on the interplay between FDI and creativity through the lens of both creative process and creative product.

Concerning creative process, the findings appear quite complex because the key role of field independence was confirmed only in some studies (e.g., Lei et al., 2020 in study 2; Li et al., 2020), whereas, in others, negative relationships (e.g., Lei et al., 2020 in study 1; Spotts & Mackler, 1967) or even no correlations (e.g., Baranovska et al., 2017) were found. Most studies focused on both visual and verbal DT, whereas only one study involved CT (Noppe & Gallagher, 1977). This implies that the role of creative thinking was not fully addressed. In addition, the relationships between FDI and the key parameters of DT (fluency, flexibility, originality, and elaboration) is unclear. Probably this fragmented result is due to the variety of scoring procedures used to assess FDI and DT. For instance, considering the scoring of FDI, some studies used the median split (e.g., Noppe & Gallagher, 1977), others the T test (Lei et al., 2020) or the top-bottom 30% (Li et al., 2020) to identify field dependents and field independents. Regarding DT scoring, instead, some studies used empirical scoring (based on the statistical frequencies of each response in the study sample) (e.g., Baranovska et al., 2017; Lei et al., 2020), whereas others evaluated DT by judge-based scoring methods (evaluation of independent judges) (Li et al., 2020). Moreover, the interplay between FDI and DT was not sufficiently evaluated in children. For instance, only one study considered children population (Saurenman & Michael, 1980), revealing the interplay between field independence and DT in children with high achievement only.

Regarding creative production, although only two relevant studies were selected, results appear to be more consistent, revealing a close relationship between field independence and individual creative production (Miller, 2007; Saracho, 1992). Both studies focused on the "creativity" value for assessing creative production: one study relied on the consensual assessment technique (Miller, 2007), whereas the other one did not (Saracho, 1992). Therefore, research in this area has demonstrated promising results, but there is much room to develop a deeper understanding of the association between FDI and creative production. Overall, the picture that emerging from this systematic review is that the FDI-creativity link has been not addressed adequately. First, most of the studies focused on creative process. In addition, some studies used self-report creativity (see Silva et al., 2012), that is, specific questionnaires or scales aimed at assessing everyday creativity, creative achievements, abilities, self-concepts, and so forth. However, although these studies (Fergusson, 1992; 1993) showed that field independents declare to be more creative, they add only a minimal contribution to understanding the relationships between FDI and creativity, being not based on performance tasks.

The work presented in this paragraph is under review in the Journal "Creativity Studies"

Giancola, M., Palmiero, M., & D'Amico, S. (*under review*). Field Dependent-Independent Cognitive Style and Creativity from the process and product-oriented approaches: A systematic review

3.2.2 Study 2 - The relationships between cognitive styles and creativity: the role of field dependence-independence on visual creative production.

Introduction

As mentioned in previous paragraphs, cognitive styles refer to how people acquire, organise, and use information (Riding & Rayner, 2013). Although the key role of cognitive styles in human functioning and behaviour has been extensively acknowledged, according to the findings provided by the systematic review in Study 1, the role of Field Dependence - Independence cognitive style (FDI) in both creative potential (divergent thinking and convergent thinking) and production (inventions) is quite complex.

Regarding divergent production, some studies revealed that field independents outperformed field dependents (e.g., Spotts & Mackler, 1967; Nisiforou, 2015) in generating ideas, whereas others found nonsignificant results (e.g., Bloomberg, 1971; Niaz et al., 2000). For instance, Li et al. (2020) revealed that field independents outperformed field dependents in scientific and social brainstorming tasks in terms of fluency and novelty, confirming previous studies in which field independents showed higher performance than field dependents in fluency, flexibility, and originality of divergent production (e.g., Bal, 1988; Nisiforou, 2015). Furthermore, Lei et al. (2020) found that field independence was positively related to fluency and originality but not to flexibility, whereas Niaz and colleagues (2000) found no significant effect of FDI. A similar scenario involves convergent production: whereas some authors stressed that field independents attained significantly higher scores than field dependents in convergent measures (e.g., Noppe & Gallagher, 1977; Chadha, 1985), others found no significant effect of FDI (e.g., Ohnmacht & McMorris, 1971), demonstrating, also for convergent of thought, a lack of empirical consensus. Finally, regarding creative

production, only one study explored the impact of FDI on people's ability to generate creative outcomes (Miller, 2007), revealing that field independents reported higher creativity scores in the creative college making task than field dependents. Note that although some authors found positive correlations between FDI and self-rated artistic abilities and artistic competencies (Fergusson, 1992; 1993), research on the impact of FDI on creative production remains scattered to date. Given the paucity of empirical research and the lack of consensus on the role of this cognitive style on creativity, the present research aims to shed further light on the issue, adopting the logic of the Geneplore model, which implies the combined effect of generation and exploration of ideas in order to generate creative inventions. Considering previous studies on creative potential measures (e.g., Noppe & Gallagher, 1977; Nisiforou, 2015; Li et al., 2020) and primary Miller's work (2007) on creative production, the present research primary aimed to verify whether field independents outperformed field dependents in generating creative objects.

Method

Participants and procedure

Sixty undergraduate college students attending different courses at "The University of L'Aquila" (L'Aquila, Italy) participated in the study (mean age = 22.30 ± 3.31). Twenty-nine of them were males (48.3 %), and thirty-one were females (51.7 %). After signing the written informed consent to participate in the study, all participants were asked to complete an anamnesis questionnaire assessing biographical and educational information, general health state, background or formal achievement in art. No participant reported psychiatric, neurological disorders, drug or alcohol addictions, and no participants declared a background or formal achievement in art. The experimental

protocol was administered individually to each participant in a quiet room of the "Socio-Cognitive Processes in Life Span Laboratory" at "The University of L'Aquila" (L'Aquila, Italy). The experiment lasted approximately 45 minutes. The Local Ethics Committee approved this experiment in accordance with the Declaration of Helsinki.

Measures

Assessment of Field Dependent Independent Cognitive Style

The Embedded Figure Test (EFT; Italian version, Fogliani et al., 1984) is widely used to evaluate the individual's predisposition toward the field dependence independence cognitive style in adults. It is a paper and pencil measure, in which participants were requested to find a simple black and white shape within a geometric coloured complex figure. The test consists of 24 cards (8 cards with simple shapes and 12 cards with complex figures) 12.9 x 7.7 cm (see Figure 1).

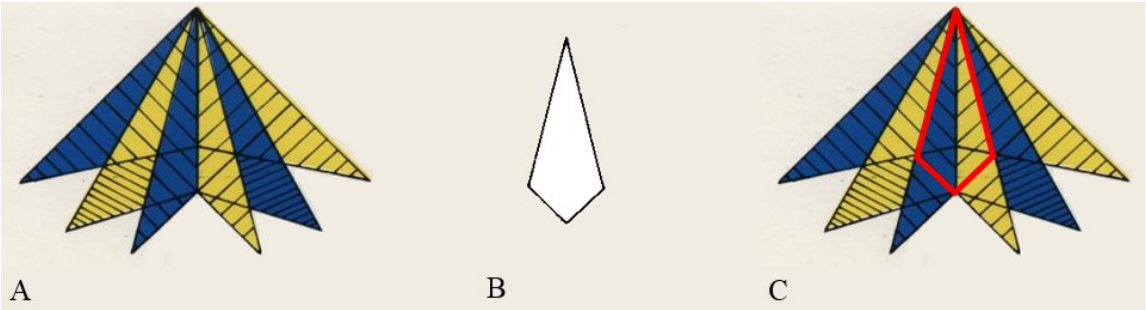

Figure 1. An example of an item taken from the Embedded Figure Test (EFT; Fogliani, Di Nuovo, Fogliani, & Pizzamiglio, 1984). A. The geometric colored complex figure. B. The simple black and white simple shape. C. The simple shape within the complex figure.

The experimenter presented the complex coloured figure one by one for 15 seconds, and the participant had to describe the figure in a loud voice. Then, the experimenter removed the complex figure and presented the simple one; after 10 seconds, he took away the simple black and white shape and presented once again the complex coloured

figure. After that, participants had to find the simple black and white shape embedded in the complex figure. They were instructed to inform the experimenter as soon as they found the figure and trace its outlines using a pencil. When the participants declared to have found the simple black and white shape within the complex figure, the experimenter annotated the elapsed time (timing). If the response (tracing of the outlines) was wrong, the experimenter continued to take the time until the participant provided the correct response or until 180 seconds were elapsed. Following Bocchi et al. 2018, the total time was divided by the number of items (12) to compute the average time used to measure the individual's cognitive style. A lower score indicated a higher predisposition towards field independence, whereas a higher score indicated a higher predisposition towards field dependence. The test manual (Witkin et al., 1971) reports that the reliability coefficients range from α. = .79 to α = .90, as assessed in different samples. In addition, the manual lists different studies supporting: EFT's convergent validity, highlighting that field-independence correlates to a variety of intellectual tasks which involve the same abilities, whereas field-dependence is associated with measures of cognitive rigidity and intolerance of ambiguity; EFT's discriminant validity, given that the EFT does not correlate with tests not based on dis-embedding abilities. Milne and Szczerbinski (2009) also suggested that individual differences on the EFT reflect a dis-embedding factor, which is not related to a general local or global perceptual style but rather to coherent motion thresholds and intelligence.

Assessment of creative production

Creative production was assessed using the Visual Creative Synthesis Task (VCST; Finke et al., 1992; Palmiero et al., 2016). Starting from three triads of visual components, the VCST requires providing three sketches of creative objects, which

could have an actual use in a specific real-world context, for instance, generating an exotic drawer set on the wall, combining one parallelepiped, one di-pyramid, and one horn (Giancola et al., 2021). The task relies on two main steps: the preinventive and inventive phases. After a practical trial, participants were requested to mentally combine and manipulate the visual components into an abstract structure (See Figures 2 and 3), one for each triad: each component could be changed in position, rotation and size but not in its general structure. Participants had 15 seconds to fix and memorise the visual components and 2 minutes to think about the preinventive structure for each triad. After this preinventive phase, participants were requested to produce a schematic drawing. During the inventive phase, participants were presented with a category name for each triad (furniture, weapon, and sport goods) and were asked to think of their invention. They had 3 minutes to describe the functioning of each invention. After the inventive phase, participants were requested to provide a title of the objects.

Following Amabile's consensual assessment technique (Amabile, 1982), three independent judges, two females and one male (mean age = 25.33 ± 4.50) evaluated preinventive structures and inventions. The judges were three psychology students who attended training on creativity and its assessment for 20 hours. The main models and descriptive frameworks of creativity were explained during the training sessions, including the SOI and the Geneplore Model. In addition, students were shown examples of creative productions already evaluated in the past by judges, and they were trained to evaluate creative productions in terms of creativity. After the training, the evaluation sessions began. Preinventive structures were evaluated by each judge along a 5-point Likert-type scale in terms of originality, defined as a form being new and not derived from something else (from 1 = very poor originality to 5 = very high originality) and synthesis, defined as the extent to which components were well assembled (from 1 =

very poor synthesis to 5 = very high synthesis). The inter-rater correlation (intra-class correlation coefficient - absolute agreement) were significant for both originality (α = .921; $p < .01$) and synthesis (α = .933; $p < .01$). Inventions were evaluated by each judge along a 5-point Likert-type scale in terms of originality defined as a product being new and not derived from something else (from 1 = very poor originality to 5 = very high originality), and appropriateness, defined as an invention with a practical instead of a hypothetical use (from 1 = very poor appropriateness to 5 = very high appropriateness). The inter-rater correlation (intra-class correlation coefficient - absolute agreement) were significant for both originality (α = .941; $p < .01$) and appropriateness (α = .959; $p < .01$). In a previous study, the inter-rater correlation (absolute agreement) for the creativity score was also very high: α = .95, $p < .001$ (e.g., Giancola et al., 2021). Overall, the VCST showed significant inter-rater correlation in previous studies, even when originality and appropriateness/practicality were evaluated separately (e.g., Palmiero et al., 2016). Regarding validity evidence, although there are no studies that specifically addressed convergent and discriminant validity of the VCST, some evidence suggests that this task has a reliable convergent validity, given that its scores were found correlated to the visual art subscale of the Creative Behaviour Inventory (Morrison & Wallace, 2001) and measures of DT (e.g., Roskos-Ewoldsen et al., 2008).

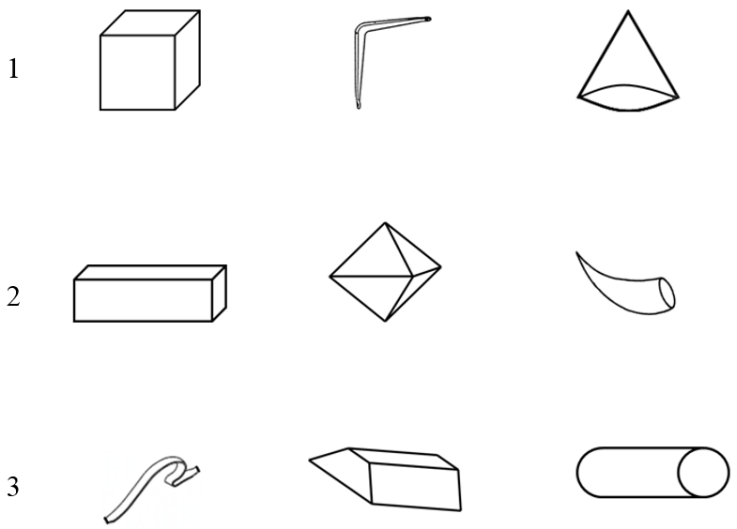

Figure 2. The three triads of components for the Visual Creative Synthesis Task (VCST): 1) cube, bracket, cone (sport goods); 2) parallelepiped, dy-pyramid, horn (furniture); 3) strip, trapezoid, cylinder (weapons).

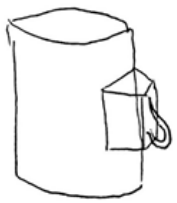

Figure 3. An example of creative invention based on the triad n.3 made up of one stripe, one trapezoid, and one cylinder. Category: Weapons; Title: Grenade; Description: This cylinder is a grenade. The cylinder contains the explosive, the trapezoid is the trigger mechanism, and the strip controls the whole grenade and has a safety function.

Results

Statistical analyses were performed using IBM SPSS Statistics v.24. Following Tascón and colleagues (2017), since the EFT does not have a scale to divide field independence and field dependence and taking into consideration that the individual's predisposition toward FDI is along a continuum, the median-split technique was applied. This method has also been used not only in previous studies on the interplay between FDI and creativity (e.g., Ohnmacht & McMorris, 1971; Noppe & Gallagher, 1977; Niaz & De Nunez, 1991) but also in other research areas including, perception (e.g., Teghil et al.,

2019), spatial cognition (Tascón et al., 2017), and problem-solving (e.g., Mefoh et al., 2017). Participants were divided by the median split of the EFT score (average solution times). Therefore, subjects with lower scores than the median (31.23) were classified as field independent (N = 30), whereas participants with higher scores than the median were classified as field dependent (N = 30). Four different univariate ANOVAs were performed with creative scores as the dependent variables and FDI as the between factor. Regarding preinventive phase results revealed a significant main effect of FDI: field independents scored significantly higher than field dependents in originality [F(1,58)=8.854; p=.004; η_p^2 = .132] and synthesis [F(1,58)=11.323; p=.001; η_p^2 = .163] of preinventive structures. In addition, regarding the invention phase, field independents outperformed field dependents in originality [F(1,58)=12.798; p=.001; η_p^2 = .181] and appropriateness [F(1,58)=6.593; p=.001; η_p^2 = .171] of productions (See Figure 4).

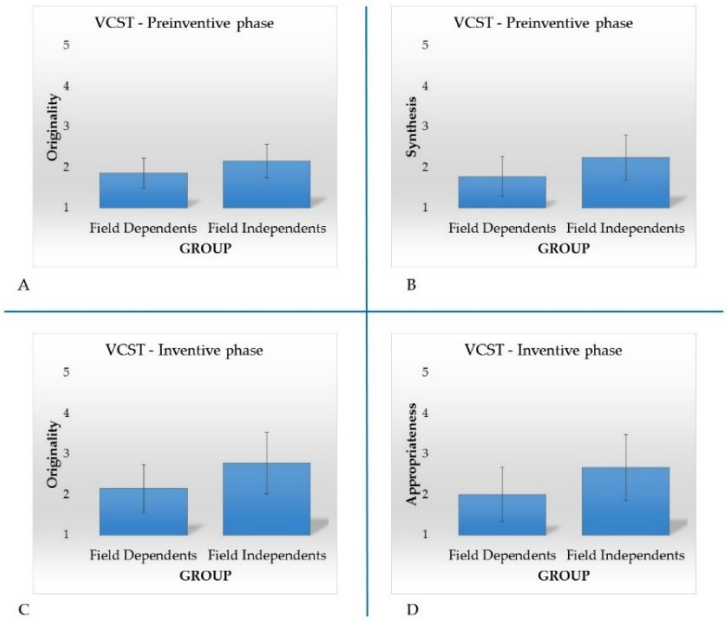

Figure 4. Mean plot: in the x-axes, the two groups (Field Dependents and Field Independents) are reported. The y-axes show the evaluation on the preinventive phase of the VCST in terms of originality (A) and synthesis (B); and the evaluation on the inventive phase of the VCST in terms of originality (C) and appropriateness (D).

Discussion

Previous research on the relationships between FDI and creativity revealed unclear results, demonstrating a lack of consensus amongst researchers (Zhang, 2017): mixed findings have been found taking into account creative thinking in terms of convergent (e.g., Ohnmacht & McMorris, 1971; Chadha, 1985) and divergent productions (e.g., Niaz et al., 2001; Nisiforou, 2015), whereas little work has been done on creative production (Miller, 2007). Given this scenario, the current research sought to investigate the extent to which the individual's predisposition towards FDI affects creativity.

Regarding the preinventive phase, results revealed that field independents showed significantly higher scores in originality and synthesis than field dependents. The faster participants were in identifying the simple shape embedded in the complex figure (field independence), the more original and well-assembled were preinventive structures. Given the nature of the task used, it is not surprising that mental imagery plays a key role during the preinventive phase of VCST: indeed, the task requires mentally transforming, combining, and synthesising visual components in order to generate preinventive structures, that is, mental prototypes of inventions. The pivotal role of mental imagery in creative tasks such as the VCST has been widely recognised in the past (e.g., Finke, 1996; Palmiero et al., 2010,2011,2016). More specifically, spatial imagery and mental manipulation of spatial forms seem to be crucial in tasks involving objects' construction (Sack et al., 2008), including creative inventions. Indeed, mental shape manipulation was found positively related with the originality score of preinventive structures (e.g., Roskos-ewoldsen, et al., 2008) and the ability to generate well-assembled and synthesised shapes (e.g., Finke et al., 1989; Finke, 1996). The role of spatial manipulation in creative tasks is also consistent with those researches using the think-aloud method in order to reveal mental processes actively involved in

creativity. For instance, Palmiero and Piccardi's (2020) study revealed that spatial thoughts - containing spatial information of size and rotation - generated during the preinventive phase positively predicted the originality of productions during the invention phase. Although this study did not detect mental imagery directly, the assumptions reported above could represent a relevant point to explain the results of the current research. Indeed, field independents seem to be more skilled than field dependents in spatial abilities implying mental imagery. Specifically, field independents showed higher performance than field dependents in tasks requiring to process different objects' features such as shape and orientation (Hindal et al., 2009) and tasks tapping visual-spatial information (Evans et al., 2013). For instance, Boccia and colleagues (2016), in a sample of 50 young adults, found that field independents outperformed field dependents in mental rotation test, and Li and colleagues' study (2016) revealed similar results in 2D and 3D map mental rotation, underling that regardless of map dimensionality, as the degree of the image rotation increased, the accuracy of the field independents' performance increased. Although the more flexible mental imagery and the better predisposition to use visual stimuli of field independents could represent a pivotal factor in this phase of the Geneplore cycle, undoubtedly, different mechanisms could affect it, and further investigations are needed.

Regarding the inventive phase, results revealed that field independents showed significantly higher scores in originality and appropriateness than field dependents, meaning that the faster were participants in identifying the simple shape embedded in the complex figure (field independence), the more creative (original and appropriate) were inventions. Results align with Miller's study (2007) and also seem to align with some previous research on creative thinking, including both divergent (e.g., Nisiforou, 2015; Li et al., 2020; Lei et al., 2020) and convergent productions (e.g., Chadha, 1985;

Noppe & Gallagher, 1977). Two main explanations can be useful in explaining the better performance of field independents. First, the assumption of the pivotal role of mental imagery in the preinventive phase can also be extended to the inventive phase. For instance, Roskos-ewoldsen et al. (2008), in a sample composed of 41 young and 41 older adults, found a positive relationship between the Paper Folding Test and originality score of productions in the Creative Invention Task. Similar results were also found by Palmiero and colleagues' study (2011), in which the individual vividness of mental imagery was positively related to the practicality score of the invention in the Mental Synthesis Task. Therefore, the nature of the VCST used in this study and the better predisposition of field independence than field dependence in mentally manipulating spatial shapes could represent a possible explanation of results during the inventive phase. Second, it has been found that the better predisposition of field independents in using their own knowledge and extracting it from memory, especially in complex tasks in which the solution is unclear, positively affects creative performance (Li et al., 2020). This assumption is consistent with the two-step form of the VCST used in this research. Indeed, unlike the one-step form (e.g., Palmiero et al., 2011) in which the category of creative inventions is specified before combining the visual components, the category is specified in the two-step form only after the assembly of components. This makes the creative process more complex, since in the combination phase, the goal of creative production is not defined, and participants have to adapt what they have previously assembled to the category provided by the task. In other words, during the two-step form of VCST, participants have to reorganise their prior knowledge in order to generate the creative product. Given that field independents, compared with field dependents, have a better capacity to extract their own knowledge, this individual predisposition could be helpful to them in reorganising and updating the

structure previously generated in order to generate the creative invention. Nevertheless, this assumption deserves further investigation.

To conclude, this research provides empirical evidence on a complex relationship involving FDI and creativity, and results seem to support the hypothesis that field independents outperform field dependents in creative performance.

The work presented in this paragraph is under review in the Journal "Brain Sciences"

Giancola, M., Palmiero, M., & D'Amico, S. (*under review*). The relationships between cognitive styles and creativity: the role of field dependence-independence on visual creative production

3.2.3 Study 3 - Exploring the interplay between fluid intelligence and creativity: the mediating role of the field dependent-independent cognitive style

Introduction

Creativity plays a pivotal role in human endeavours from art, science, and architecture to everyday problem solving, allowing people to access the fullness of available information and limiting the risk of being locked into old concepts (Olatoye et al., 2010). In terms of individual differences, one of the main research topics in the psychology of creativity involves the association between intelligence and the individual ability to generate creative outcomes. In his seminal work, Guilford (1967) coined the distinction between divergent thinking (DT) and convergent thinking (CT), placing them within the umbrella of the Structure of Intellect Model. Guilford emphasised that there are individual differences in various abilities subserving intelligence, including DT. Interestingly, Guilford noticed that DT emerged mainly in creative people, assuming that DT represents a manifestation of creativity. Empirical evidence confirmed that DT predicts the number of creative achievements (e.g., Kim, 2008) and their quality (e.g., Beaty et al., 2013). Besides, even though Guilford associated CT mainly with intelligence, being CT defined by logical strategies and the ability to find a single correct solution to a clearly defined problem, more recent theories stressed that creative production demands both DT and CT (Zhu et al., 2019). According to this latter perspective, while DT represents a manifestation of creative potential (Runco & Acar, 2012), playing an essential role in generating new ideas, CT is necessary for evaluating the effectiveness of such ideas, transforming divergence into a creative invention (Cropley, 2006). Besides, even though intelligence has been depicted as one of the main cognitive processes contributing to creativity (e.g., Simonton, 2014), across years, the intelligence-creativity link has also been analysed focusing on the

involvement of several extra-cognitive factors, including, amongst others, personality traits, emotions, motivation, and cognitive styles (e.g., Furnham, 2016; Hosseini et al., 2021; Shi et al., 2016). For instance, measuring Gf (using the Wechsler Intelligence Scale for Children), DT (by the Torrance Test of Creative Thinking) and legislative, judiciary, and executive thinking styles (using the Thinking Style Inventory) in a sample of 12-to-16-years-old students, Hosseini et al. (2021) found that the executive thinking style mediated the association between Gf and divergent production. In addition, Furnham (1995) hypothesised that different cognitive styles could moderate, instead of mediate, the effect of intelligence in individual accomplishment, facilitating, enhancing or inhibiting the role of Gf on people's performance (Furnham, 1995). Thus, whereas Hosseini et al. (2021) apprised the mediating role of cognitive styles, Furnham (1995) only suggested their moderating role in the Gf-creativity link. In this direction, the present study attempts to combine the two approaches, focusing specifically on the mediating and moderating role of field dependence-independence cognitive style (FDI) in the interplay between intelligence and creativity in both creative potential and real-world visual creative production.

Intelligence and creativity

According to the Cattell and Horn Model (Cattel, 1963; Cattel, 1971; Horn & Noll, 1997), two main g factors define intelligence: crystallised intelligence (Gc) and fluid intelligence (Gf). Whereas Gc denotes the richness, breadth, and depth of knowledge, which increases over time, depending on cultural and educational background, Gf represents a hereditary factor, which allows people to reason, solve problems, and understand the relationships amongst concepts independently of previously acquired knowledge, especially in complex and demanding contexts (Jaeggi et al., 2008). Given

its pivotal role in human functioning, intelligence has been deeply analysed, considering different human activities, including generating relatively new, surprising, and satisfying ideas or creative factual works. As reported by Sternberg and O'Hara (2000), the relationships between intelligence and creativity have depicted one of the most interesting and debated topics in the psychology of creativity, which can be summarised into five theoretical views: 1) creativity is a subset of intelligence (Guilford, 1967; Cattell, 1971); 2) intelligence as a subset of creativity (e.g., Smith, 1970; Sternberg & Lubart, 1995); 3) intelligence and creativity as overlapped sets (e.g., Barron, 1963); 4) both constructs as essentially coincident sets (e.g., Haensly & Reynolds, 1989); 5) intelligence and creativity as disjoint sets (e.g., Getzels & Jackson, 1962; Wallach & Kogan, 1965). Even though empirical evidence supports each of these perspectives, research on the association between intelligence and creativity has shown weak correlations or unclear results (for a meta-analysis, see Kim, 2005). Specifically, regarding Gf, which is the topic of the present research, positive correlations were found with verbal DT (e.g., Batey et al., 2009; 2010), whereas other investigations revealed inconsistent results, especially in terms of ideational fluency (e.g., Benedek et al., 2012a; Karwowski et al., 2016). No relationships were also found with creative achievement and self-evaluation of personal creative attributes (e.g., Batey et al., 2010; Benedek et al., 2017; Karwowski et al., 2016). Given this mixed scenario, using advanced statistical analyses such as the latent variable approach, Silvia (2008) reanalysed the classical Wallach and Kogan's study (1965), in which intelligence was not correlated with creativity, and found that intelligence showed a modest relationship with originality and a stronger association with fluency. Following Silvia's results, the latent variable approach has been widely used to investigate the role of intelligence in different facets of creativity, including ideas generation (e.g., Nusbaum & Silvia, 2011),

creative achievements (e.g., Jauk et al., 2014) and creative production (e.g., Greengross & Miller, 2011; Primi, 2014; Silvia & Beaty, 2012), revealing compelling evidence. Although the latent variable approach seems to provide interesting results, some studies underlined no significant associations (e.g., Benedek et al., 2012b), demonstrating that the research on the interplay between intelligence and creativity is still divided and lacks complete consensus (Kaufman & Plucker, 2011).

Intelligence and Field-Dependent-Independent cognitive style

Regarding the cognitive underpinnings of FDI, a large body of research stressed that such a cognitive style reflects the efficiency of different controlled mental processes, including not only the Core Executive Functions, made up of working memory, inhibitory control, and cognitive flexibility (e.g., Brosnan et al., 2002; Miyake et al., 2001) but also the Higher Order Executive Functions, which include both Gf and planning (e.g., Duncan, 2013; Huygelier et al., 2018).

Active reasoning patterns characterising Gf were found to predict field independence (Huygelier et al., 2018), confirming previous studies, showing positive correlations between Gf and FDI (Goodenough & Karp, 1961; McKenna, 1984). Besides, this relation remains substantial in studies on children (e.g., Campbell, 1972; Ghuman, 1977), adolescents (e.g., Tinajero & Páramo, 1997), adults (e.g., Widiger et al., 1980) as well as in cross-cultural research (e.g., Berry, 1976). Even though there is a general agreement that FDI tasks are measures of cognitive style, some authors underlined that Gf and FDI tools might assess the same construct, opening the debate whether FDI represents a cognitive style or a cognitive ability (e.g., Huygelier et al., 2018; McKenna, 1984). Although such a debate is far from being solved, some studies underlined that academic performance differences between field independent and field dependent

people remain unaffected when controlling for intelligence. These findings suggested that intelligence and FDI clearly represent two different constructs (Rittschof, 2008; Tinajero & Paramo, 1997). This latter describes specific individual differences in the extent to which people differ in processing information from the surrounding environment rather than cognitive ability.

Field-Dependent-Independent cognitive style and creativity

Although cognitive styles-creativity link has a long tradition of research, mainly in DT (Kozhevnikov et al., 2013), in the recent past, the specific interest in the interplay between FDI and creativity has received increasing attention in both creative potential and real-world creative production (e.g., Miller, 2007; Nisiforou 2015; Li et al., 2020; Lei et al., 2020). This new wave of interest on the issue could be traced back to the misleading findings provided by previous research and the need to clarify the role of FDI in both creative thinking and production (Zhang, 2017). Although some previous studies found nonsignificant results (e.g., Bloomberg, 1971; Niaz et al., 2000), others underlined that field independent subjects outperformed field dependent ones in generating new ideas in different DT tasks. Li and colleagues (2020) found that field independents attained significantly higher scores than field dependents in scientific and social brainstorming tasks in terms of fluency and novelty, stressing that these differences became nonsignificant when environmental cues were present. Regarding the interplay between FDI and CT, some studies stressed the impact of field independence in convergent production (Noppe & Gallagher, 1977; Chadha, 1985), whereas others found nonsignificant differences (e.g., Ohnmacht & McMorris, 1971). Only one study investigated the role of FDI on creative production, revealing that field independents were more able in making creative collages than field dependents (Miller,

2007). In addition, some studies revealed positive correlations between field independence and creative achievement, such as art (Fergusson, 1992; 1993), offering further insight into how this cognitive style affects creativity.

The present study

The logic behind this research was to shed further light on the Gf-creativity link focusing on the involvement of a third variable, represented by cognitive styles. Specifically, the current study intends to evaluate the extent to which individual predispositions such as FDI affects the interplay between Gf and creativity, considering both creative potential and real-world visual creative production. On the one hand, creative potential was evaluated following Vartanian and colleagues' framework (2007), which involves the joint effect of DT, CT, and creative personality. On the other hand, according to the product perspective of creativity (e.g., Kaufman & Sternberg, 2010), visual creative inventions were evaluated in terms of creativity, an index meeting the criteria of originality and appropriateness. Specifically, whereas originality was conceived as the extent to which inventions deviate from what is considered traditional or familiar, appropriateness was assumed as the degree of usefulness, relevance and fit of such inventions within a specific context. In order to evaluate real-world visual creative production, we used the Visual Creative Synthesis Task (VCST), realising on the Geneplore Model (Finke et al., 1992), which encompasses a generative phase followed by an exploratory one. The generation phase brings forth preinventive structures, that is, mental representations of future inventions generated without any constraints in mind (Jaarsveld & Lachmann, 2017). Such representations can be described as a set of emergent, spontaneous and undirected ideas, characterised by different degrees of creative potential (Ward, 2001). Conversely, the explorative phase

allows interpreting and evaluating preinventive structures in terms of their possible implications and functionalities.

The current research offers a holistic view of the role of intelligence on creativity in both creative potential and real-world visual creative production. The first hypothesis was formulated as follows: H1 - Gf is related to creativity in terms of creative potential and real-world visual creative production (e.g., Benedek et al., 2014).

Besides, the research evaluates whether the Gf-creativity link was affected by cognitive styles. Although research on the interaction amongst Gf, cognitive styles, and creativity is scattered to date, following previous studies (Hosseini et al., 2021), the second hypothesis was: H2 - FDI mediates the Gf-creativity association in both creative potential and real-world visual creative production.

Finally, some authors hypothesised that cognitive styles could moderate, instead of mediate, the effect of intelligence in individual accomplishment, facilitating, enhancing or inhibiting the role of Gf on people's performance (Furnham, 1995). In order to appraise the hypothesis of a moderating role of cognitive styles on the interplay between Gf and creativity, the third hypothesis advanced in this study was: H3 - FDI moderates the association between FDI and both creative potential and real-world visual creative production.

Method

Participants

One-hundred undergraduate students ($mean_{age}$ = 22.19 ± 2.78; $mean_{educational\ level}$ = 13.27 ± .86, $range_{educational\ level}$ = 13-16; 44 females) took part in the current research. Subjects were recruited from two different psychology university courses (Developmental Psychology and Psychopathology of Language and Communication Development). All

participants were Italian with no history of neurological and psychiatric disorders and none of them reported having a background or formal achievement in art. Participation was voluntary and all subjects provided their consent to the use of the collected anonymous data. Subjects were not given any rewards for taking part in the study. The Local Ethics Committee, in accordance with the Declaration of Helsinki, approved the present research.

Materials

Assessment of fluid intelligence

The Kaufmann Brief Intelligence Test, Second Edition (KBIT-2; Kaufman & Kaufman, 2005; Italian version, Bonifacci & Nori, 2016) is a brief test of intelligence for people aged 4-90 years, widely accepted as prototypical measures of fluid reasoning (Kaufman, 2009). For our purpose, we used the matrices subtest only. The task consisted of 46 nonverbal items - like matrices developed by Raven (1936) - composed by meaningful (people and objects) and abstract (designs and symbols) visual patterns. For example, on top, there might be a picture depicting an eye associated with a book and a hear associated with a question mark. The picture below includes six pictures: a foot, a carrot, a radio, a dish, a hat, and two socks. For this matrix, the correct answer is the radio. Participants are instructed to pick from one of the six choices to fill in the matrix. Participants are required to solve one matrix per time. The task stops after four consecutive wrong responses and the administration lasted approximately 10 minutes. The raw score was computed as follows: sum of the matrices correctly solved (1 point for each matrix) minus the number of errors. Then, final row scores were standardised in order to generate the nonverbal IQ age-based score. The KBIT-2 matrices showed good internal consistency as reported in the technical manual: $\alpha = .90$; the mean test-retest reliability

= .83 (Nori et al., 2018). In addition, Bain and Jaspers's (2010) review reported high convergent validity for the KBIT-2 matrices, which correlated with other tests of intelligence, of academic achievement, at various age levels.

Assessment of creative potential

In order to tap creative potential, in the current research, we used the Alternative Uses Task (AUT; Torrance 1987; Italian version, Sprini & Tomasello 1989), the Remote Associates Test (RAT; Mednick & Mednick, 1967; Italian version, Salvi et al., 2020), and the Creative Personality Scale (CPS; Gough, 1979).

In the AUT, participants were requested to find as many alternatives uses as possible for carton boxes in a time limit of 10 minutes. Although the AUT responses are usually scored for fluency, flexibility, and originality, following Vartanian and colleagues (2007), we evaluated the AUT only in terms of fluency, which reflects the number of relevant (appropriate) alternative uses of carton boxes provided by participants. The fluency score was chosen as the unique measure of DT based on two considerations: 1) fluency allows accounting for almost all the variance in DT tasks (e.g., Guilford, 1967; Plucker & Renzulli 1999; Vartanian et al., 2007); 2) fluency conflates with the other scores of DT (e.g., originality and flexibility) (Silvia et al., 2008). Note that to counter the fluency contamination effects, different scoring methods for assessing DT have been developed (for a review see Reiter-Palmon et al., 2019). However, even the scoring methods aimed to address the fluency contamination issue (e.g., ratio and residual scores) suffer of other potentially confounding effects, such as low reliability (Forthmann et al, 2020). Besides, different studies revealed that quantity of DT responses represents a linear function of quality, showing high correlation between fluency and creativity (Silvia, 2008, Wallach & Kogan's, 1965). This led many

researchers to use only fluency scores for assessing DT (e.g., Batey, Chamorro-Premuzic, & Furnham, 2009; Preckel, Wermer, & Spinath, 2011). In this study, responses were considered as appropriate when they involved an actual use in a specific context, rather than a hypothetical use (e.g., a carpet, that is, an open carton box lying on the floor). The fluency score of the AUT showed good internal consistency as reported in the technical manual: α = .99; the mean test-retest reliability = .93. Regarding the convergent validity evidence, different studies showed that the AUT fluency score correlated to other measures of creativity, including openness to experience, which is a trait creativity (Friis-Olivarius & Christensen, 2019), and creative achievement (Wang et al., 2021). Notably, as said above, given that the AUT fluency score correlates also to quality scores of DT and creativity, an adequate discriminant validity cannot be accomplished (Silvia et al., 2008).

The RAT consists of 30 questions validated in Italian (see Salvi et al., 2010) and each question is composed by 3 stimulus words such as "*foto*" (photo), "*riassunto*" (summary) and "*libro*" (book). Participants were asked to provide a target word that could be related to all three stimulus words. For this example, the target word is "*sintesi*" (synthesis). Participants received 1 point for each correct response and the total number of correct solutions was computed. The administration of this test required approximately 10 minutes. Following Salvi et al. (2020), internal consistency of the RAT was: α = .89. In addition, by the Item Response Theory authors showed that the RAT conveyed information over different ability levels. The validity was also satisfactory given that the RAT correlated to classic insight problems, anagrams and Standard Progressive Matrices, all measures that tap convergent thinking, and to the Creative Achievement Questionnaire, although it also correlated to fluency and flexibility scores of DT.

Finally, the CPS relies on a 30-item checklist characterised by adjectives positively (e.g., capable, insightful, and original) and negatively (e.g., conservative, traditional, and cautious) related to creativity. Participants were requested to select, amongst the 30 items, all relevant adjectives that could be applied to them; each positive item received a +1 score, whereas each negative item received a -1 score. We computed the CPS total score subtracting the total score of the negative items from the total score of the positive ones. A total score > 0 indicates a positive creative personality; conversely, a total score < 0 revealed a negative creative personality. The administration of the CPS lasted approximately 5 minutes. The CPS is part of the Adjective Check List formed by 300 adjectives (Gough, 1979). The specific CPS' internal consistency was evaluated using different samples: $\alpha > .70$. Freiberg-Hoffmann et al. (2019) also reported a satisfactory internal consistency for the CPS: $\alpha > .85$. In addition, the CPS showed also a good convergent validity, correlating to other measures of creativity (correlation indices ranged between .14 and .40). Other studies found that the CPS correlated positively to openness to experience, extraversion, and other measures of creative personality (Kaduson & Schaefer, 1991; Wolfradt & Pretz, 2001), creative process and deep learning approach (Freiberg-Hoffmann et al., 2019).

Assessment of real-world visual creativity

Real-world visual creative production was assessed using the Visual Creative Synthesis Task (VCST; Finke et al., 1992; Palmiero et al., 2016). Following the Amabile's (Amabile, 1982) consensual assessment technique, 2 female independent judges (mean age = 21.50; ± .70) evaluated the productions along a 5-points Likert-type scale in terms of a single creativity score (from 1 = very poor creativity to 5 = very high creativity). Ideally, high-creative productions corresponded to high levels of originality and

appropriateness. These two criteria have been widely identified to define creativity (Barron, 1955; Finke et al., 1992; Kaufman & Sternberg, 2010; Runco & Jaeger, 2012; Stein, 1953; Sternberg & Lubart, 1991). Originality depicts the degree of remoteness and uncommonness of productions, whilst appropriateness refers to the relevance and usefulness, exemplifying the ability to produce an outcome that fits the needs and constraints of a given situation (Abraham, 2018). Notably, the judges, two undergraduate psychology students, attended a specific training (20 hours), in which they were instructed on definitions and main theoretical models of creativity. Therefore, the judges were instructed to give holistic ratings of creativity reflecting the two basic attributes, namely originality, defined as the degree of novelty and uncommonness, and appropriateness, defined as the degree of relevance and usefulness. Before the students began to evaluate participants' creative inventions, they were shown examples of creative objects already evaluated by a panel of judges, and they practised evaluating creative productions in terms of creativity. The inter-rater correlation (absolute agreement) for the creativity score was significant (creativity: $\alpha = .87$, $p < .001$). The average ratings of scores provided by the independent judges were used as the final score for inventions produced.

Assessment of Field-Dependence-Independence cognitive style

The Embedded Figure Test (EFT; Witkin et al., 1971; Italian version, Series A, Fogliani et al., 1984) taps the individual predisposition toward FDI. The average response times (RTs) was used to measure of the individual's cognitive style: whereas shorter RTs indicated a higher predisposition towards field independence, a longer RTs indicated a higher predisposition towards field dependence.

Procedure

All participants were individually tested in a quiet room of "Socio-Cognitive Processes in Life Span Laboratory" at the University of L'Aquila. Subjects provided their written informed consent before participating in the experiment and were informed about the purpose of the study and the possibility to drop out at any time. Afterword, they were asked to fill in a short anamnesis questionnaire assessing socio-demographic information, including biographical and educational level, age, gender and general health state. Then, participants completed the experimental protocol, including: 1) Kaufmann Brief Intelligence Test - Second Edition; 2) Alternative Uses Task; 3) Remote Associates Test; 4) Creative Personality Scale; 5) Visual Creative Synthesis Task; and 6) Embedded Figure Test. The order of the measures was randomised across participants to control potential presentation effects. The experiment lasted approximately 50 minutes. After all measures were completed, participants were thanked and debriefed.

Data Analysis

Statistical analyses were performed by IBM SPSS Statistics version 24. In order to determine a more reliable measure of creative potential (Martindale, 1999; Dawson et al., 2011), following Vartanian and colleagues (2007), we computed a Creative Potential Index (CPI), converting each measure of the AUT, RAT, and CPS tests in z-scores and averaging them. After that, to investigate the hypothesis that FDI mediates the association between Gf and creativity, we used the PROCESS macro for SPSS (version 3.5; Hayes, 2017). We run two mediation models using Hayes' Model 4 (Hayes, 2017). The significance of the mediating effects was analysed using 5000 resample of bootstrapped estimates with 95 % bias-corrected confidence intervals-CIs

(Preacher & Hayes, 2008). In the first model (Model A), Gf was the independent variable (x), FDI was the mediator (m), and creative potential was the dependent variable (y). In the second (Model B), we used the same independent and mediator variables, setting real-world visual creative production as the dependent variable. Figure 1 shows the theoretical mediating models advanced in the study.

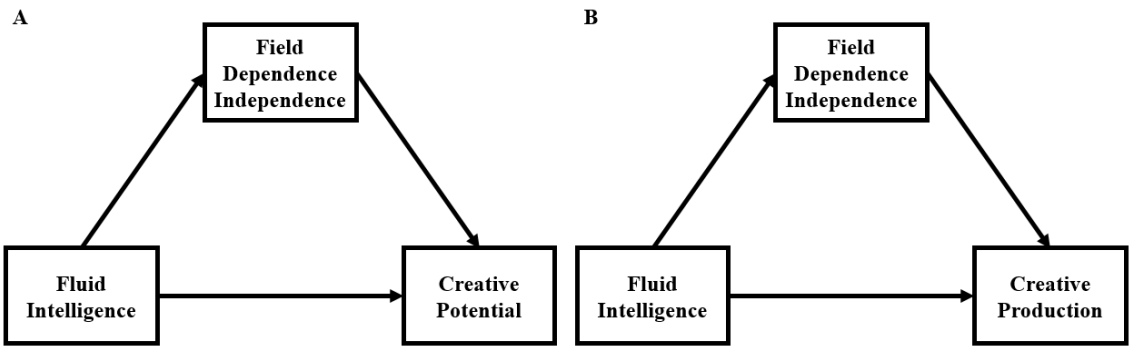

Figure 1. The theoretical mediating model. Both A and B models included Gf as the independent variable and the FDI as the mediator variable. Model A was employed in order to detect the mediating role of FDI in the Gf-creative potential link, whereas Model B was used to describe the mediating role of FDI in the association between Gf and real-world visual creative production.

Besides, in order to verify the hypothesis of the moderating role of cognitive style in the interplay between Gf and creativity, using the PROCESS macro for SPSS (version 3.5; Hayes, 2017), we run two moderation analyses. In the first, Gf was the independent variable (x), creative potential was the dependent variable (y), and FDI was the moderator variable (w). In the second, Gf, FDI, and real-world visual creativity were independent, moderator, and dependent variables, respectively. To avoid multicollinearity, following Preacher and Hayes' (2008), the moderation analyses were performed with 5000 bootstrapped samples. In addition, according to Cohen and colleagues (2003), predictors were mean-centred, and since moderators are continuous variable, their values are computed at -1 SD to +1 SD from the mean (Aiken et al., 1991). The path diagrams (Model 1) used to evaluate the moderating effect of FDI on

both creative potential (Model C) and real-world visual creativity (Model D) are reported in Figure 2.

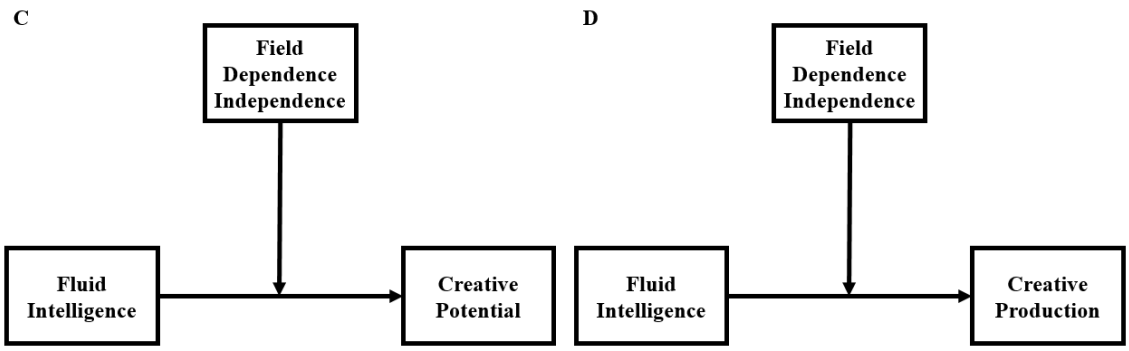

Figure 2. The theoretical moderating model. Both C and D models included Gf as the independent variable and the FDI as the moderator variable. Model C was employed in order to detect the moderating role of FDI in Gf-creative potential link, whereas Model D was used to describe the moderating role of this cognitive style in the association between Gf and real-world visual creative production.

Results

Preliminary analyses revealed that all measures were normally distributed (Kolmogorov-Smirnov Test: Z_{KBIT-2}=.077, ns; Z_{AUT}=.173, ns; Z_{RAT}=.109, ns; Z_{CPS}=.161, ns; Z_{VCST}=.177, ns; Z_{EFT}=.215, ns). Pearson's correlation has been computed using a level of significance $\alpha = .05$ (see Table 1), showing generally weak and moderate (only one) correlations (Akoglu, 2018) among the variables of interest: KBIT-2 was positively correlated with AUT (r=.247; p<.05), RAT (r=.307; p<.01), CPS (r=.215; p<.05), and VCST (r=.316; p<.01), confirming that Gf is related to creative potential and real-world visual creative production (H1); KBIT-2 was negatively related to EFT (r=-.316; p<.01), whereas EFT was negatively correlated with AUT (r=-.421; p<.01), RAT (r=-.394; p<.01), and VCST (r=-.367; p<.01).

		M	*SD*	1	2	3	4	5	6
1.	KBIT-2	105.49	13.03	-					
2.	AUT	10.88	4.86	.24*	-				
3.	RAT	11.73	5.21	.30**	-.01	-			
4.	CPS	9.22	3.15	.21*	.00	.30**	-		
5.	VCST	2.58	.46	.33**	.22*	18	.09	-	
6.	EFT	39.37	13.71	-.31**	-.42**	-.39**	-.22	-.36**	-

Table 1. Means, standard deviations, and inter-correlations amongst all variables. *p < .05 (two tailed); ** p< .01 (two tailed), N = 100. KBIT-2 = Kaufmann Brief Intelligence Test, Second Edition; AUT = Alternative Uses Task; RAT = Remote Associates Test; CPS = Creative Personality Scale; VCST = Visual Creative Synthesis Task; EFT = Embedded Figure Test.

Mediation analyses showed a significant and positive indirect effect of Gf on creative potential and production through FDI for both Model A - with 36 % as percentage of mediation (β = .0071, CI 95% = [.0028, .0122]) and Model B - with 26.6 % as percentage of mediation (β = .0032, CI 95% = [.0010, .0058]). As shown in Table 2, although FDI does not account for the entire interplay between Gf and creativity, revealing two partial mediations, its significance provides evidence to support the hypothesis advanced in H2: FDI mediates the Gf-creativity link in both creative potential (Model A) and real-world visual creative production (Model B).

Finally, moderation analyses showed no moderating effect of FDI not only in the Model C (t = .366; p = .714) but also in the Model D (t = 1.694; p = .093). Thus, the hypothesis that FDI moderates the Gf-creativity link in both creative potential and real-world visual creative production (H3) was rejected.

Model	Path coefficients			
	a (SE)	*b (SE)*	*c (SE)*	*c' (SE)*
Model A	-.331 (.100)**	-.021 (.003)***	.019 (.004)***	.012 (.004)**
Model B	-.331 (.100)**	-.009 (.003)**	.012 (.003)***	.008 (.003)*

Table 2. Path coefficients of the mediation analysis for both creative potential (Model A) and real-world visual creative production (Model B). Paths: a = the effect of Gf on creativity; b = the effect of FDI on creativity; c = the effect of Gf on creativity, when FDI is not included as a mediator; c' = the effect of Gf on creativity, when FDI is included as a mediator. *p < .05; **p < .01; ***p < .001

Discussion

The debate about the intelligence-creativity link has characterised the empirical research for over half a century within the domain of creative potential and real-world visual creative production, providing modest or unclear results. The current study aims to shed further light on the association between Gf and creativity, also considering the role of a third variable, exemplified by FDI.

Correlation analysis revealed that the KBIT-2 was positively related to the AUT, RAT, CPS, and VCST, suggesting that the better the ability to reason, solve problems, and understand the relationships amongst concepts, regardless of previously acquired knowledge, the more creativity. Thus, these findings confirm that Gf is related to creativity in terms of creative potential and real-world visual creative production (H1). These results support previous studies, stressing the hypothesis of an executive account of creativity (Benedek & Jauk, 2018; 2019; Benedek & Fink, 2019). Specifically, following this view, creativity requires not only spontaneous forms of thought - such as insight - and previous individual knowledge but also controlled mental processes, including working memory (e.g., Benedek et al., 2014), cognitive inhibition (e.g., Benedek et al., 2012a; Cheng et al., 2016), cognitive flexibility (e.g., Benedek et al., 2014) as well as Gf (e.g., Benedek et al., 2014; Nusbaum & Silvia, 2011). The involvement of these controlled mental processes becomes crucial in evaluating and approving the solutions amongst the different ideas previously generated (Benedek & Jauk, 2018).

In order to clarify the involvement of FDI in the Gf-creativity link, we performed both mediation and moderation analyses. The mediating analysis showed a significant mediating role of FDI on both individuals' creative potential (Model A) and real-world visual creative production (Model B), confirming the hypothesis that FDI mediates the

Gf-creativity link (H2). Conversely, a non-significant moderation effect in both creative potential (Model C) and real-world visual creative production (Model D) was found, disconfirming the hypothesis that FDI could moderate the association between Gf and creativity (H3). Altogether, these findings suggest that FDI represents a third variable involved in a chain, in which FDI transmits the effect of Gf to creativity (mediation effect), instead of a variable that can facilitate, enhance, or inhibit the effect of Gf on creativity (moderation effect). In this vein, results are in line with Hosseini and colleagues' study (2021), in which the executive thinking style mediated the association between Gf and DT. Mediation analysis showed that higher scores of Gf predicted shorter times in performing the EFT, that is, field independence predisposition (path a). This relationship supports both studies arguing that FDI reflects the efficiency of controlled mental processes, including Gf (e.g., Miyake et al., 2001; Brosnan et al., 2002; Rittschof, 2008) and the research stressing that active reasoning patterns characterising Gf predict the individual predisposition toward field independence, which, in turn, allows to set up goals, sub-goals and executing actions more accurately (Huygelier et al., 2018). This result is also in line with Li and colleagues (2020), who argued that field independents usually display a higher level of cognition, differentiation, and stronger reasoning skills that allow being more accurate in individual performance, including creativity. In addition, the mediation analysis showed that shorter times in performing the EFT predicted higher creative outcomes (path b). This relationship supports studies highlighting that field independence positively affects the individual creative performance in terms of both creative potential (Lei et al., 2020) and creative production (e.g., Miller, 2007).

Yet, research on executive functioning suggested that FDI is modulated by inhibitory control, cognitive flexibility, and working memory (e.g., Miyake et al., 2001):

inhibitory control is crucial in suppressing the surrounding embedded context; cognitive flexibility switches between stimuli; working memory keeps in mind the target stimulus (Huygelier et al., 2018). Therefore, the greater the involvement of the core executive functions, the greater the individual predisposition toward field independence. In addition, executive functions, such as flexibility of DT (Nusbaum & Silvia, 2011) and shifting (Krumm et al., 2018), were found to mediate the association between Gf and creativity. In this direction, although we did not directly measure executive functioning, it is reasonable to assume that FDI (specifically field independence) accounts for the interplay between Gf and creativity through the effects of executive functioning. This hypothesis is intriguing, but it needs to be corroborated by further empirical evidence.

Note that the correlations between the variables of interest ranged from weak to moderate. Specifically, only the correlation between FDI and DT was moderate. Besides, the mediating effect of FDI showed different strengths: FDI explained higher mediation percentage (36 %) when creative potential was the outcome (Model A), whereas it explained a lower mediation percentage (26.6 %) when real-world visual creativity was the outcome (Model B). Two different explanations can be acknowledged for these results: first, given that the creative potential involved three different constructs, namely DT, CT, and creative personality, it might be that the summative effect of FDI on the three variables determining the creative potential yielded a higher mediation percentage; second, given that cognitive styles, including FDI, rely on processing modes of information (e.g., acquisition, organisation and elaboration) across different situations (Kozhevnikov et al., 2005), it is possible that FDI related better to creative processes (DT and CT) and individual predisposition to creativity (creative personality) rather than to the outcome of creativity.

The work presented in this paragraph is under review in the Journal "Thinking Skills and Creativity"

Giancola, M., Palmiero, M., & D'Amico, S. (*under review*). Exploring the interplay between fluid intelligence and creativity: the mediating role of the field dependent-independent cognitive style

3.2.4 Study 4 - Does field-dependent-independent cognitive style mediate the fluid intelligence-divergent thinking link in children and adolescents?

Introduction

As mentioned earlier, previous research stressed that DT requires spontaneous forms of thought and controlled mental processes (Benedek & Jauk, 2018), including executive functioning (e.g., fluid intelligence, working memory, inhibition, and so forth). Although these studies mainly focused on adult samples, they underlined that such high order intellectual abilities could play a pivotal role in creative performance, determining the goal-directedness of creativity. Of course, other individual or extra-cognitive factors, including motivation, personality, emotions, and cognitive styles, could represent the driving force of creativity, sometimes in an unconscious way (e.g., Miller, 2007; Batey et al., 2009). For instance, the individual predisposition in acquiring, organising, and processing information, underpinned by cognitive styles, could play a pivotal role in solving problems which require creative solutions (Kirton, 1976; Zhu & Zhang, 2011). Although these variables (e.g., intelligence and cognitive styles) can represent a necessary condition for creative performance, considered alone, they are not sufficient for creativity at all. Indeed, creativity can be operationalised due to a confluence of multiple individual resources such as cognition, cognitive styles, personality, motivations, emotions, and so forth (e.g., Miller, 2007; Batey et al., 2009). The current research sought to extend the results of Study 3, seeking to verify the mediating role of the field dependent-independent cognitive style (FDI) in the GGf-creativity link in Italian children and adolescents. It should be noted that research on creativity in children and adolescents is growing to date yet limited compared with studies on adulthood (Krumm et al., 2018), and, since the developmental processes in children (Study 4 A) and adolescents (Study 4 B) are different from other age groups, it

is not appropriate to generalise results (van der Zanden et al., 2020). Therefore, the individual underpinnings of creativity in children and adolescents deserve to be more thoroughly investigated. The current research relies on two main hypotheses. 1) Since the involvement of high order intellectual abilities in creative performance is crucial in determining the goal-directedness of creativity during the evaluation of different original ideas (Kleinmintz et al., 2019), the first hypothesis was advanced as follows: H1 - Gf is positively correlated to DT in both children and adolescents (e.g., Benedek et al., 2014). 2) In line with the assumption that creativity requires the contribution of different individual resources such as intelligence and cognitive styles (Sternberg & Lubart, 1991) and taking into account that Gf and FDI are two related constructs (e.g., Duncan, 2013; Huygelier et al., 2018), the second hypothesis was: H2 - FDI mediates the interplay between Gf and DT in both children and adolescents.

Study 4 - Experiment A

Method

Participants and procedure

Thirty-two Italian children aged 6 to 10 years (mean age = 8.06, S.D. = 1.48; 15 F) were enrolled. No children showed primary visual or hearing impairments, neurological conditions, emotional or behavioural problems, learning difficulties, and other neurodevelopmental diseases. The Ethics Committee approved the study in accordance with the Declaration of Helsinki. Signed informed consent was obtained from parents and a verbal assent from each child.

Materials

Assessment of fluid intelligence

The Coloured Progressive Matrices (CPM; Raven & Raven, 2003), one of the most widely used instrument for assessing nonverbal abilities, was employed for evaluating Gf. CPM comprises 36 items divided into three different series (A, Ab, and B) and each series relies on 12 items, in which graphic elements that change from left to right and from top to bottom have a specific system of relations. The number of correct responses were collected.

Assessment of field dependence independence cognitive style

The Embedded Figure Test for children (CEFT; Witkin et al., 1971) was used to tap children predisposition toward field dependence independence. The CEFT highly correlated with the Embedded Figure Test – EFT (see for measure details Study 3 in this dissertation) in a sample of teenagers aged between 11 and 12 years old (r = .85). Similarly to the EFT, the CEFT required to find one of two simple coloured figures (a tent and a house) within a lager coloured complex figure. After a training session, in which children familiarised with the simple figures and had to find them in the complex ones, children were presented 25 testing items. Differently from the EFT, the CEFT has not time limit. The number of correct responses were collected.

Figure 1. A practice trial example of the Children's Embedded Figure Test (CEFT) with the tent target shape (triangle) alongside the complex figure, in which the tent is embedded.

Assessment of divergent thinking

The Alternative Uses Task (AUT; Guilford, 1967) was used to evaluate the children's DT. In the AUT children were requested to find alternative uses of a cardboard box. The following instruction was used: "be fluent and be creative: in this test, you will be asked to find alternative uses for a cardboard box. We ask you to find as many alternative uses as possible and being as creative as possible". Participants were given five minutes to perform at this task and alternative uses were scored with the snapshot method (Silvia et al., 2009) by two undergraduate students, one female and one male (mean age = 30.00 ± 4.24). Students attended a specific training (20 hours), in which they were instructed on the definition of creativity, its main theoretical models, and scoring methods, including the snapshot method. In addition, students were shown examples of alternative uses already evaluated by a panel of judges and they practised evaluating uses of common objects in terms of creativity. Guilford's notion of creative ideas as uncommon, remote, and clever were used as scoring guidelines (Silvia et al., 2009). Responses were evaluated along a 5-points Likert-type scale from 1 "not at all creative" to 5 "very creative". The inter-rater correlation (absolute agreement) was significant for the creativity score of the AUT - Cardboard box (creativity: $\alpha = .91$, $p < .001$). The average

ratings of scores provided by the independent judges were used as the final score for the AUT.

Assessment of covariates

In order to control for potential effects of demographic variables, age and gender were collected by a short demographic questionnaire. Besides, a subtest of the BVL 4-12 (Marini et al., 2015) was also employed to control for semantic fluency effect (the internal consistency of the BVL semantic fluency subtest was α = .81). Therefore, age, gender, and BVL semantic fluency were entered in the mediation model as covariates.

Statistics

Statistical analyses were performed using IBM SPSS Statistics version 24 for Windows. Descriptive statistics and bivariate correlations were computed for preliminarily evaluations, whereas a mediation analysis was computed to examine whether FDI accounted for the covariance between Gf and DT. To investigate this latter hypothesis, the PROCESS macro for SPSS was used (version 3.5; Hayes, 2017), running Hayes' Model 4 (Hayes, 2017), in which Gf was the independent variable (x), FDI was a mediator (m), and DT was the dependent variable (y). Figure 2 shows the theoretical mediating model of the study.

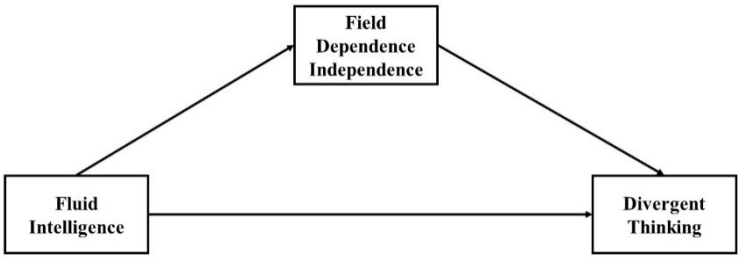

Figure 2. The theoretical mediating model, including Gf as the independent variable, the FDI as a mediator variable, and DT as the dependent variable.

The evaluation of the mediating role of FDI involved examining: the interplay between Gf and FDI (path a), the association between FDI and DT (path b), the effect of Gf on DT, and the impact of Gf on DT, when FDI is included as a mediator (path c'). This mediation analysis controlled for demographic variables such as age and gender as well as for children's semantic fluency. The 95 % CIs must not cross zero to satisfy the criteria of mediation (Preacher & Hayes, 2008). All significance was set to $\alpha = .05$.

Results

Descriptive Statistics and correlational analysis

Data screening revealed that there were neither missing nor outliers in the dataset. The skewness and kurtosis values showed that the data were normally distributed (skewness < |2|; kurtosis < |7|; Hancock et al., 2010). Table 1 shows means, standard deviations, and Pearson's correlational analysis for age, gender, semantic fluency, CPM, CEFT, and AUT.

	Mean	*SD*	1	2	3	4	5	6
1. Age	8.06	1.48	1					
2. Gender	0.53	0.50	-.26	1				
3. SemanticFluency	25.00	5.01	.95**	-.35	1			
4. CPM	26.81	4.78	.71**	-.02	.68**	1		
5. CEFT	21.09	4.09	.45**	.14	.37	.65**	1	
6. AUT	2.37	1.23	.28	-.01	.28	.47**	.60**	1

Table 1. Means, standard deviations, and inter-correlations amongst all variables. ** $p < .01$ (two tailed), N = 32. Gender was dummy coded such that 0 = girls and 1 = boys. CPM = Coloured Progressive Matrices; CEFT = Children Embedded Figure Test; AUT = Alternative Uses Task.

Mediation analysis

As reported in Figure 3, after controlling for age, gender, and semantic fluency, mediation analyses with 5000 bootstrap samples showed that Gf was positively associate with FDI ($b = .48$, $p < .05$), which in turn impacted DT ($b = .19$, $p < .01$).

Notably, the residual direct effect was not significant (b = .04, p > .05), which indicates that FDI fully mediated the association between Gf and DT (indirect effect = .09, 95 % CI = .016 - .188). The total effect was also significant (total effect = .14, 95 % CI = .005 - .284).

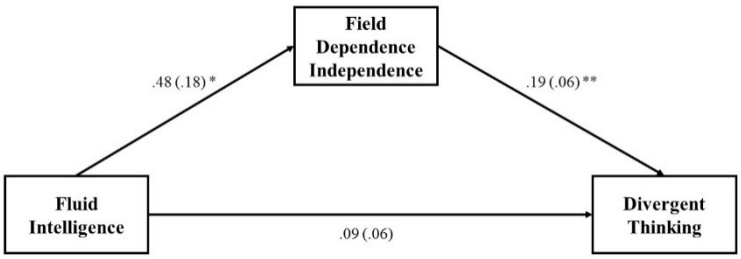

Figure 3. The mediating effect of FDI between Gf and DT. Path values are: the path coefficients (standard errors). * p < .05 ** p < .01.

Study 4 - Experiment B

Method

Participants and procedure

Eighty Italian adolescents (mean age = 16.40; SD = 1.09; range 15-18; 46 F) took part in the current and all participants were high-school students. Before undertaking the experiment, the aim and procedure of the study were explained as well as the option to drop out at any time. For adolescents below the age of 18, parental consent was obtained. All participants were requested to fill in a demographic questionnaire, assessing biographical (age and gender) as well as general health state. Participants completed the experimental protocol individually on voluntary basis. Anonymity was guaranteed and subjects did not receive any reward for participating in the study. The experiment lasted approximately 50 minutes.

Materials

Assessment of fluid intelligence

Raven's Standard Progressive Matrices (RSPM; Raven, 2000) is a Gf multiple-choice test encompassing 60 items divided into 5 series labelled A, B, C, D, and E. It consists of increasingly difficult matrices with little dependency on language abilities. Each series relies on 12 items, in which graphic elements that change from left to right and from top to bottom have a specific system of relations. Subjects were requested to complete the item amongst 6 or 8 possible graphic elements. Completion time for this test was between 20-40 minutes.

Assessment of field dependence independence cognitive style

The Leuven Embedded Figure Test (L-EFT; De Wit et al., 2017) is a computerised measure of FDI and consists of 64 items, in which participants had to find a simple target shape embedded in a complex figure. Subjects were presented one target shape on the top of the computer screen and three complex figures presented next to each other on the bottom of the screen. The target shape and the three complex figures had a size of 3 cm^2 and appeared simultaneously on the screen. All 64 items (1 practice and 63 test items) were presented until the participants provided the correct answer: when the answer was wrong, participants were shown a feedback after which they could provide a new answer until they select the correct complex figure. All items were presented randomly, and the total response times (RTs) was computed. The task required approximately 5-10 minutes.

Assessment of divergent thinking

As in the Experiment A, the Alternative Uses Task (AUT; Guilford, 1967) was used to evaluate the adolescents' DT and we scored the alternative uses with the snapshot method (Silvia et al., 2009). As in the previous experiment, the same two undergraduate students evaluated alternative uses. Responses were evaluated along a 5-points Likert-type scale from 1 "not at all creative" to 5 "very creative". The inter-rater correlation (absolute agreement) was significant for the creativity score of the AUT - Cardboard box (creativity: $\alpha = .94$, $p < .001$). The average ratings of scores provided by the independent judges were used as the final score for each AUT.

Statistics

Descriptive statistics were used to analyse demographic characteristics of the sample, a bivariate correlational analysis was computed for preliminary analysis, whereas the PROCESS macro for SPSS (version 3.5; Hayes, 2017) was used to run the mediation analysis (Model 4; Hayes, 2017), in which Gf was the independent variable (x), FDI was a mediator (m), and DT was the dependent variable (y).

Results

Descriptive Statistics and correlational analysis

Data screening revealed that there were neither missing nor outliers in the dataset. The skewness and kurtosis values showed that the data were normally distributed (skewness $< |2|$; kurtosis $< |7|$; Hancock et al., 2010). Means, standard deviations, and Pearson's correlational analysis for age, gender, RSPM, L-EFT, and AUT are presented in Table 2. The correlational analysis showed that the RSPM was positively correlated with the AUT ($r = .34$; $p < .01$).

		Mean	*SD*	1	2	3	4	5
1.	Age	16.40	1.09	1				
2.	Gender	0.43	0.49	-.17	1			
3.	RSPM	42.37	8.53	-.03	.15	1		
4.	L-EFT	335.19	134.41	-.13	-.07	-.43**	1	
5.	AUT	2.35	1.15	.07	.29**	.34**	-.67**	1

Table 2. Means, standard deviation, and inter-correlations amongst all variables. ** p < .01 (two tailed), N = 80. Gender was dummy coded such that 0 = girls and 1 = boys. RSPM = Raven's Standard Progressive Matrices; L-EFT = Leuven Embedded Figure Test; AUT = Alternative Uses Task.

Mediation analysis

After controlling for age and gender, mediation analyses with 5000 bootstrap samples, Gf was negatively associate with FDI (b = -6.888, p < .001), which in turn impacted DT (b = -.005, p < .001). Notably, the residual direct effect was not significant (b = .004, p > .05), which indicates that FDI fully mediated the association between Gf and DT (indirect effect = .037, 95 % CI = .017 - .059). The total effect was significant (total effect = .041, 95 % CI = .013 - .069)

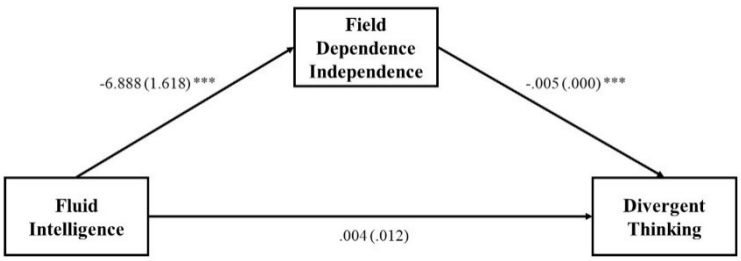

Figure 4. The mediating effect of FDI in the association between Gf and DT. Path values are the path coefficients (standard errors). *** p < .001.

Discussion

The current research focused on cognition, operationalised by Gf, individual predispositions underpinned by FDI, and divergent production in both children and adolescents.

Correlational analysis showed that the Gf was positively related to the AUT in both children and adolescents, suggesting that the better the ability to reason and solve problems independently of previous and acquired knowledge, the more individual DT. This result confirms the H1 and is in line with previous studies, stressing the positive association between intelligence and creativity as well as the role of goal-directedness in individual creative performance. Following these perspectives, creativity requires spontaneous forms of thought, contributing to the quirkiness of ideas and controlled mental processes such as executive functions, which are needed to evaluate ideas in terms of future usability and functionality (Benedek et al., 2014). Benedek and Jauk (2018) stated that when people are asked to find alternative uses of common objects (e.g., a car tire), they have a well-defined goal, which needs to be divided into sub-goals by specific controlled strategies. Such sub-goals (e.g., identify relevant object features) bring people to generate different candidate solutions (e.g., the lamp is round and therefore a car tire could be used as a lamp), which need to be processed and evaluated in terms of different constraints imposed by the task goal (e.g., generate an alternative use which meets the criteria of uncommonness, remoteness, and cleverness). Therefore, better evaluation skills underpinned by controlled mental processes could play a pivotal role in identifying high potential ideas worth investing for their realisation (Sternberg & Lubart, 1991). Correlation analysis corroborates this view, as claimed by the creative cognition theory (e.g., Finke et al., 1992) and suggested by recent neuroscientific research (e.g., Beaty et al., 2016). Notably, this study shed also further light on the relationship between the individual predisposition toward FDI and DT (Zhang, 2017). The correlational analysis confirmed that the more the individual predisposition toward field independence, the more the ability to produce uncommon, remote, and clever ideas.

The second goal of the current research was to shed further light on the joint impact of cognitive foundations, operationalised by Gf, and individual differences, underpinned by FDI in DT considering both children and adolescents. At this aim, in Experiment A and B, a model in which FDI mediated the interplay between Gf and DT was advanced. Mediation analysis revealed that FDI mediated the Gf-DT link confirmed the H2. Overall, results contributed to exploring the multifaceted nature of creativity from a person-centred perspective, emphasising that creativity is deeply rooted in internal and individual factors that belong to the realm of intelligence and cognitive styles in the current study. Specifically, from this perspective, DT represents an emergent entity resulting from a complex network of interconnected and interdependent agents such as Gf and FDI. Therefore, creativity can be operationalised as more than the simple sum of the single effects of each internal resource (Zhang & Sternberg, 2011). In line with the Investment Theory of Creativity (Sternberg and Lubart, 1991), creative performance results from a confluence of individual elements or resources (e.g., intelligence and cognitive style). Considering this complex and dynamic model, and the positive coefficient of the indirect effect, it is reasonable to assume that goal-directedness, underpinned by Gf, involves better skills to perceive, acquire, manage environmental information as well as better abilities to use knowledge, characterising field independence, which in turn increase the chance to generate creative ideas. In addition, the role of field independence in the mediation model is in line with Giancola and colleagues' study (2021), in which low levels of agreeableness moderated the interplay between planning (one of the main components of the Higher-Order Executive Functions along with Gf) and creativity. Indeed, like highly agreeable people, field dependents are inclined to be contextual and socially oriented and influenced by social pressures (Martinsen, 1997). This individual predisposition brings to conform to others'

opinions, impairing the disposition to think or act creatively (Amabile & Prat, 2016). By contrast, like low agreeable people, field independents being less affected by contextual pressure, express more spontaneously their own creative ideas, even if such ideas are far from what is usually considered familiar or traditional, that is, ideas that could determine possible tensions and impair the relationships with others (Giancola et al., 2021).

In conclusion, this study analysed the mediating role of FDI in the association between intelligence and individual divergent production, highlighting that the research topic deserves further investigation and offers new research directions. First, it would be interesting to the extent these results to non-verbal domains of DT, such as visual (e.g., Palmiero et al., 2020), musical (Palmiero et al., 2020), motor (e.g., Palmiero et al., 2019) and so forth. Second, DT represents only a portion of creative process, which concerns the way people solve a problem. Future research should also investigate other components, including convergent thinking. In addition, FDI is sensitive to social elements or contexts such as the expected evaluation or evaluative pressure (Miller, 2007). Thus, although it was beyond the scope of this study, it cannot be ruled out that some of these variables (e.g., openness to experience, intrinsic motivation or positive emotions) might play a role in the interplay between Gf, FDI, and DT. Therefore, future investigations should consider them when examining the mediating role of FDI in the Gf-creativity link. Finally, results increase the knowledge about the interplay between Gf and creativity, showing that amongst different individual resources, cognitive styles are needed when people have to solve problems implying creativity.

The works presented in this paragraph are in progress.

3.3 Disentangling the role of cognitive processes and personality in creative production in youth

In the following paragraphs the impact of cognitive processes - underpinned by the ability to plan - and personality traits on creativity has been acknowledged. Specifically, the Study 6 (see paragraph 3.3.1) evaluates the moderating role of Big Five on the association between planning and the real-world creative production. In turn, the Study 7 (see paragraph 3.3.1) addresses the impact of Trait Emotional Intelligence on real-world creativity through the effect of both divergent and convergent thinking.

3.3.1 Study 5 - The contribution of planning to real-world creativity: The moderating role of agreeableness

Introduction

Although the evaluation of individual performance in creative thinking has unquestionably dominated the creativity research, characterising the process-oriented approach (e.g., Lin & Lien, 2013), attention has been also paid to the individual differences in making ideas embodied into a tangible form within real-world contexts (e.g., Bhattacharya & Petsche, 2005; Palmiero et al., 2016; Verstijnen et al., 1998). Such a perspective is known as the product-oriented approach (e.g., Kaufman & Sternberg, 2010; Sternberg & Lubart, 1991), by which creativity is conceived as the ability to produce original and appropriate outcomes (e.g., Mumford, 2003).

Notably, creativity has been analysed from different perspectives (e.g., Damian & Simonton, 2015), stressing the involvement of cognitive (e.g., fluid and crystallised intelligence), extra-cognitive (e.g., socio-cultural differences, individual beliefs and emotions) and environmental variables. According to the Investment Theory of Creativity (ITC; Sternberg & Lubart, 1991) a blend of cognitive (e.g., intelligence,

knowledge, intellectual style), affective-conative (e.g., personality and motivation) and environmental resources is needed to generate relevant creative works. Whereas cognitive resources are responsible for generating creative thoughts, explaining how creativity is materialised, personality addresses the extent to which cognitive resources are used to generate novel ideas (Shi et al., 2016). Considering that a single resource could lead people to modest levels of creative performance (Sternberg, 2012), in this study, the focus was on the joint effect of cognition (planning) and personality traits (Big Five) on real-world creativity. Creativity requires not only the Core Executive Functions (CEFs - Benedek et al., 2014; De Dreu et al., 2012; Zabelina et al., 2012), but also mental simulations of possible future actions (e.g., Matheson & Kenett, 2020), characterising the ability to plan (Mumford et al., 2001), one of the High Order Executive Functions (HOEFs - Diamond, 2013). In addition, creativity is related to personality attributes, including, for instance, willingness to overcome obstacles, to take sensible risks, to tolerate ambiguity (Sternberg & Lubart, 1991; 1995), as well as more specific traits such as the Big Five dimensions (e.g., Feist,1998; Silvia et al., 2011). This led to hypothesise the moderating role of personality traits in the association between planning and real-world creativity.

Executive Functions and creativity: the role of planning

Creativity requires not only periods of incubation in which spontaneous processes are involved (e.g., insights) but also a set of controlled mental processes (Benedek & Jauk, 2019). According to Benedek and Jauk (2018) the interplay between controlled mental processes and creativity could be observed at the level of EFs. Although different theoretical models of EFs can be acknowledged in the literature (e.g., Barkley, 1994), there are three main Core Executive Functions (CEFs), encompassing working memory,

inhibitory control, and cognitive flexibility (Huizinga et al., 2006; Miyake et al., 2000). According to Diamond's (2013) hierarchical framework, whereas inhibitory control and working memory inhibit people's previous perspectives and load a new one, making possible cognitive flexibility (Diamond, 2013; Diamond & Ling, 2019), each of these CEFs are considered a necessary component for the Higher-Order Executive Functions (HOEFs) (Diamond, 2013) made up of fluid intelligence (Gf) – including reasoning and problem-solving - and planning.

Creativity has been found related to working memory (e.g., De Dreu et al., 2012), cognitive inhibition (e.g., Zabelina et al., 2012), cognitive flexibility (e.g., Pan & Yu, 2016), Gf (e.g., Nusbaum & Silvia, 2011), and planning (e.g., Osburn & Mumford, 2006), which is the focus of the current research. The ability to plan has been conceptualised from different perspective, which however stressed the pivotal role of mental simulations of purposeful and future actions within the planning process (Mumford et al., 2001). Such mental simulations represents a distinctive trait of human beings, affecting a multitude of everyday life activities (e.g., Eichmann et al., 2019), including creative performance (e.g., Osburn & Mumford, 2006). Following this perspective, creativity can be considered not only as the product of simulated ideas, alternatives, and solutions (Matheson & Kenett, 2020) but also as the result of specific planned activities aimed at creating new factual works (e.g., an artwork, a tool). Thus, given that real-world creative production can be pursued through mental simulations of a possible set of future actions, we specifically focused on planning.

Evidence about the planning-creativity link is scattered and incomplete to date in terms of both the process and the product-oriented approaches. Regarding the process-oriented approach, planning was invoked as a key element in divergent production. Fluency and originality scores of DT were closely related to two critical planning skills, such as

penetration (identification of critical causes, restrictions, resources, and contingencies) and forecasting by three different mechanisms: a) promoting idea refinement; b) promoting opportunistic exploitation of emergent opportunities; and c) stimulating the generation of new ideas and approaches in an attempt to overcome anticipated problems (Osburn & Mumford, 2006). In addition, specific training on planning could positively affect the solution of creative problems (e.g., Marta et al., 2005) as well as the quality, originality and elegance of ideas generated (Caughron & Mumford, 2008).

Surprisingly, regarding the product-oriented approach, the role of planning in real-world creative production has been studied mainly in narrative and storytelling. Riedl and Young (2006) defined the ability to plan as a "technology for story generation", which allows finding a good plot model and a causal coherence of characters in terms of actions and believability. Although these findings defined a relevant contribution to the role of planning in real-world creativity, they represent only a piece of the puzzle, which needs further investigations.

Personality and creativity

According to Feist (1998) personality and creativity share the concept of uniqueness since creativity is closely tied to the exclusivity of ideas, whereas personality traits make people different from each other. Although different models of personality have been associated with creativity, the Big Five or Five-Factor Model (FFM; McCrae & Costa, 1987) - made up of five different personality dimensions, including openness to experience, extraversion, neuroticism, conscientiousness, and agreeableness - has gained increasing popularity, showing significant empirical evidence (Batey & Furnham, 2006). Whereas openness to experience and extraversion seem to represent two strong predictors of creativity, allowing people to be more interested in

“quirkiness” (Furnham & Bachtiar, 2008), research on neuroticism, conscientiousness, and agreeableness is unclear. Openness to experience refers to an individual’s predisposition toward open-mindedness, intellectual curiosity, aesthetics, imagination, and originality (Feist, 1998). Therefore, it is not surprising that this personality trait is widely considered the “cardinal characteristic” of creativity (Kerr & McKay, 2013), including DT, everyday creativity, creative achievement, and creative self-concepts (Silvia et al., 2009). Extraversion reflects the tendency to be energetic, active, ambitious, and assertive (Feist, 1998) enhancing the individual disposition to creativity (Baas et al., 2008; Sung & Choi, 2009), in terms of everyday creativity, creative achievement, self-rated creativity and art judgment. Neuroticism represents a generalised predisposition to emotional instability, which brings people to be anxious, insecure and fearful (Goldberg, 1990), avoiding situations where the risk of failure is very high. Although some researches described a negative relation between neuroticism and creativity, stressing that creativity needs to assume the risk of going beyond the conventional and socially accepted by having calm, emotional stability and self-confidence (Sung & Choi, 2009), other studies found non-significant relationships (e.g., Berenbaum & Fujita, 1994). In turn, conscientiousness corresponds to the individual predisposition to work hard and persistently achieve the goal (Goldberg, 1993). Although some studies suggested that conscientiousness seems to negatively affect creativity since the impulse control and compliance with the norms could interfere with the free-flowing idea generation (e.g., Raja & Johns, 2010), other studies found positive (e.g., Chen, 2016) or insignificant (e.g., King et al., 1996) relationships. Finally, agreeableness captures the interpersonal side of creativity (Silvia et al., 2011). People with high agreeableness are usually affiliative, cooperative, supportive, and warm (Feist, 1998), whereas people with low agreeableness tend to be less sympathetic,

empathic, altruistic, compliant and less likely to solve or avoid conflicts with others (Baer et al., 2008). Markers of low agreeableness such as hostility and arrogance were found to predict creative eminence (Feist, 1993). Moreover, it has been found that hostility predicted high creative achievement (Feist, 1998) in scientist and artists and that artists showed low agreeableness than the general population (e.g., Burch et al., 2006). Conversely, positive interpersonal traits such as honesty, likeability, and humour predicted creative achievements (Feist & Barron, 2003). Positive relationships were also found in everyday creative activities (e.g., Chen, 2016) and divergent production (e.g., Silvia et al., 2008). Finally, non-significant results on the association between agreeableness and creativity were found (e.g., Furnham & Bachtiar, 2008; Furnham et al., 2008). Despite these controversial findings, personality is still widely recognised as a critical factor that could spur on or inhibit creativity.

Planning, personality, and creativity

Creativity can be conceptualised not only as a simple sum of each individual resources but also as the multiplicative interaction amongst them (Sternberg, 2012). In line with the ITC (Sternberg & Lubart, 1991), there are thresholds for some factors (e.g., planning) below which creativity is not possible regardless of the levels on the other resources; one factor (e.g., personality) can compensate the weakness of another factor (e.g., planning); interactions may occur between high or low levels of factors, giving rise multiplicatively to high or low levels of creativity, respectively. Focusing on the joint effect of individual resources, Jafri and colleagues (2016) found that the interplay between emotional intelligence (EI) and creativity was moderated by the individual's disposition to take personal initiatives, also known as the proactive personality. Such a moderating role of personality was also explored considering the FFM: Ivcevic and

Brackett (2015) found that openness to experience moderated the interplay between EI and the evaluation of creative behaviours. In addition, the HOEFs and FFM interactively predicted creativity. Silvia (2008) found that Gf showed a smaller effect on creativity when personality was used as a covariate. This finding was confirmed by further research, hypothesising the moderating role of FFM on the Gf-creativity link (e.g., Shi et al., 2016; 2017). Shi and colleagues (2017) found that openness to experience plays a moderating role between Gf and DT, confirming the joint effect of one of the main HOEFs sub-components and personality on creativity. Therefore, given that Gf is closely related to creativity, it is reasonable to expect that planning can also be related to creativity, and that this interplay is moderated by personality.

The present study

Using the logic underlying the ITC (Sternberg & Lubart, 1991), the present work was aimed at investigating the joint contribution of planning and FFM dimensions to creative production in real-world contexts. Specifically, the Big Five personality dimensions were considered a moderator variable instead of a mediator, that is, a third variable that could facilitate, enhance or inhibit the effect of the interplay between planning and creativity. The Tower of London was used to assess planning, whereas the Visual Creative Synthesis Task, including preinventive and inventive phases, was used to assess creativity. This latter relies on the Geneplore Model (Finke, et al., 1992), encompassing two stages: the generative phase by which people build up mental representations, also known as preinventive structures, and the explorative phase by which the preinventive structures are interpreted and evaluated in order to generate a final creative invention.

Hypotheses were formulated as follows: H1 - planning ability is positively related to real-world creativity (e.g., Benedek & Jauk, 2019; Osburn & Mumford, 2006); H2 - people more able to plan are more creative when openness to experience is high (e.g., Shi et al., 2016; 2017); H3 - people more able to plan are more creative when extraversion is high (e.g., Furnham & Bachtiar, 2008). Given the lack of consensus on the other personality traits, three unidirectional hypotheses were formulated as follows: H4 - Neuroticism, H5 - conscientiousness, and H6 - agreeableness moderated the association between planning and creativity.

Method

Participants

Eighty-three young adults (mean age = 23.26 ± 3.64) were recruited (41 M; 42 F) on a voluntary basis. All subjects signed the informed consent and filled the anamnesis questionnaire, assessing biographical and educational information, general health state, background or formal achievement in art. From the anamnesis questionnaire, no participant reported psychiatric, neurological disorders, drug and alcohol addictions, and no background or formal achievement in art. The experiment was conducted in a quiet room of the "Socio-Cognitive Processes in Life Span Laboratory" at "The University of L'Aquila" (L'Aquila, Italy). The whole experiment lasted approximately 1 hour. The Local Ethics Committee approved this experiment in accordance with the Declaration of Helsinki.

Materials and Procedure

Assessment of planning

Planning ability was assessed using the Italian version of the Tower of London - 16 (ToL-16; Boccia et al., 2017), which includes 16 problems of increasing difficulty, which are determined by the number of moves allowed. Trials vary from 2 (minimum level of difficulty) to 7 moves (maximum level of difficulty). The apparatus consists of a board (25 x 10 cm) with three vertical pegs of different increasing lengths (6, 12, 18 cm) and three balls (4cm in diameter) of a different colour (red, white, and green). Starting from the same configuration (starting-configuration), participants were asked to reproduce a new configuration (final-configuration) by moving the three balls without violating four main rules:1) the problem had to be solved within a maximum number of moves written on the sheet of the final configuration; 2) the balls could be moved one at a time; 3) the balls cannot be placed outside the board; 4) each peg could hold a specific number of balls, that is, the first peg only one ball, the second two balls, the third three balls. A visual representation of the starting-configuration and the four additional items of the ToL-16 are reported in Figure 1.

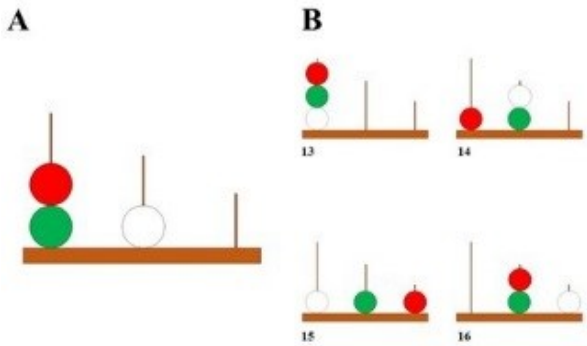

Figure 1. A. The starting-configuration of the Tower of London (ToL-16). B. The additional final configurations of the ToL-16: items 13 and item 14 (6 moves); item 15 and item 16 (7 moves).

The accuracy score was computed as follows: 3 points if the configuration was solved at the first attempt; 2 points at the second attempt; 1 point at the third attempt; 0 points if the problem was not solved. The total accuracy score index resulted from the sum of the score on each trial (maximum score = 48).

Assessment of creative production

Creativity was assessed using the Visual Creative Synthesis Task (VCST; Finke et al., 1992; Palmiero et al., 2016), which requires creating objects belonging to pre-established categories, starting from three triads of visual components (see Figures 2 and 3).

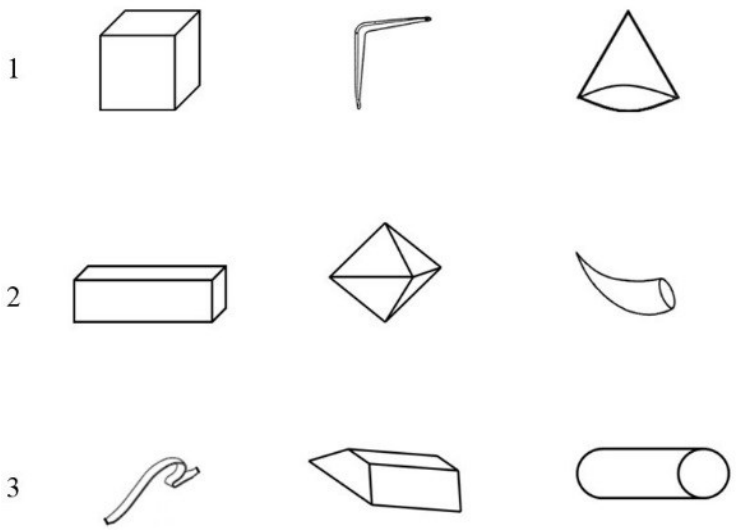

Figure 2. The three triads of components for the Visual Creative Synthesis Task (VCST): 1) cube, bracket, cone (sport goods); 2) parallelepiped, dy-pyramid, horn (furniture); 3) strip, trapezoid, cylinder (weapons).

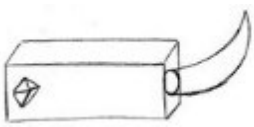

Figure 3. An example of a creative invention based on the triad n.2. The triad is composed of one parallelepiped, one di-pyramid, and one horn. Category: Furniture; Title: Drawer; Description: This

furniture is an exotic drawer set on the wall. The parallelepiped is the drawer, the di-pyramid represents the handle, and the horn has the coat-rock functions.

Following the Amabile's (Amabile, 1982) consensual assessment technique, 3 independent judges, 2 females and 1 male (mean age = 25.00; ± 4.78), evaluated the inventions of the VCST. Productions were evaluated by each judge along a 5-points Likert-type scale in terms of creativity (from 1 = very poor creativity to 5 = very high creativity). Ideally, high-creative productions corresponded to high levels of originality and appropriateness. The inter-rater correlation (absolute agreement) for the creativity score was significant (creativity: $\alpha = .95$, $p < 0.001$). The average ratings of scores provided by the independent judges were used as the final score for inventions produced.

Assessment of personality

The Big Five Questionnaire (BFQ; Caprara et al., 1993) was employed. The test is a self-report measure characterised by 132 items on a Likert scale from 1 to 5 (1 = absolutely false; 5 = absolutely true), exploring the five dimensions of personality according to the FFM: Openness to Experience (BFQ-O) (e.g., "*I am always informed about what is happening in the world*"), Extraversion (BFQ-E) (e.g., "*I seem to be an active and vigorous person*"), Neuroticism (BFQ-N) (e.g., "*It is not often I get to be nervous*"), Conscientiousness (BFQ-C) (e.g., "*I tend to be very thoughtful*"), and Agreeableness (BFQ-A) (e.g., "*I understand when people need my help*"). In the present sample, the Cronbach's α of the five personality dimensions were: BFQ-O ($\alpha = .78$), BFQ-E ($\alpha = .76$), BFQ-N ($\alpha = .89$), BFQ-C ($\alpha = .77$), and BFQ-A ($\alpha = .79$).

Results

Statistical analyses were performed using IBM SPSS Statistics version 24. All measures were normally distributed (Kolmogorov-Smirnov Test: Z_{ToL-16}=.187, ns; Z_{VCST}=.836, ns; Z_{BFQ-O}=.714, ns; Z_{BFQ-E} =.290, ns; Z_{BFQ-N}=.736, ns; Z_{BFQ-C}=.849, ns; Z_{BFQ-A} =.805, ns). In order to verify the common method bias (CMB), we used Harman's single factor test (Podsakoff et al., 2012). The single factor explained 29.26 % of variance, revealing that the present data showed no CBM problems (the criterion for CBM problems is R2 ≥ 50%). Pearson's correlation has been computed using a level of significance α = . 05 (see Table 1).

		Mean	*SD*	1	2	3	4	5	6	7
1.	ToL-16	35.85	4.38	1						
2.	VCST	2.54	.74	.418**	1					
3.	BFQ-O	84.50	10.43	.113	.241*	1				
4.	BFQ-E	77.83	10.08	.026	.021	.405**	1			
5.	BFQ-N	69.42	14.19	.019	-.014	.100	.002	1		
6.	BFQ-C	83.80	10.02	.179	.263*	.504**	.310**	-.035	1	
7.	BFQ-A	77.08	11.02	-.246*	-.338**	.389**	.080	.068	.103	1

Table 1. Means, standard deviation, and inter-correlations amongst all variables. *p < .05 (two tailed); ** p< .01 (two tailed), n=83. ToL-16 = Tower of London; VCST = Visual Creative Synthesis Task; BFQ-O = Openness to Experience; BFQ-E = Extraversion; BFQ-N = Neuroticism; BFQ-C = Conscientiousness; and BFQ-A = Agreeableness.

The correlational analysis showed that ToL-16 was positively correlated with VCST (r=.418; p<.01), confirming the H1. VCST was positively correlated with BFQ-O (r=.241; p<.05), BFQ-C (r=.263; p<.05) and negatively correlated with BFQ-A (r=-338; p<.01).

Moreover, in order to investigate the hypothesis that personality moderated the interplay between planning and creativity, the PROCESS macro for SPSS (version 3.5; Hayes, 2017) was used, running five moderation analyses (Model 1), with planning (ToL-16)

as independent variable (x), creativity (VCST) as dependent variable (y), and Big Five personality dimensions as moderator variables (w). Following Preacher and Hayes (2008), the moderation analyses were performed with 5000 bootstrapped samples, and in order to avoid multicollinearity, following Cohen and colleagues (2003), predictors were mean-centred before being entered in the analyses. According to Aiken and colleagues (1991), since moderators are continuous variable, their values are computed at -1 SD to +1 SD from the mean. See Figure 4.

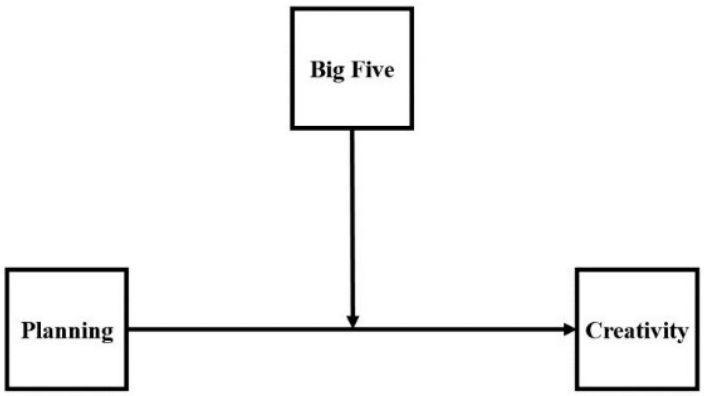

Figure 4. The path diagram (Model 1) detecting the moderating effect of Big Five personality dimensions on the planning-creativity link.

No moderating effect was found considering BFQ-O as a moderator ($t = -.838$; $p = .404$) but the main effect of planning on creativity was significant ($t = 3.847$; $p < .001$). No moderating effect was found considering BFQ-E ($t = -1.536$; $p = .128$) but the main effect of planning on creativity was significant ($t = 4.019$; $p < .001$). No moderating effect was found considering BFQ-N as a moderator ($t = .786$; $p = .434$) but the main effect of planning on creativity was significant ($t = 4.118$; $< .001$). No moderating effect was found considering BFQ-C ($t = -.703$; $p = .484$), whereas the main effect of planning on creativity was significant ($t = 3.834$; $p < .001$). Agreeableness moderated the association between planning and creativity. As reported in Table 2, there were

significant main effects of ToL-16and BFQ-A, and a significant and negative interaction effect of ToL-16 x BFQ-A on VCST.

	B	*SE*	*t*	*p*	LLCI	ULCI
Constant	2.4993	.0703	35.5623	.0000	2.3594	2.6392
ToL-16	.05337	.0164	3.2715	.0016	.0210	.0864
BFQ-A	-.0176	.0065	-2.7100	.0082	-.0305	-.0047
ToL-16 x BFQ-A	-.0040	.0012	-3.2929	.0015	-.0064	-0016

Table 2. Magnitude and statistical significance of planning and agreeableness on creativity.ToL-16 = Tower of London; BFQ-A=Agreeableness.

The moderated regression analysis results were significant [F(3,79) = 12.739, p <.000. The R^2 for the entire model was .32. Analysis showed that planning was positively related to creativity for low (B = .097, SE = .019, t = 4.949, CI 95% = [.058, .137]) and middle (B = .053, SE = .016, t = 3.271, CI 95% = [.021, .086]) level of agreeableness, but not for high agreeableness (B = .009, SE = .022, t = .433, CI 95% = [-.035, .054]) (See Figure 5).

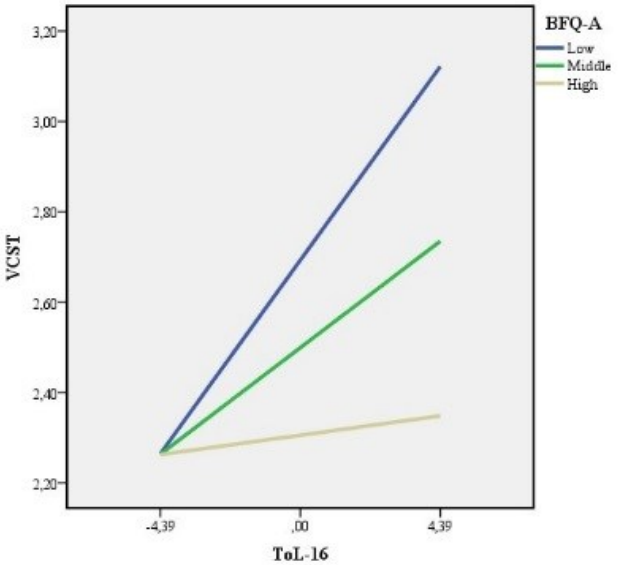

Figure 5. Simple slopes of the interaction of planning and agreeableness on creativity. ToL-16 = Tower of London; VCST = Visual Creative Synthesis Task; BFQ-A=Agreeableness.

Discussion

The current research made two important theoretical contributions. First, the study contributed to explore the interplay between planning and real-world creative production. Correlational analysis showed that ToL-16 was positively related to VCST, suggesting that the better planning abilities, the more creative real-world productions, confirming the H1. As early mentioned, planning could be portrayed as an ability involving mental simulations of future actions, including those that lead to creativity (Mumford et al., 2002). In addition, according to the Geneplore Model, the production of original and appropriate outcomes results from a circular motion involving generative and explorative phases. The generative phase is characterised by a set of mental processes that promote the rise of preinventive structures, such as retrieving existing forms of knowledge from memory and the association among them. Such processes affect the generative phase in terms of speed and automaticity, and no particular goal-directed mental processes are needed (Finke et al., 1992). Indeed, at this level, preinventive structures could only be defined as a set of emergent, spontaneous and undirected ideas (Finke & Slayton, 1988) characterised by different degrees of creative potential (Ward, 2001). By contrast, during the exploration phase, preinventive structures are continuously modified, elaborated, and estimated for their possible limits and future implications. This implies that, while in the generative phase, people tend to diverge, producing as many preinventive structures as possible without any limits in mind, in the explorative phase, goal-directedness is required to anticipate the functionality of such structures (Goel & Pirolli, 1992). In other words, whereas generating preinventive structure needs automatic and fast forms of thought, typically named Type 1 or System 1, their evaluation involves controlled, analytic, and slow form of thought typically labelled Type 2 or System 2 (Benedek & Jauk, 2018). In this vein,

planning could represent a crucial Type 2 mental process, which invokes creativity goal-directedness (Jaarsveld & Lachmann, 2017), determining a goal-oriented simulation of preinventive structures in order to increase the likelihood of generating an outcome that meets both the criteria of originality and appropriateness. This means that people need to generate as many alternatives as possible, which must be carefully estimated and simulated to reach satisfying and meaningful creative products. This assumption is in line with studies using the think-aloud method while participants performed creative tasks. For instance, Palmiero & Piccardi (2020) found that the Creative Mental Synthesis Task originality score was positively predicted by the inventive motor thoughts, underlining that they take part in the goal-directed planning of objects by simulating actions, which positively affect the originality of inventions.

Second, the study contributed to explore the joint effect of cognition and personality dimensions on creativity. At this aim, five moderation analyses were performed in which planning was the independent variable, real-world creativity was the dependent variable and FFM personality dimensions were the moderators. When each personality dimension was entered into the model, results were surprising. Results revealed only the moderating effect of agreeableness, confirming the unidirectional hypothesis advanced in H6. In addition, moderation analysis revealed that with low-middle agreeableness, a stronger relationship between the ability to plan and creativity occurs. This result is consistent with studies stressing the negative relationships between agreeableness and creativity (e.g., Feist, 1993, 1998). Strong desire for interpersonal harmony, coherence, cooperation, and care about social relationships, as well as the tendency to conform to others' opinions and ideas to preserve the status quo and the quality of interpersonal relationships, were found to impair the disposition to think and act creatively (Amabile & Prat, 2016). Indeed, generating and expressing ideas far from what is usually

considered familiar or traditional can often represent a challenge to the status quo that can negatively affect interpersonal relationships, determining possible tensions with others (Sung & Choi, 2009). This result is also in line with research stressing that experiencing anger - a negative emotion closely related to hostility that is a marker of low agreeableness (Clark et al., 1996; Lerner & Keltner, 2001) - induces creative thought when people solve problems (George & Zhou, 2002; Yang & Hung, 2015). Besides, low levels of agreeableness were found to moderate the effect of anger induction on divergent production (Kao & Chiou, 2020). Therefore, a reasonable synthesis for results could be that the individual tendency to be less agreeable brings people to plan their future actions on their own in order to promote the optimal circumstances for acting outside the box.

However, the failure of the moderating effects of the other FFM dimensions advanced in H2-H5 needs an explanation. One should consider the interaction between FFM traits and the mental operations involved in the tasks addressing the planning-creativity link: whereas the ToL-16 is a measure of CT (e.g., Hutten et al., 2019), the VCST requires both DT (non-goal directed processes) to generate preiventive structures and CT (goal-directed processes) to anticipate the functionalities of future inventions (Jaarsveld & Lachmann, 2017). In this vein, given that personality traits can differentially interact with CT or DT with a different weight, the moderating effect of same of them on the relationship between planning and creativity could disappear. Indeed, openness to experience (e.g., Kaufman et al., 2016) and extraversion are mostly related to DT (e.g., Chamorro-Premuzic & Reichenbacher, 2008) than CT. By consequence, these traits would not act as moderators because they mainly load on DT, lacking the convergent component involved in the relationship between planning and creativity. Regarding neuroticism and conscientiousness, the extent to which they load on CT or DT is

unclear. This means that these traits would not act as moderators because they might lack the divergent or convergent components involved in the planning-creativity link. One could also speculate that low-middle agreeableness was a moderator because it loaded on both CT and DT. Of course, although this interpretation is intriguing, it should be taken with caution, needing more empirical evidence. In conclusion, results of the current study could offer further insight into the interactionist perspective whereby real-world creative production results from a complex and mutual interaction between goal-oriented mental processes and extra-cognitive factors such as personality dimensions.

The work presented in this paragraph is published in the following paper:

Giancola, M., Palmiero, M., Piccardi, L., & D'Amico, S. (2021). The contribution of planning to real-world creativity: The moderating role of agreeableness. *Thinking Skills and Creativity*, *41*, 100890.

3.3.2 Study 6 - Divergent but not convergent thinking mediates the trait emotional intelligence-real-world creativity link: an empirical study

Introduction

Since the 50s, Guilford (1950) argued that the research on creativity represented an understudied yet essential research field (Kaufman & Beghetto, 2009), opening to the empirical analysis of the nature of creativity. Overall, two different main approaches can be pursued to study creativity: the process-oriented approach (e.g., Guilford, 1967) and the product-oriented approach (e.g., Kaufman & Sternberg, 2010; Sternberg & Lubart, 1991). Across years both approaches have been analysed through the lens of different cognitive (e.g., intelligence, memory, attention) and extra-cognitive factors (e.g., personality, emotions, thinking styles) (e.g., Kellner & Benedek, 2017; Silvia et al., 2021). In the present study, the extent to which real-world creative production is supported by trait Emotional Intelligence (EI) (Petrides & Furnham, 2001) through the effects of divergent thinking (DT) and convergent thinking (CT) was explored. Previous research has sought to identify the role of emotion in creativity, emphasising the benefits of positive or negative feelings or the activating-deactivating role of specific emotions (e.g., Baas et al., 2008; Pannells & Claxton, 2008). However, rather than recognising some emotions as supportive or damaging for creativity, there is a need to focus on a constellation of emotion-related self-perceptions and dispositions underpinned by trait EI (Hoffmann et al., 2021). This latter belongs to the realm of personality (Petrides & Furnham, 2001), traditionally associated with creativity (Eysenck, 1995; Giancola et al., 2021). The novelty of this study relies on the investigation of real-world creativity as a construct resulting from the interaction amongst interconnected and interdependent agents or individual resources such as trait EI combined with DT and CT (Lambert, 2020).

The association between trait emotional intelligence and creativity

Trait EI is broadly conceptualised as a set of affective predispositions related to emotional self-perceptions and emotional self-efficacy. Although different models of trait EI can be acknowledged in the literature, such as the Bar-On Model (Bar-On, 1997) - in which trait EI represents the individual perception of emotional and social skills which regulate the relationships with the self and others - a more comprehensive model of trait EI has been proposed by Petrides and Furnham (2001). According to this framework, trait EI refers to a constellation of emotion-related self-perceptions and disposition, comprising well-being, self-control, emotionality, and sociability, which lies at the lower levels of personality hierarchies and outside the taxonomy of human cognitive ability (Carroll, 1993; Petrides & Furnham, 2001; Petrides et al., 2007). Therefore, trait EI belongs to the realm of personality (Petrides & Furnham, 2001), including, for instance, empathy and assertiveness (Goleman, 1995). Prior research on the role of trait EI in creative process and creative production revealed unclear or modest results (see for a review, Xu et al., 2019). Regarding the process perspective, Guastello and colleagues (2004) found no significant correlation between the global trait EI and DT measured by the Comprehensive Ability Battery (Hakstian & Cattell, 1976) and the "What if" task (Guastello, 1994). Similarly, no significant relationships were found between the Figural Form of the Torrance Test of Creative Thinking and trait EI (e.g., Sánchez-Ruiz, et al., 2011; 2015). However, other studies showed a significant and positive interplay between trait EI and DT: Takeuchi and colleagues (2015) foiund that trait EI facilitated DT as measured by the S-A Creativity Test (Society_for_Creative_Minds, 1969). Notably, to the knowledge of the current research, no study addressed the impact of trait EI on CT.

Furthermore, unclear results are also shown in terms of creative production: although some studies reveal a positive relationship between trait EI and creativity defined in terms of innovative production concepts (e.g., Tsakalerou, 2016), others show non-significant or weak associations (e.g., Wolfradt et al., 2002). For instance, Wolfrad and colleagues (2002), assessing trait EI by the Emotional Intelligence Scale (Schutte et al., 1998), find that only emotional self-efficacy shows a weak positive correlation with participants' ability to invent creative heading to a comic picture, whilst the other dimensions, namely empathy, utilisation, and perceiving are not significant.

Process- and product-oriented approaches to creativity

The process-oriented approach explores the involvement of mental operations that underlie creativity, such as DT and CT. The former refers to a cognitive ability that allows finding new ideas or solutions to open-ended problems or tasks and is indexed by fluency, flexibility, and originality. The latter refers to a cognitive ability, which allows reaching one single known solution to a closed problem by existing knowledge or traditional methods (Cropley, 2006; Guilford, 1967; Zhu et al., 2019). While DT represents a reliable measure of individual creative potential (Runco & Acar, 2012) and creative achievement (Kim, 2008), CT plays a pivotal role in evaluating the effectiveness of ideas generated by DT(Cropley, 2006), providing integration and synthesis of ideas (for instance, by homospatial thinking) (see Lubart, 2016).

By contrast, the product-oriented approach focuses on producing creative outcomes (e.g., novels, poetry, paints, music, and the like), which can be evaluated across different attributes, the most important ones being originality and appropriateness (e.g., Bhattacharya & Petsche, 2005; Palmiero et al., 2016; Verstijnen et al., 1998). Whereas the concept of originality refers to novelty, uniqueness, and unusualness of inventions,

appropriateness relies on the usefulness, relevance, and fit of such inventions in a specific context (Abraham, 2018).

The process and product-oriented approaches represent two sides of the same coin, given that the production of creative works cannot occur without the contribution of creative processes. In this vein, DT without CT might bring people to the risk of generating only quasi-creativity or pseudo-creativity (Cropley, 2006). For example, looking at the Geneplore Model (Finke et al., 1992), which implements the production of inventions, DT and CT play a different role in the creative cycle based on generative and explorative phases. On the one hand, DT seems to support the generative phase of the creative act, given that the creator is engaged in thinking of possible pre-inventive ideas. On the other hand, CT mainly supports the explorative phase of the creative act, being involved in the selection and evaluation of unstructured ideas previously generated and the attribution of meaning to create an actual invention. In other words, DT is related to the generation of spontaneous, undirected and non-meaningful ideas, whereas CT is related to the refinements of pre-inventive and emergent ideas (Jaarsveld & Lachmann, 2017; Martindale, 2007) in terms of limits, applications, possible improvements, and future implications. However, although the contribution of DT and CT to real-world creativity appears to be established from a theoretical point of view, the research provided scarce and mixed evidence.

Regarding DT, some studies revealed moderate correlations between DT and the creative performance measures (e.g., scientific creativity - Huang and colleagues, 2017), whereas others showed that DT tests are not significantly correlated with creative performance (e.g., design - Brougher and Rantanen, 2009). This might be due to the lack of DT for predictive or concurrent validation of test performance against real-world creativity criteria (Kogan & Pankove, 1974; Stevenson et al., 2019; Zeng et al., 2011).

In addition, evidence about the relationships between CT and the production of creativity is even less consistent. Some studies highlighted that the integration and synthesis of different elements as defined in terms of homospatial thinking supported creativity: when superimposed visual images representing an externalised presentation of the homospatial conception were presented to artists and writers, more artistic and literary creations were produced than when the images were presented separately (e.g., Rothenberg, 1988). In this vein, the ability to synthesise and integrate concepts was also found related to scientific creativity (de Vries & Lubart, 2017). However, other studies found that CT does not relate to real-world creativity, for instance, creative achievement (e.g., Beaty et al., 2014; Zhu et al., 2019).

The present study

The current research aims to explore the interplay between trait EI and creativity, advancing an interactionist approach (e.g., Giancola et al., 2021), in which DT and CT synergistically contribute to generating real-world creative outcomes. A parallel mediation model was hypothesised to explore the role of DT and CT in the relationship between trait EI and actual creativity. Creative outcomes were assessed using the Visual Creativity Synthesis Task (Finke et al., 1992), relying on the logic of the Geneplore Model (Finke et al., 1992), according to which a cyclic motion between generative and explorative phases represents the engine for generating inventions. Creative objects were evaluated in terms of creativity, taking into consideration the notion of creative realism (e.g., Finke, 1995; Kaufman & Sternberg, 2010; Sternberg & Lubart, 1991), emphasising that creative outcomes should be original, novel, inspiring and making sense in actuality (appropriate), tackling real-world issues to satisfy people' wants (Zeng et al., 2011).

Based on previous research findings on the relationships involving trait EI, DT, CT, and real-world creativity, three hypotheses were advanced:

Hypothesis 1 (H1) - trait EI does not directly affect real-world creativity (Hoffman & Russ, 2012; Zenasni & Lubart, 2009; Wolfradt et al., 2002);

Hypothesis 2 (H2) - DT mediates the relationships between trait EI and real-world creativity (e.g., Huang et al., 2017);

Hypothesis 3 (H3) - CT mediates the trait EI-creativity link (Rothenberg, 1988; de Vries & Lubart, 2019).

Method

Participants

The sample consisted of 63 (30 M; 33 F) Italian adults whose mean age was 21.37 years (SD = 1.93; age range: 19-25). Every participant signed the informed consent and filled in the demographic questionnaire on biographical and educational information, health state, and background in art. No participants reported neurological disorders as well as drug and alcohol addiction. Furthermore, none of them had a background in art. All participants were volunteers, and they did not receive any reward for participating in this research. The experiment lasted approximately 45 minutes. The Local Ethics Committee approved this experiment in accordance with the Declaration of Helsinki.

Measures

Trait EI was evaluated using the Trait Emotional Intelligence Questionnaire - Short Version (TEIQue–SF; Cooper & Petrides, 2010; Italian version Di Fabio & Palazzeschi, 2011a,b), which consists of 30 multiple-choice items, divided into four sub-scales: well-being, which reflects a generalised sense of positive feeling and happiness; self-control,

which reflects people degree of controlling and regulating impulses; emotionality, which reflects the ability to perceive and express emotions in order to develop relationships with others; sociability, which reflects the capability to build social relationships in different domains, such as familiar and friend contexts. Items are evaluated along a 7-point Likert scale, ranging from 1 (Completely disagree) to 7 (Completely agree). The administration of this questionnaire required approximately 10 minutes. Besides the four sub-scores, this test gives back also a global trait EI score by summing up items scores and dividing by the total number of items. The internal consistency reliability was as follows: well-being (TEIQue-SF-WB) $\alpha = .75$; self-control (TEIQue-SF-SC) $\alpha = .81$; emotionality (TEIQue-SF-E) $\alpha = .71$; sociability (TEIQue-SF-S) $\alpha = .80$; whole test (TEIQue-SF-TOT) $\alpha = .77$.

To tap DT, we used the Alternative Uses Task (AUT; Torrance 1974; Italian version, Sprini & Tomasello, 1989), in which participants were requested to find as many alternatives uses as possible for carton boxes in a time limit of 10 minutes. According to the technical manual (Sprini & Tomasello, 1989), the following indices were considered: the number of relevant verbal responses (AUT-Fluency); the number of categories listed in the technical manual or opportunely created if not listed, that was suitable to encompass the relevant responses (AUT-Flexibility); the sum of weights of statistically frequent or infrequent responses provided by the reference sample (AUT-Originality); 0 points for responses provided by 5% or more of 500 people; 1 point for responses provided by 2 – 4.99 % of 500 people; 2 points for both responses provided by < 2 % of 500 people and responses not listed in the technical manual. Since the three scores of AUT were highly correlated with each other, following Runco and colleagues (2010), we converted each AUT index in z-scores and then summed to obtain a global DT index, which was used in the mediation analysis. The Remote Associates Test

(RAT; Mednick & Mednick, 1967; Italian version, Salvi et al., 2020) was used to assess CT. The RAT and requires to find a target word (e.g., synthesis) that could be related to three test words (e.g., photo, summary, and book) in order to form a compound word (photosynthesis), a synonymous (synthesis = summary) and a semantic association (book synthesis). During the RAT, participants have to solve thirty RAT triplets in a time limit of 10 minutes, and the total number of correct solutions has been computed.

Real-world creative production is evaluated by the Visual Creative Synthesis Task (VCST; Finke et al., 1992; Palmiero et al., 2016), which requires creating objects belonging to pre-established categories, starting from triads of visual components. The task relies on two main steps: the preinventive and inventive phases. After a practical trial, participants were asked to create three objects. They mentally combine and manipulate the visual components into an abstract structure, one for each triad of components, which could be changed in position, rotation and size but not in its general structure. Participants have 15 seconds to fix and memorise the visual components and 2 minutes to think about the preinventive structure for each triad. After this preinventive phase, participants have to produce a schematic drawing. During the inventive phase, participants were presented with a category name for each triad (furniture, weapon, and sport goods) and were asked to think of their invention. They have 3 minutes to describe the functioning of each invention. After the inventive phase, participants are requested to provide a title of the objects. Following the Amabile's consensual assessment technique (Amabile, 1982), 3 independent judges, two females and one male (mean age = 25.33; ± 4.50) evaluated the productions along a 5-points Likert-type scale in terms of a single creativity score (from 1 = very poor creativity to 5 = very high creativity) which encompassed both the criteria of originality and appropriateness. The judges were three undergraduate psychology students attending a specific training (20 hours) (see

Giancola et al., 2021). The inter-rater correlation (absolute agreement) for the creativity score is significant ($\alpha = .96$, $p < .001$). The average rating of scores, provided by the independent judges, has been used as the final score for inventions produced.

Results

Statistical analyses were performed using IBM SPSS Statistics version 24 for Windows. All data were tested for normality and all measures were normally distributed (Kolmogorov-Smirnov Test: $Z_{TEIQue\text{-}SF\text{-}WB}$ =.061, ns; $Z_{TEIQue\text{-}SF\text{-}SC}$ =.349, ns; $Z_{TEIQue\text{-}SF\text{-}E}$ =.592, ns; $Z_{TEIQue\text{-}SF\text{-}S}$ =.910, ns; $Z_{TEIQue\text{-}SF\text{-}TOT}$ =.952, ns; $Z_{AUT\text{-}Fluency}$ =.180, ns; $Z_{AUT\text{-}Flexibility}$ =.244, ns; $Z_{AUT\text{-}Glob}$ =.422, ns; Z_{RAT} =.324, ns; Z_{VCST} =.718, ns), except for AUT originality: (Kolmogorov-Smirnov Test: $Z_{AUT\text{-}Originality}$ =.044, sig). Correlational analyses were performed using Spearman's Rho. Means, standard deviations, and correlational analysis are shown in Table 1.

		Mean	*SD*	1	2	3	4	5	6	7	8	9	10	11
1.	TEIQue-SF-WB	5.19	1.10	1										
2.	TEIQue-SF-SC	4.30	1.07	.33**	1									
3.	TEIQue-SF-E	5.19	.83	.33**	.36**	1								
4.	TEIQue-SF-S	4.74	.86	.41**	.28*	.52**	1							
5.	TEIQue-SF-TOT	4.92	.72	.69**	.67**	.75**	.68**	1						
6.	AUT-Fluency	11.25	5.26	.58**	.67**	.55**	.51**	.82**	1					
7.	AUT-Flexibility	7.29	2.67	.64**	.66**	.52**	.49**	.81**	.84**	1				
8.	AUT-Originality	10.62	6.79	.36**	.50**	.61**	.53**	.68**	.75**	.74**	1			
9.	AUT-Glob	.00	2.76	.58**	.67**	.61**	.56**	.84**	.93**	.94**	.88**	1		
10.	RAT	8.36	4.44	.18	.11	-.15	-.03	.05	.06	.08	-.05	.02	1	
11.	VCST	2.55	.74	.36**	.47**	.31*	.27*	.50**	.59**	.56**	.61**	.62**	.21	1

Table 1. Means, standard deviation, and inter-correlations amongst all variables. ** $p < .01$ (two tailed) * $p < .05$ (two tailed), N = 63. TEIQue-SF = Trait Emotional Intelligence Questionnaire - Short Version: WB = Well-Being; SC = Self-Control; E = Emotionality; S = Sociability; TOT = Total Score; AUT = Alternative Uses Task; RAT = Remote Associates Test; VCST = Visual Creative Synthesis Task.

In order to investigate the hypotheses that DT and CT mediate the association between trait EI and creative production, we use the trait EI global score[1], the global DT index, the RAT score as CT, and the creativity score as real-world creative index.

The PROCESS macro for SPSS (version 3.5; Hayes, 2017) is used for the mediation analysis. We advance a mediation model (see Figure 1), with trait EI as the independent variable (x), DT and CT as the two mediators (m), real-world creativity as the dependent variable (y), and age and gender as the covariates.

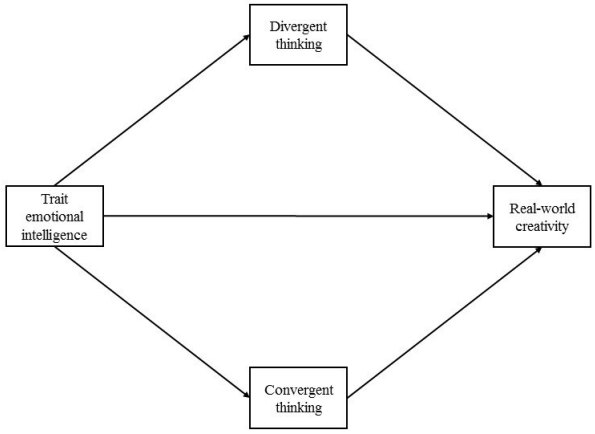

Figure 1. The theoretical mediating model (Hayes' Model 4 with two parallel mediators; Hayes, 2017) used in the current research, including trait EI as the independent variable, DT and CT as mediators, and real-world creative production as the dependent variable.

Mediation analyses have been performed with 5000 bootstrap samples. Bootstrapping is a non-parametric approach that bypasses the problem of non-normality and enables an accurate test of the indirect effect (Bollen & Stine, 1990), mainly in small samples (Preacher & Hayes, 2008). After controlling for age and gender, results (see Figure 2) reveal that trait EI is positively and significantly associated with DT ($B = 3.03$, $p < .001$), which in turn affects real-world creativity ($B = .14$, $p < .01$). In addition, trait EI is not related to CT ($B = .18$, $p = .82$) but the latter is positively and significantly associated with real-world creativity ($B = .03$, $p < .05$). The direct effect is not significant ($B = .06$,

p = .74). To sum up, the mediation analysis reveal that DT fully mediates the trait EI-real-world creativity link (indirect effect = .4223, 95 % CI = .13, .77), whereas the mediating role of CT is not significant (indirect effect = .00, 95 % CI = -.05, .06). Finally, the total effect is significant (total effect = .48. 95 % CI = .26, .70).

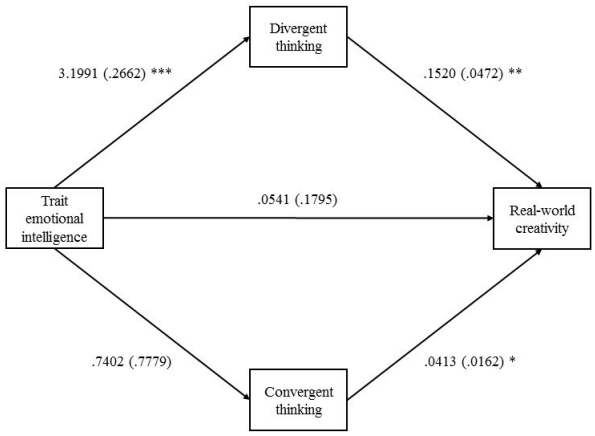

Figure 2. The mediating effect of DT in the association between trait EI and real-world creativity. Path values are the path coefficients (standard errors). Indirect effect = .0311, SE = .0088, 95 % CI = .0138 to .0487. *** p < .001; ** p < .01; * < .05.

Discussion

The current research tested the mediating role of divergent thinking (DT) and convergent thinking (CT) in the relationship between trait EI and real-world creativity. Specifically, the approach adopted in this study led to understanding the contribution of trait EI through two essential components of creativity. Results showed that only DT fully mediated the relationship between trait EI and real-world creativity, whereas CT was only related to creativity. These results support both H1 and H2 but reject H3.

In detail, trait EI does not directly predict creativity, as revealed by previous studies (e.g., Wolfradt et al., 2002; Zenasni & Lubart, 2009), but needs the contribution of DT. According to the Investment Theory of Creativity (Sternberg & Lubart, 1991), creative production represents a construct resulting from a confluence of different agents or interacting individual resources, including cognition (e.g., DT) and personality (e.g.,

trait EI). Whereas cognitive resources are crucial during the generation of creative thoughts, explaining how creativity is materialised, personality is responsible for the extent to which such cognitive resources are used (Shi et al., 2016). Given our results, this means that trait EI enables creativity and manages cognitive resources appropriately when the individual can think divergently. Considering this interactionist perspective and the positive coefficient of the indirect effect, we can assume that well-being, self-control, emotionality, and sociability involves a better ability to think divergently, which in turn increases the likelihood of producing a creative invention. Although this interactionist view fits with the mediating role of DT, the failure of the mediation of CT needs an explanation. In this study, this latter was found to be involved in the creative process as it directly related to real-world creativity but was not supported by trait EI. Overall, individuals characterised by higher EI solve problems in cooperative, beneficial, and positive ways (e.g., Morrison, 2008). In particular, trait EI is related to adaptability, involving flexibility toward changing situations and lifestyles (Petrides & Furnham, 2003), and attention skills, facilitating, guiding, and signalling attention to key matters (Rivers et al., 2012). In addition, high trait EI was found positively associated with irrelevance processing. Individuals with high trait EI use irrelevant information to obtain more associations, which are beneficial to creative thinking (e.g., DT) (Agnoli et al., 2019). These characteristics of trait EI lead to flexible planning and problem solving, developing more alternatives and widening perspectives (Alavi et al., 2019), which CT subsequently evaluates. In this vein, it is likely that trait EI primarily relates to DT, which is also based on flexibility and exploration of alternatives (e.g., Guilford, 1967; Nusbaum & Silvia, 2011; Torrance, 1974), as well as on the flexible management of attentional resources (e.g., Zabelina & Robinson, 2010; Zabelina et al., 2016; Zabelina & Ganis, 2018), rather than to CT, which does not involve variability

(Cropley, 2006) and is based more on the strongly constrained process (Hommel et al., 2011).

Thus, if, on the one hand, the generation or real-world inventions relies on interactions amongst some individual resources, on the other hand, this study opens the issue of whether CT interacts with other individual factors in order to produce creativity in real-world contexts. Indeed, CT is a key element of creativity, involved in selecting, synthesising and evaluating ideas. Since CT was not found to be related to trait EI, one can speculate that CT supports creativity acting by an independent path when such a personality factor is involved. The extent to which CT operates independently of other variables needs further exploration. In conclusion, albeit this study represents only a little piece of a complex puzzle, it contributes to shedding further light on the knowledge about the multidimensional nature of real-world creativity, a field of research that deserves further investigation.

The work presented in this paragraph is under review in the Journal "Creativity Research Journal"

Giancola, M., Palmiero, M., & D'Amico, S. (*under review*). Divergent but not convergent thinking mediates the trait emotional intelligence-real-world creativity link: An empirical study

3.4 A new perspective for divergent thinking

Strong evidence suggested that human activities, like consumption of natural resources, food production, and fossil fuel combustion, are the main reasons for several environmental issues, including, among many others, acceleration of climate change, loss of biodiversity, and environmental pollution. It is widely recognised that this environmental degradation has a negative impact on mental and physical health, depicting a troubling scenario for actual and forthcoming generations. Tackling the environmental crisis requires understanding the individual cognitive and extra-cognitive antecedents of people's practices that dispose them to concern for and take actions in protecting the natural environment and in mitigating its degradation, such as choosing public transport or using green vehicles (e.g., bike, electric car, and the like), reducing meat consumption, recycling, composting, and so forth. Altogether these actions are labelled as pro-environmental behaviours (PEB). The study in the following paragraph (Study 7) focuses on divergent thinking as key driver for solving current sustainable development challenges. Specifically, in this study adolescents' divergent production was described as a mediator between personality (Big Five) and the disposition toward eco-friendly practices such as reduction, reuse, and recycling.

3.4.1 Study 7 - Does late adolescents' divergent thinking mediate the association between big five and eco-friendly behaviours? A path analysis study

Introduction

Sustainability, understood as the development meeting the needs of the present and forthcoming generations (Kuhlman & Farrington, 2010), represents a complex and wicked challenge that requires addressing interconnected and often diverging social, financial, and environmental concerns (Mitchell & Walinga, 2017). In terms of environmental concerns, consensus reports revealed troubling deterioration of Earth's ecosystems by the end of the 21st century (Mikhaylov et al., 2020). This environmental crisis represents a growing threat to humanity, and the main agent of such a threat is paradoxically human behaviours (Boeve-de Pauw et al., 2011). Instances of environmental issues are well known (e.g., loss of biodiversity and natural disasters), and their resolution is a matter of a heated debate amongst institutions, media and ultimately researchers. A groundswell of recent academic research asserted that tackling the environmental problem requires widespread behavioural change at different levels, including not only societies and organisations but also individuals (Bleidorn et al., 2021). Specifically, the contribution of people in mitigating troubling today ecological scenario relies on engaging in a set of deliberate, effective, and anticipatory actions (Pro-Environmental Behaviour - PEB), focused on caring for the natural environment or at least not harming it (e.g., energy conservation, reducing car use, recycling, composting, and so forth).

Researchers have a general agreement in recognising personality as one of the main determinants of environmental concern and PEB (e.g., Brick & Lewis, 2016). Specifically, previous research on adult samples revealed that Openness, one of the five orthogonal dimensions described in the Big Five – Five-Factor Model (FFM; Goldberg,

1990; McCrae & John, 1992), is closely related to caring for the natural environment. Investigating such predictors in adolescence is essential for addressing the planet's environmental crisis. Indeed, adolescents will deal with the environmental consequences and actively pursue positive change for the environment (Poškus, 2020a). They also show a quicker engagement in novel trends as well as higher levels of curiosity and environmental awareness than adults (Gamba & Oskamp, 1994), representing a potentially powerful force for positive environmental changes (Poškus, 2020a). In addition, late adolescence, the developmental stage ranging from 18-22 years (Silva et al., 2017), represents a turning point in terms of civic engagement, responsibility toward the community, moral reasoning, and future orientation (Zarrett & Eccles, 2006) that are crucial for making decisions and engaging in efforts for long-term goals that community needs (for instance, ensuring the ecological sustainability of the planet for actual and forthcoming generations). In this vein, the current research aims to evaluate, in late adolescents, the relationships between the five orthogonal dimensions of the FFM and PEB, also detecting the involvement of a third variable, Divergent Thinking (DT). We specifically focused on the latter, considering that it represents a beneficial factor for breaking fixed thinking and promoting a variety of innovative and useful methods to solve problems that require countering long-distance consequences and imagining long-term goals (e.g., the environmental crisis) (Wang et al., 2021).

Therefore, in the current study, we hypothesised that DT could be a crucial cognitive ability involved in the association between people's disposition (personality) and actions (PEB). In order to test this hypothesis, we performed a path analysis, advancing a mediation model, in which the FFM traits were the focal predictors, PEB was the outcome, and DT played the role of the mediator.

Personality and Pro-Environmental Behaviour

Although the environmental crisis depicts a universal problem, there are huge variations amongst people's willingness to engage in PEB and such differences can be appreciated at the level of personality. Most personality research focuses on the FFM, which includes Openness, Extraversion, Neuroticism/Emotional Stability, Conscientiousness, and Agreeableness. These dimensions account for all differences in human personality and individual differences (e.g., manners of thought, emotions, behaviours), and the variance in such dimensions is almost exclusively attributable to genetic factors (Veselka et al., 2012). Opened people usually show features like originality, imagination, and curiosity toward knowledge; extraverted individuals are friendly, outgoing, and talkative; neurotics are usually insecure and worrisome; conscientious people are energic, hard-working, and ambitious, this trait involving orderliness, dutifulness and deliberation; finally, agreeable individuals are cooperative, sympathetic and trust others (Desrochers et al., 2019).

Research on the relationships between personality and PEB in adolescence is rare. For instance, Poškus and Žukauskienė (2017), in a sample of 612 adolescents (aged 13-17 years old), found that only Extraversion and Agreeableness were positively associated with perceived behavioural control of recycling behaviour. In another work, Poskus (2020b), clustering different personality traits, found that adolescents with high scores in Extraversion, Agreeableness, Conscientiousness, Openness, and low scores in Neuroticism show high intentions in different pro-ecologic practices, including recycling, electricity conservation, and water conservation.

Note that there is a consistent body of research examining the association between personality and environmentalism in adulthood (e.g., Ashton & Lee, 2007; Brick & Lewis, 2016; Hilbig et al., 2013). Prior studies have shown that pro-environmental

attitudes and behaviours are robustly associated with Openness (e.g., Brick & Lewis, 2016; Hilbig et al., 2013; Puech et al., 2019). Specifically, the aesthetic appreciation of nature and intellectual curiosity, usually shown by highly open people, bring them highly motivated to understand humanity's impact on nature and preserve the environment (Brick & Lewis, 2016; Hirsh & Dolderman, 2007). Regarding Agreeableness, Conscientiousness, Emotional Stability, and Extraversion, results are mixed. Some studies suggested positive relationships with pro-ecological practices, including emission-reduction, electricity conservation, and recycling; however, other studies found negative or non-significant results (Brick & Lewis, 2016; Hilbig et al., 2013; Milfont & Sibley, 2012; Swami et al., 2011).

Big Five and Divergent Thinking

FFM dimensions are also related to DT, an index of creative potential (Runco & Acar, 2012). DT involves generating creative products, either in tangible or intangible form. Namely, it is used to find a variety of solutions to problems that do not require standard and unique solutions but can be solved using different and novel ideas (Guilford, 1967) by recombining multiple unrelated concepts (Nijstad et al. 2010). This means that DT requires individuals to disengage from prevailing modes of thought (Benedek et al., 2014; Japardi et al., 2018). Amongst others, adolescence also affects the development of creative identity (Barbot & Heuser, 2017), with implications for DT. According to Kleibeuker et al. (2016), visual and verbal DT develop following different trajectories during adolescence. For instance, the quantity parameters (e.g., fluency) of verbal DT is already developed in adolescence, whereas the quality (e.g., originality) continues to develop; by contrast, visual DT has developed already in middle adolescence.

Studies on the relationships between the FFM traits and DT in adolescence are scarce. Erbas and Bas (2015) showed that in 15 years old adolescents' Openness to experience and Conscientiousness significantly predicted mathematical DT, whereas Extraversion, Agreeableness, and Neuroticism did not. Interestingly, Cotter et al. (2020) showed that adolescents (13-18 years old) with lower levels of originality and fluency had also lower levels of intellect and imagination, two facets of Openness to experience; in addition, adolescents with the 'low' originality-fluency scores also showed lower levels of anxiety, vulnerability, and sympathy. In another study involving late adolescents (mostly 18-19 years old subjects), Openness and Conscientiousness predicted DT, positively and negatively, respectively, whereas Agreeableness showed a smaller effect size on DT; then, Extraversion and Neuroticism only explained a little variance of DT (Silvia et al., 2008).

Notably, in adults, mainly Openness (Puryear et al., 2017) was found to predict DT positively (e.g., Baas et al., 2008; Käckenmaster et al., 2019; Weiss et al., 2021). Extraversion, Conscientiousness, and Agreeableness were also found to predict DT (e.g., Furnham & Bachtiar, 2008; Silvia et al., 2008; 2009), although many studies showed that these traits are mostly related to the quantity rather than to the quality of ideas (for a systematic review see also Puryear et al., 2017), or are even unrelated to DT (Chamorro-Premuzic, & Furnham, 2005; King et al., 1996; McCrae, 1987; Reiter-Palmon et al., 2009). Conscientiousness and Agreeableness were also found negatively to predict DT (Harada, 2021; Puryear et al., 2017; Silvia et al., 2015). Finally, Neuroticism was found negatively (see Puryear et al., 2017) or not associated with DT (see Pickering et al., 2016; McCrae, 1987), for instance, under threat of evaluation (Chamorro-Premuzic, & Reichenbacher, 2008).

Divergent Thinking and Pro-Environmental Behaviour

The United Nations 2030 Agenda for Sustainable Development explicitly refers to creativity as a key driver for solving current sustainable development challenges (Awan et al., 2019). In terms of pro-environmental issues, the role of DT and ultimately creativity was mainly analysed in the field of strategic environmental management, and specifically, in research addressing the role of developing new ideas about green innovation, services, processes, or practices that are judged to be original, novel, and useful for firms and organisations to obtain competitive advantages in terms manufacturing wastes, industrial pollution, and the like (Porter & Van der Linde, 1995; for a review see Awan et al., 2019). In this vein, Fraijo and colleagues (2010) assured that creativity represents an essential component of people's pro-environmental competency since it allows finding novel solutions to changing problems in the socio-physical milieu. This means that DT, along with convergent thinking and practical knowledge, provides a path for organisations to get more profound breakthrough ideas for sustainability (Awan et al., 2019; Mitchell & Walinga, 2017).

More specifically, DT was conceptualised as a necessary individual resource for tackling environmental problems and creating a sustainable future (Cheng, 2019; Sandri, 2013; Stables, 2009). For example, Cheng (2019) showed that training individuals in DT and critical analysis around an ordinary item (e.g., toy) could be useful to develop five attributes related to pro-environmental sustainability (ES) creativity: 1) sensitivity and problem finding; 2) creative problem-solving; 3) self-creating lifestyle; 4) creative and futures thinking for societal ES problems; 5) re-definition of creativity, ES and their relationship. This study highlighted that education in creative ES could promote not only individual competencies but also intrinsic motivation, which, in turn, can enhance even long-term ES behaviours. Sierra-Pérez et al. (2016) showed that DT, along with

convergent thinking, is involved in eco-ideation related to creating new products and solutions, for instance, using cork. Corral-Verdugo and colleagues (2015), addressing the link existing between individual universal virtues and sustainable behaviours (e.g., pro-environmental practices), found that the ability to solve problems through divergent solutions, open-mindedness, and curiosity toward knowledge is essential in fostering environmental sustainability.

The goal of the current study

The current research was designed to test the relationships between FFM and PEB via DT in late adolescence. Specifically, this study tested a model in which personality, cognition, and actions are involved in a causal chain, in which FFM personality traits affects people's ability to generate as many creative (uncommon, remote, and clever) ideas as possible, which, in turn, predicts how individuals behave in terms of ecologically friendly actions. Therefore, a multiple parallel mediation model was carried out, in which the FFM traits were the focal predictors, PEB was the outcome, whereas the number of appropriate ideas (DT fluency) and the quality of responses evaluated in terms of uncommonness, remoteness, and cleverness (DT creativity) were the mediators. DT was included as the mediator in the model because it represents a factor, which is not only a cognitive facet dependent on personality (e.g., Feist, 1998), but also a proximal pre-determinant of goal-directed actions, given that thinking in a divergent fashion supports actual problem solving and behaviours, including sustainable practices (Corral-Verdugo et al., 2015).

Specifically, based on the literature reported above, the study aims to add some new evidence to the complex relationship between personality, cognition, and behaviour by advancing the following hypotheses:

H1) FFM traits are differentially related to DT;

H2) DT is more closely associated with PEB;

H3) both DT fluency and DT creativity mediate the relationship between FFM traits and PEB, regardless of age and gender.

Method

Participants

One hundred forty-six healthy late adolescents (M_{age} = 19.91, SD_{age} = 1.31, 68.5 % females) take part in this research. All subjects received information about the topic of the study and provided their consent to participate. First, they were asked to fill in a short questionnaire on age, gender, education, and their general health state. No subject reported psychiatric, neurological disorders, drug or alcohol addictions. Afterwards, participants carried out the DT task and completed the Big Five Inventory-10 and the Pro-Environmental Behaviour Scale. All subjects participated voluntarily and no rewards were offered.

Measures

Big Five Inventory-10 (BFI-10) (Rammstedt & John, 2007; Guido et al., 2015). This test consists of 10 items, two for each personality trait: Openness, Emotional Stability, Extraversion, Agreeableness, and Conscientiousness. Participants were asked to evaluate each item in terms of 'I see myself as someone who...', using a 5-point Liker scale ranging from (1) = *totally disagree* to (5) = *totally agree*. The BFI-10 has good reliability in all the subscales, also representing a reliable tool for researchers to easily investigate the relationships between the FFM factors and other psychological constructs, especially in online surveys, where participants can lose interest quickly, not

answer properly at later stages or abandon the survey (Guido et al., 2015). It has also been validated in USA and Germany. The Italian version has been used in different online studies (e.g., Coco et al., 2021; Di Crosta et al., 2021). In the present study the internal consistency was determined with the Cronbach's alpha coefficient: Openness ($\alpha = .73$); Emotional Stability ($\alpha = .68$); Extraversion ($\alpha = .68$); Agreeableness ($\alpha = .65$); Conscientiousness ($\alpha = .70$).

Alternative Uses Task (Guilford, 1967). By this task, participants were asked to provide as many different and creative alternative uses for a cardboard box as possible within the time limit of 5 minutes. Participants were advised to use all the time available. Responses were scored in terms of fluency (number of appropriate ideas) and creativity (quality of responses) by two independent judges (1 male and 1 female: mean age = 29 years, SD = 3.5), who attended a specific training (20 hours) on creativity, DT and their assessment. Specifically, judges were instructed to evaluate the appropriateness of the responses considering the applicability of ideas in a specific context and provide the number of responses (fluency). Furthermore, the snapshot scoring approach was used to evaluate the creativity of ideas (see Silvia et al., 2009). Given that this approach does not involve ratings of each unique response, it reduces the cognitive workload and possible errors (i.e., some ideas can be overlooked) (see Forthmann et al., 2017). In detail, judges were instructed to award a single rating to the entire set of responses (one set for each subject) by integrating the three basic dimensions of creative quality: uncommonness, remoteness, and cleverness, using a 5-points Likert-type scale. Thus, each set was given two scores, one for fluency and one for creativity, by averaging the two judges' fluency and creativity scores, respectively. The inter-rater correlations (intra-class coefficient, absolute agreement) for fluency was: $\alpha = .97$, $p < .001$; for creativity: $\alpha = .91$, $p < .001$.

Pro-Environmental Behaviour Scale (Tapia-Fonllem et al., 2013, Giancola et al., 2021). This scale is a questionnaire adapted from Kaiser's (1988) brief version of the General Ecological Behaviour Scale. The questionnaire consists of 16 items focused on pro-environmental actions, such as reuse, recycling, conserving resources and so forth. Participants were instructed to evaluate each item along a 4-points Likert-type scale ranging from (0) = never to (3) = always. The internal consistency for the total score of PEB through Cronbach's alpha coefficient was found to be good: $\alpha = .82$.

Statistics

Descriptive and correlational analyses were conducted by IBM SPSS Statistics version 20 for Windows (IBM Corporation, Armonk, NY). Correlations were computed for preliminary analysis on the relationships involving all variables in the study. A path analysis was computed by AMOS software version 20 to test the mediating effect of DT on the association between FFM dimensions and PEB. The maximum likelihood estimation method was chosen to estimate all model path coefficients and to compute fit statistics. The significance of the mediating effects was analysed using 5000 resample of bootstrapped estimates with 95 % bias-corrected confidence intervals (Preacher & Hayes, 2008). In order to assess the overall model fit, the following goodness of fit measures and recommended cut-points were used: Normed Chi-Square (χ^2/df: < 5, acceptable fit and < 2 good fit; Arbuckle, 2011), Comparative Fit Index (CFI: ≥ .90 acceptable and ≥ .95, desirable; Hu & Bentler, 1999), Goodness of Fit Index (GFI: ≥ .90 acceptable and ≥ .95, Jöreskog & Sorbom, 1996), Root Mean Square Error of Approximation (RMSEA: ≤ .05 good fit and ≤ .08 acceptable fit, Kline, 2005).

Results

All variables were normally distributed (skewness < |3|; and kurtosis < |8-10|), and no extreme values were found in the dataset considering the Mahalanobis distance statistics (D^2). Table 1 displays mean, standard deviation, skewness, kurtosis, and correlations amongst variables.

		Mean	*SD*	S	K	1	2	3	4	5	6	7	8	9	10
1.	Age	19.91	1.31	.22	-1.02	1									
2.	Gender	.32	.46	.80	-1.37	-.15	1								
3.	Openness	3.27	1.27	-.36	-.95	.09	-.10	1							
4.	Emotional Stability	3.21	1.09	-.05	-.78	.10	-.15	.05	1						
5.	Extraversion	2.66	1.18	.40	-.64	.06.	00	.37**	-.10	1					
6.	Agreeableness	3.54	1.02	-.47	-.46	.05	-.17*	-.28**	-.08	-.36**	1				
7.	Conscientiousness	3.46	.78	-.03	-.58	.00	.10	-08	-.29**	-.02	.06	1			
8.	DT Creativity	2.06	1.06	.95	-.13	.10	-.08	.54**	.01	.45**	-.48**	-.12	1		
9.	DT Fluency	4.64	3.35	1.21	-96	.03	-.05	.53**	-.06	.50**	-.42**	-.03	.87**	1	
10.	PEB	1.92	.43	-.42	.06	-.05	-.05	.30**	-.07	.20*	-.18*	.02	.44**	41**	1

Table 1. Mean, standard deviations, skewness, kurtosis, and inter-correlations amongst all variables. ** p < .01 (two tailed), N = 146. Gender was dummy coded: 0 = females; 1 = males; S = Skewness, K = Kurtosis, DT = Divergent Thinking, PEB = Pro-Environmental Behaviour.

The preliminary analysis examined correlations between personality and DT variables. Emotional Stability and Conscientiousness did not correlate with DT creativity and DT fluency. DT creativity correlated with Agreeableness (r = -.48 p < .01), Openness (r = .54 p < .01), and Extraversion r = .45 p < .01). Besides, DT fluency correlated with Agreeableness (r = -.42 p < .01), Openness (r = .53 p < .01), and Extraversion (r = .50 p < .01). Furthermore, PEB correlated with DT creativity (r = .44 p < .01) and DT fluency (r = .41 p < .01). Therefore, the mediation model comprises the following paths only: DT creativity and fluency as predicted by agreeableness, Openness, and Extraversion and PEB as predicted by Agreeableness, Openness, Extraversion, DT creativity and DT fluency. In order to control spurious age and gender effects, they were entered in the

model as covariates by linking them to DT creativity, DT fluency and PEB. Figure 1 shows the mediation model advanced in the current research.

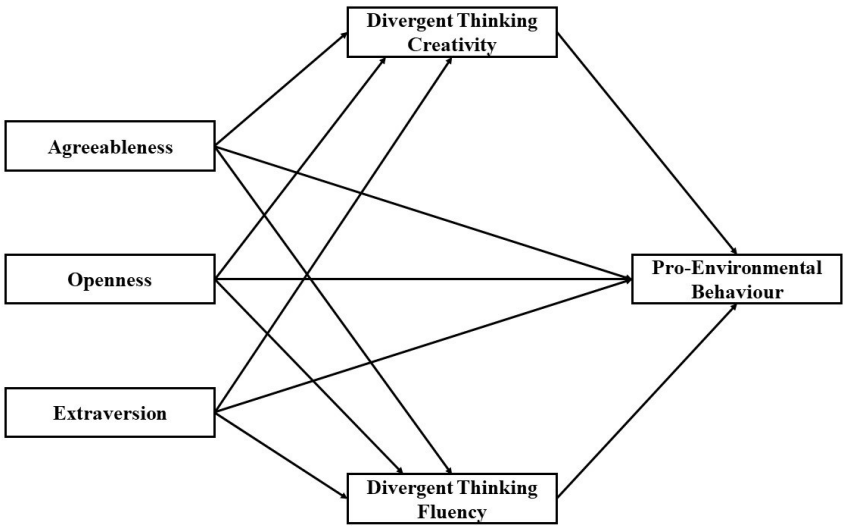

Figure 1. The mediating model of the current research. Agreeableness, Openness, and Extraversion are the focal predictors, Divergent Thinking (DT) creativity and DT fluency are the two parallel mediators, and Pro-Environmental Behaviour is the outcome. The covariates age and gender were omitted for presentation purposes.

The model showed an overall good fit to data (χ^2/df = 1.99; CFI = .98; GFI = .97; RMSEA = .08). The results of the direct paths revealed that Agreeableness negatively predicted DT creativity (b = -.34, 95% CI: (-.48 -.20), β = -.33, p < .001) and DT fluency (b = -.75, 95% CI: (-1.18; -.30), β = -.23, p < .01) but not PEB (b = .01, 95% CI: (-.05; .09), β = .04, p = .63). Openness positively predicted DT creativity (b = .30, 95% CI: (.18; .42), β = .36, p < .001) and DT fluency (b = .92, 95% CI: (.58; 1.28), β = .35, p < .001) but not PEB (b = .03, 95% CI: (-.04; .10), β = .08, p = .43). Extraversion positively predicted DT creativity (b = .17, 95% CI: (.03; .32), β = .19, p < .05) and DT fluency (b = .81, 95% CI: (.35; 1.28), β = .28, p < .001) but not PEB (b = -.003, 95% CI: (-.06; .06), β = -.01, p = .98). In addition, DT creativity predicted PEB (b = .14, 95% CI: (.03; .26), β = .35, p < .05), whereas DT fluency did not (b = .01, 95% CI: (-.02; .04), β = .08, p = .52). Regarding covariates, age was not significantly related to DT creativity

(b = .04, 95% CI: (-.05; .14), β = .06, p = .33), DT fluency (b = -.04, 95% CI: (-.36; .28), β = -.01, p = .81), and PEB (b = -.03, 95% CI: (-.08; .01), β = -.10, p = .16). Gender was also not significantly related to DT creativity (b = -.21, 95% CI: (-.50; .06), β = -.09, p = .12), DT fluency (b = -.48, 95% CI:(-1.33; .35), β = -.06, p = .26), and PEB (b = -.02, 95% CI: (-.16; .11), β = -.02, p = .77). Figure 2 displays the path analysis and standardised coefficients for each path. The indirect effects of Agreeableness (b = -.05, 95 % CI [-.097, -016]), Openness (b = .04, 95 % CI [.012, .087]), and Extraversion (b = .02, 95 % CI [003, 073]) on PEB via DT creativity were significant. Conversely the indirect effects of Agreeableness (b = -01, 95 % CI [-.042. 014]) Openness (b = .01, 95 % CI [-.020, .043]), and Extraversion (b = .01, 95 % CI [-.016, .043]) on PEB via DT fluency were not significant.

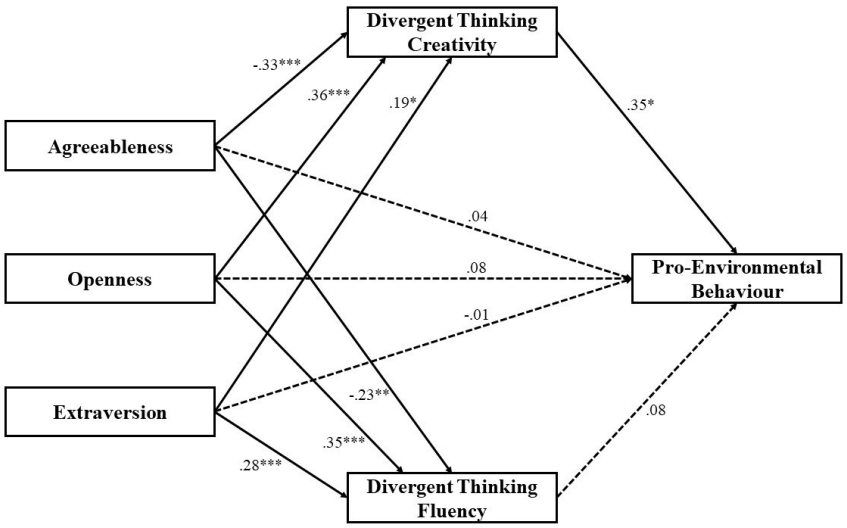

Figure 2. Path analysis in which Agreeableness, Openness, and Extraversion relate to Pro-Environmental Behaviour (PEB) trough Divergent Thinking (DT) creativity and DT fluency. Coefficients shown in the figure are standardised. The paths from age and gender were omitted for presentation purposes and are as follows: age-DT creativity: β = .06, p = .33; age-DT fluency: β = -.01, p = .81; age-PEB: β = -.10, p = .16; gender-DT creativity: β = -.09, p = .12; gender-DT fluency: β = -.06, p = .26; gender-PEB: β = -.02, p = .77. *** p < .001, ** p < .01, * p < .05

Discussion

Although previous research evaluated the interplay between Big Five (FFM) traits and Divergent Thinking (DT), and between DT and Pro-Environmental Behaviour (PEB), to the knowledge of the current work, no study has simultaneously detected the relationship patterns amongst these three variables. Therefore, the extent to which DT mediates the relationships between personality and PEB was explored in the present study. Notably, this study focused on late adolescence, considering the relevance of such a developmental stage to enhance civic engagement and morality (Zarrett & Eccles, 2006), which could have critical implications for pro-environmental actions sustainable behaviours.

The FFM traits were used as focal predictors in the path analysis, whereas DT's quantity (fluency) and quality (creativity) were entered in the model as mediators. DT was assumed to account for the personality-PEB link since it relies on finding non-conventional solutions to open problems and, consequently, contributing to developing new pro-environmental ideas and actions enhancing sensitivity, creative problem finding, and problem-solving related to pro-environmental issues (see Cheng, 2019). In this vein, DT is hypothesised as the primary element of creativity, which originates from personality and can drive individuals in facing and solving ecological and sustainable challenges.

First, results showed that only Openness and Extraversion positively correlated to PEB, whereas Agreeableness negatively correlated to PEB. Given that the path analysis found no significant direct effect, previous studies in adolescence which found direct positive involvement of the FFM traits (except for Neuroticism) in perceived behavioural control of recycling behaviour (Poškus & Žukauskienė, 2017), or more specific pro-environmental practices (Poskus, 2020b) were only partially confirmed. This means that

the relationships between personality and PEB is rather complex and can change according to the developmental stage investigated or the mediation factors included in the model. More specifically, for the mediation hypotheses, results highlighted that the FFM traits entered in the path analysis were differentially related with DT: Openness and Extraversion were positively related with DT creativity and DT fluency, whilst Agreeableness was negatively associated with DT creativity and DT fluency. Results also revealed that only DT creativity was associated with PEB in late adolescents. This scenario confirms the hypothesis advanced in H1 and H2 and partially the hypothesis in H3.

Consistent with previous research (Brick & Lewis, 2016), Openness represents a good marker of pro-environmental actions in this study. Higher aesthetic appreciation, intellectual curiosity, imagination, and originality, usually characterising Openness, bring people to behave more pro-environmentally friendly (Brick & Lewis, 2016; Hirsh & Dolderman, 2007). Low Openness, indeed, reflects a relatively smaller flexible repertoire of cognitive and behavioural strategies that can represent a barrier to moral practices, including PEB (Soutter et al., 2020). In addition, results revealed that the interplay between Openness and PEB is fully mediated by DT creativity. This implies that open-mindedness impacts the individual's ability to diverge and think up uncommon, remote, and clever ideas, which, in turn, fosters people to behave pro-environmentally.

Similar to the effect of Openness, Extraversion was positively associated with PEB completely through the effect of DT creativity. The energetic and ambitious dispositions characterising Extraversion (Caprara et al., 1993) bring people to behave more pro-environmentally (Brick & Lewis, 2016; Hirsh & Dolderman, 2007). In addition, high extroversion involves the desire to give a positive image of themselves (Caprara et al.,

1993), the tendency to engage with others, talkativeness and confidence, as well as self-expression and low fate control, which are associated with pro-environmental actions (Inglehart & Baker, 2000; Leung & Bond, 2004). The full mediation effect of DT creativity appears to account for the effect of Extraversion in support of pro-environmental practices.

Unlike the positive indirect effects of Openness and Extraversion on PEB through the mediator of DT creativity, Agreeableness was negatively associated with PEB completely through the effect of DT creativity. Regarding Agreeableness, note that the negative coefficient of the mediation depends on the negative interplay involving Agreeableness and DT creativity. Previous studies showed that social desirability preserves the status quo and the quality of interpersonal relationships but impairs creativity (Amabile & Prat, 2016) because agreeable individuals do not want to express alternative and divergent ideas, which might negatively affect interpersonal relationships (Giancola et al., 2021b). Therefore, it is reasonable to assume that less agreeable people are more prone to generate creative ideas useful for acting pro-environmentally friendly.

Taken together, the results of the current study substantiate the hypothesis that DT might serve as one underlying mechanism that explains the impact of some personality dimensions on pro-environmental practices. In this vein, DT might help people to produce a wide range of original ideas that, if carefully elaborated in terms of appropriateness, motivate new simple and ordinary pro-environmental practices, including creative recycling, reusing of old materials, reducing the consumption of water, electricity and paper and so forth. In this sense, DT can be conceptualised as an individual creative potential that originates from some personality traits and brings people to a specific type of everyday pro-environmental creativity (Cheng, 2019). In

other words, given that DT and ultimately creativity are considered a form of self-actualisation (Maslow, 1968) and can promote intrinsic motivation, self-initiation, and self-determination in individual behaviours (Hennessey, 2000), divergent thinking might serve as an essential driving force to deal with the environmental crisis. Therefore, the divergence of thought allowing people to trigger the imaginative consciousness, facilitate problem-solving from different perspectives, and enable new connections, might represent a precious weapon in the context of wicked problems related to the battle against environmental crisis (Hensley, 2020).

The work presented in this paragraph is under review in the Journal "Thinking Skills and Creativity"

Giancola, M., Palmiero, M., & D'Amico, S. (*under review*). Does late adolescents' divergent thinking mediate the association between Big Five and eco-friendly behaviours? A path analysis study

Chapter 4 – General discussion

4.1 Conclusions

The current dissertation aims to deepen the impact of cognitive and extra-cognitive factors as well as their interactions on creativity, taking into account different developmental stages. Specifically, six studies (Study 1-6) mainly focus on factors underpinning creativity in children and youth, whilst a further study (Study 7) provides a new perspective of divergent thinking as a tool for positive youth development and pro-ecological sustainability. In this paragraph, the main findings of the studies are summarised and discussed, whereas section 4.2 describes some limitations and future research directions.

First of all, Study 1 sought to review the current literature on the impact of Field Dependence Independence cognitive styles (FDI) on creativity across the life span, considering a twofold perspective, including the process-oriented approach and product-oriented approach. In other words, the research question of this first study was to verify whether FDI affected creativity. Although field independents have been considered creative people (e.g., Bloomberg, 1967; 1971), the literature review revealed that the association between FDI and creativity is highly complex. For instance, some previous researches provided evidence that field independents are more creative than field dependents, others revealed that field dependents are more creative than field independents, whereas some studies found non-significant associations between FDI and creative potential measures. Besides, note that the impact of FDI in children's creative potential is understated to date: only one study has addressed such an issue, revealing that field independent children showed higher divergent thinking (DT) than field dependent ones (Saurenman & Michael, 1980). Surprisingly, considering the impact of FDI on creative production, only two studies revealed a positive association

between field independence and the ability to generate creative inventions. Note that one study (Miller, 2007) relied on adults, whereas the other focused on children's creativity (Saracho, 1992). Although these studies offer promising evidence, the findings are still insufficient to understand the FDI-creativity link across the life span fully. Thus, from Study 1, three main conclusions can be acknowledged: 1) the association between FDI and creativity is not linear but multidimensional; 2) albeit the association between FDI and creativity might exist, evidence, covering the life span, are scattered and fragmentary to date; 3) findings of previous research are controversial and challenging to compare.

Based on the literature review in Study 1, Study 2 investigated the association between FDI and creative production, seeking to provide empirical evidence from a sample of young adults. Results revealed that field independents are more creative than field dependents in generating creative objects (e.g., furniture). These findings align with previous studies on creative production (e.g., Miller, 2007). Specifically, they support the view that field independents through a higher level of cognition and differentiation as well as more analytical reasoning that allows dividing a problem into sub-problems and evaluating their relationships are more accurate in different everyday performances, which might also include everyday objects generation (Miller, 2007).

Considering results provided by Study 2, Study 3 explores one of the most debated associations in psychology literature: the fluid intelligence (Gf)- creativity link, considering FDI as a third variable involved in such an interplay. Specifically, Study 2 focused on youth and advanced a model in which FDI mediates the association between Gf and creativity in both creative potential (declined in terms of divergent thinking, convergent thinking, and creative personality) and real-world visual creativity (evaluated by the Visual Creative Synthesis Task). Results revealed a mediating role of

FDI in both Gf-creative potential and Gf-real-world visual creative production links. For both the associations, analyses showed a positive indirect effect, supporting that the individual predisposition toward field independence could play a key role in the interplay between Gf and creativity. In order to provide more empirical evidence on such a mediating effect, Study 4 hypothesises a model in which FDI mediates the Gf-DT link in both children (Study 4 – Experiment A) and adolescents (Study 4 – Experiment B). Results confirmed the mediating effect of FDI in both children and adolescents. Altogether these findings show two main implications. First, the results shed further light on the multifaced nature of creativity, stressing that both creative potential and production rely on a complex network of different individual resources, including FDI. Although the individual disposition toward field dependence independence tends to evolve across the life span (greater field independence with age - Akshoomoff & Stiles, 1996; Amador-Campos & Kirchner-Nebot, 1997), the FDI seems to maintain its effect on creativity from childhood to adulthood (emerging adulthood). Besides, the results of Study 3 and Study 4 offer pedagogical implications for teaching and learning. Specifically, it is widely recognised that field independent students tend to deal with problems analytically, breaking down an issue in small parts and finding possible relationships amongst them. Thus, by stimulating students to apply more analytical strategies, teachers and educators could promote students' involvement of cognitive resources (e.g., Gf) in a variety of learnings, requiring the generation of many different ideas and their critical evaluation, including both scientific disciplines (e.g., mathematics, science, architecture, and engineering-related fields) and more product-oriented activities (e.g., visual arts, music, and poetry). Therefore, stimulating student's analytical strategies might be useful for explicitly nurturing creativity, providing more opportunities for choice and discovery, encouraging and stimulating resources for

creativity (e.g., Gf, intrinsic motivation and so forth), establishing a creative-supportive learning environment, and providing opportunities for students to use their imagination during the learning process (Patson et al., 2021).

Moving to Study 5, the research question was to deepen the interactions between cognitive and extra-cognitive factors involved in real-world visual creativity in a sample of youth. Specifically, Study 5 addresses the moderating role of the Big Five (made up of five different personality dimensions, including Openness, Extraversion, Neuroticism, Conscientiousness, and Agreeableness) on the association between the ability to plan and creativity. Results revealed that planning was positively related to real-world visual creative production, whereas Agreeableness, at low-middle levels, represented the only personality dimension moderating the planning-creativity link. Although the role of Agreeableness has been widely debated in the literature about creativity, note that specific quality of high Agreeableness such as the desire of interpersonal harmony, coherence, cooperation, care about social relationships, tendency to conform to others' opinions and ideas to preserve the status quo and the quality of interpersonal relationships, negatively affect the disposition to think and act creatively (Amabile & Prat, 2016). Indeed, generating and expressing ideas far from what is usually considered familiar or traditional can often represent a challenge to the status quo that can negatively affect interpersonal relationships, determining possible tensions with others (Sung & Choi, 2009). Therefore, the individual tendency to be less agreeable, which implies a reduced disposition to be compliant and less caring about others' opinions, ideas, and judgments, brings people to better plan their future actions in order to promote the optimal circumstances for acting outside the box.

In turn, like previous studies, Study 6 looks at real-world visual creativity as a construct resulting from interacting individual resources, including personality traits, DT, and CT.

In this way, Study 6, combining the process and product-oriented approach of creativity, advanced a model in which real-world visual creative production is supported by Trait Emotional Intelligence (trait EI) through the mediating effects of DT and CT. Results revealed that only DT fully mediated the relationship between trait EI and real-world visual creativity. These findings suggested that trait EI, encompassing well-being, self-control, emotionality, and sociability, involves a better DT ability, which in turn increases the likelihood of producing a creative invention. Note that albeit CT did not mediate the association between trait EI and creativity, results showed that CT was directly related to creative production, but trait EI did not support it. This implies that trait EI primarily relates to DT, which mainly relies on flexibility, exploration of alternatives, and management of attentional resources rather than CT, which does not involve variability.

To sum up, if, on the one hand, Study 6 (and previous researches in the current dissertation, for instance, Study 3, 4, and 5) lay on the idea that creativity represents the results of a blend of different individual cognitive and extra-cognitive resources, on the other hand, it opens the issue of whether CT interacts with other individual factors in order to generate creative inventions. Indeed, even though CT has been recently recognised as a key element of creativity, being involved in selecting, synthesising and evaluating divergent ideas, in the mediating model advanced in Study 6, CT was not associated with trait EI. Given these findings, one can speculate that when trait EI is involved in creative production, CT supports creativity acting by an independent agent only.

Finally, Study 7 addressed the environmental crisis of our time, advancing DT as a key driver for solving current sustainable development challenges. Specifically, Study 7 examined the mediating role of DT (evaluated in terms of quality or creativity and

quantity, that is, the number of ideas generated) in the association between the Big Five personality traits and Pro-Environmental Behaviour (PEB) in late adolescents. Notably, the focus was on late adolescence since this developmental stage involves crucial facets for PEB, such as civic engagement, responsibility toward the community, moral reasoning, and future orientation. Results indicated that Openness, Extraversion, and Agreeableness were indirectly associated with PEB through the full mediation of DT creativity. The results of Study 7 substantiate the idea that DT might help people to produce a wide range of original ideas that, if carefully elaborated in terms of appropriateness, motivate new simple and ordinary pro-environmental practices (e.g., creative recycling, reusing of old materials, reducing the consumption of water, electricity and paper and so forth). Therefore, DT could represent an individual creative potential that brings people to a specific type of everyday pro-environmental creativity (Cheng, 2019). Given that DT is considered a form of self-actualisation (Maslow, 1968), promoting intrinsic motivation, self-initiation, and self-determination in individual behaviours (Hennessey, 2000), it might serve as an essential driving force to deal with the environmental crisis. Specifically, DT allowing people to trigger the imaginative consciousness, facilitate problem-solving from different perspectives, and enable new connections, might represent a precious weapon in the context of wicked problems related to the battle against environmental crisis (Hensley, 2020).

4.2 Limitations and future directions

All studies in the present dissertation are not free of limitations, which, however, can suggest useful purposes for more detailed future research.

First, considering the systematic review proposed in Study 1, note that some limits can concern the approach used, which focuses only on published works and articles written

in English. In addition, the strength of the studies was not considered in this systematic review. Of course, the study highlighted some limits inherent to the studies reviewed. Specifically, a significant number of studies are correlational, whilst few pieces of research have a between design. In some studies, demographic information was not reported, the creativity tasks were not described, and, in some cases, divergent thinking (DT) and convergent thinking (CT) were confounded with creative production. Notably, the review also showed that all studies on the role of Field Dependence Independence (FDI) on creativity did not rely on a clear theoretical framework. In this vein, future research should address the FDI-creativity link using a clearly defined theoretical and methodological approach, also including life span and gender differences perspectives.

Regarding studies on the role of FDI in creativity, limitations can be summarised as follows. First, the studies used a cross-sectional design; thus, it is impossible to draw conclusions about causal relationships amongst the variables of interest. Thus, considering research on the developmental trend of FDI, showing greater field independence with age (Akshoomoff & Stiles, 1996; Amador-Campos & Kirchner-Nebot, 1997), future longitudinal studies should be addressed in order to evaluate potential trajectory changes toward creativity. Besides, Study 3 and 4 evaluated the mediating role of FDI in the association between fluid intelligence (Gf) and creativity in both creative potential and production. However, according to the Cattell and Horn Model (e.g., Cattel, 1971), intelligence comprises Gf and crystallised intelligence (Gc). Therefore, to better understand the involvement of FDI in the intelligence-creativity link, future studies should analyse the mediating role of FDI, also considering the richness, breadth, and depth of the individual knowledge underpinned by Gc. Finally, albeit it is widely recognised that FDI plays a pivotal role in human functioning and behaviour (Mefoh & Ezeh, 2017), the role of other cognitive styles could also be considered in

future studies in order to make a more granulose picture of the mediating role of cognitive styles in the association between intelligence and creativity.

Regarding Study 5, exploring the moderating role of Big Five on the association between planning and real-world visual creativity, note that the study relies on the Geneplore Model (Finke et al., 1992). The latter describes creative production as the result of a cycle involving the generation and exploration of preinventive structures, a set of prototypes of creative inventions that can be generated, evaluated, and modified during the Geneplore cycle. Given that some people could be more skilled in generating preinventive structures, others could be more able to evaluate and modify them. Since Study 5 evaluated only the object generated, future studies should consider individual levels of competence within the Geneplore cycle (Finke et al., 1992). In addition, Study 5 analysed personality only through the Big Five model. Other personality frameworks can be considered as moderators of the association between planning and real-world visual creative production, including, amongst others, the Big Two model (DeYoung, 2006) and the Dark Triad taxonomy (Paulhus & Williams, 2002).

Regarding the limitations of Study 6, note that similarly to Study 5, Study 6 considered only Trait EI as a focal predictor in a model in which DT and CT were the mediators and real-world visual creativity was the outcome. In order to ensure the complexity of the model, further research should consider as independent variables other facets of personality (e.g., Big Five, Dark Triad, and so forth), cognitive styles (e.g., FDI). Finally, some limitations can be found for the last research: Study 7. Like previous experiments in this dissertation, one limit regards the cross-sectional design, which did not allow checking for possible change across years. In this vein, further research based on longitudinal design is required. Besides, note that the study focused on late Italian adolescents only. Future studies should provide more empirical evidence of the

mediating role of DT in the association between Big Five and PEB, including more heterogeneous samples. In addition, PEB was evaluated using a self-report questionnaire only. In order to ensure a more granulose evaluation of pro-ecological practices, further studies should use performance tasks such as the Pro-Environmental Behaviour Task (Lange et al., 2021) or the Work for Environmental Protection Task (Lange & Dewitte, 2021).

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