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

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ABSTRACT

Creativity can be conceptualised as the result of a blend of individual interacting resources. The present study investigated in a sample of 83 young Italian adults the interplay amongst planning, personality, and real-world creativity, assuming the Big Five personality dimensions as moderator variables. The ability to plan was assessed by means of the Tower of London, whereas creativity was evaluated using the Visual Creative Synthesis Task, in which participants were asked to generate real-world creative objects (e.g., weapon). Three independent judges evaluated the inventions in terms of creativity, which includes both originality and appropriateness dimensions. Results showed that planning was positively related to real-world creative production, whereas agreeableness, at low-middle levels, represented the only personality dimension moderating the planning-creativity link. Our results suggested 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. Future research directions are also discussed.

1. Introduction

Creativity has been widely recognised as an essential psychological construct, leading people to excel in different contemporary society sectors, including art, science, economy and education. It also plays a pivotal role in daily life problem solving (Cropley, 1990), contributing to individual social responsibility, well-being (Cameron, Crane, Ings, & Taylor, 2013; Tong, Zhu, Zhang, Livuza, & Zhou, 2019), and having clear implication for active aging (Palmiero, 2015). Creativity received a great deal of empirical consideration since the mid-20th century, by the Structure of Intellect Model (Guilford, 1967) in which creative thinking represents the interaction between divergent thinking (DT) and convergent thinking (CT). 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, Nori, & Piccardi, 2016; Verstijnen, van Leeuwen, Goldschmidt, Hamel, & Hennessey, 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). Originality represents the

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degree of novelty of the production, making an outcome unique and unusual, whereas appropriateness refers to the degree of usefulness, relevance and fit of such productions within a specific context (Abraham, 2018).

Creativity has been deeply 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, Dai, & Lu, 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, Jauk, Sommer, Arendasy, & Neubauer, 2014; De Dreu, Nijstad, Baas, Wolsink, & Roskes, 2012; Zabelina, Robinson, Council, & Bresin, 2012), but also mental simulations of possible future actions (e.g., Matheson & Kenett, 2020), characterising the ability to plan (Mumford, Schultz, & Van Doorn, 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, Kaufman, Reiter-Palmon, & Wigert, 2011). This led us to hypothesise the moderating role of personality traits in the association between planning and real-world creativity.

1.1. 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, Dolan, & Van der Molen, 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, 2018), 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 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, Galanter, & Pribram, 1960); a mental activity involving the identification and organization of subtasks that people need in problem-solving activities (Chaiklin, 1984), which affects the likelihood of success of the action planned (Brichcín & Rachardžo, 1995); a goal-directed process playing a pivotal role not only in selecting and organising actions (e.g., Read, Mitchell, & Akresh, 1987) but also in simulating methods to achieve a goal (e.g., Simons & Galotti, 1992). The main attribute that characterised and joined all these perspectives concerns the involvement 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, which affects a significant number of everyday life activities (e.g., Eichmann, Goldhammer, Greiff, Pucite, & Naumann, 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, Leritz, & Mumford, 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.

1.2. 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, 2008). 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, Nusbaum, Berg, Martin, & O'Connor, 2009). Extraversion reflects the tendency to be energetic, active, ambitious, and assertive (Feist, 1998) enhancing the individual disposition to creativity (Baas, De Dreu, & Nijstad, 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, Walker, & Broyles, 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, Oldham, Jacobsohn, & Hollingshead, 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, Pavelis, Hemsley, & Corr, 2006). Conversely, positive interpersonal traits such as honesty, likeability, and humor 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, Batey, Anand, & Manfield, 2008). Despite these controversial findings, personality is still widely recognised as a critical factor that could spur on or inhibit creativity.

1.3. 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, Dem, and Choden (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.

1.4. 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 FFM 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, Ward, & Smith, 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.

2. Method

2.1. Participants

Eighty-three adults (mean age = 23.26 ± 3.64; age range = 19–31) 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.

3. Materials and procedure

3.1. 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 × 10 cm) with three vertical pegs of different increasing lengths (6, 12, 18 cm) and three balls (4 cm in diameter) of a different color (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 Fig. 1.

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).

3.2. Assessment of creativity

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

The task consists of two main steps: the preinventive phase and the inventive phase. After a practical trial, participants were requested to mentally combine and manipulate the components into an abstract structure, 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 memorised the components and 2 minutes to think about the preinventive structure for each triad. After this preinventive phase, a schematic drawing was produced. During the inventive phase, participants were presented with a category name for each of the triad (furniture, weapon, and

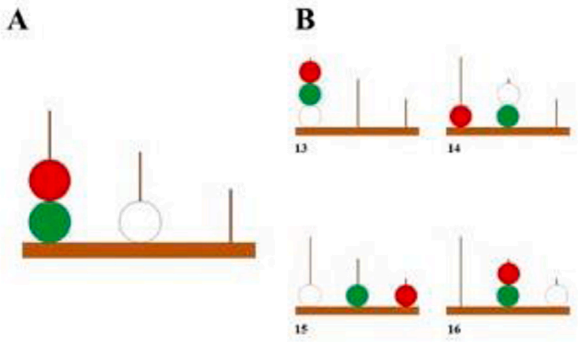

Fig. 1. A. The starting-configuration of the Tower of London (ToL-16). B. The additional final configurations of the ToL-16: items 13 and item 14 (6 moves); item 15 and item 16 (7 moves).

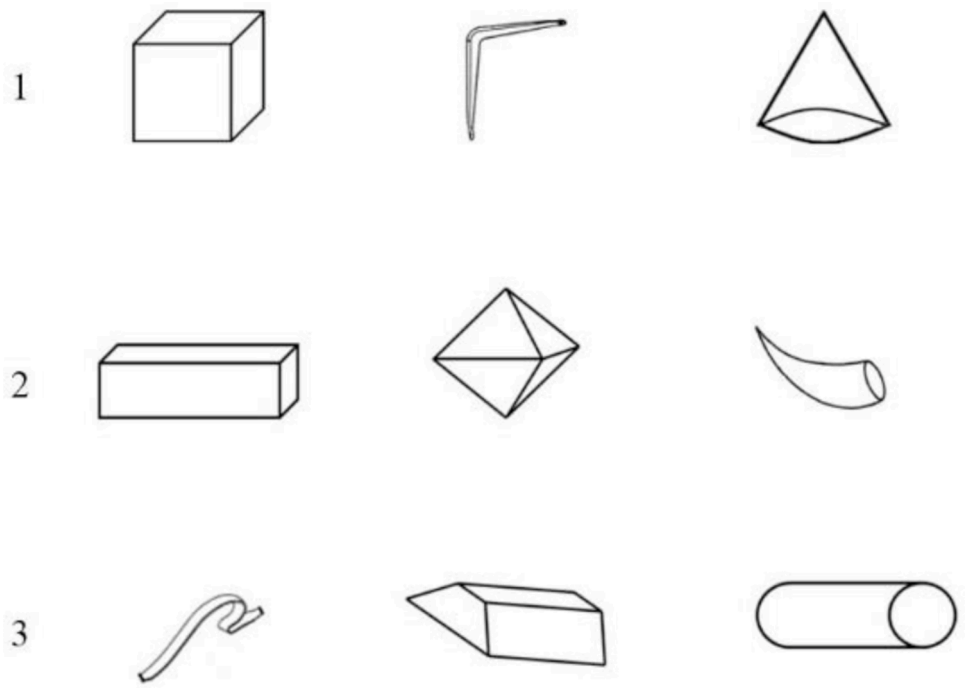

Fig. 2. The three triads of components for the Visual Creative Synthesis Task (VCST): 1) cube, bracket, cone (sport goods); 2) parallelepiped, dy-pyramid, horn (furniture); 3) strip, trapezoid, cylinder (weapons).

sport goods) and were requested to think of their invention. For each invention, they had 3 minutes to describe the functioning. Finally participants were requested to provide a title of the objects (see Fig. 3).

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 judges were three psychology students who attended specific training (20 hours) on creativity and its assessment. During the training sessions, students were instructed on definitions of creativity in terms of originality and appropriateness. Main theoretical frameworks and models on creativity, including the Geneplore Model, were explained and discussed. In addition, students were shown examples of real-world creative outcomes 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: $\alpha = .95$, $p < .001$). The average ratings of scores provided by the independent judges were used as the final score for inventions produced.

3.3. Assessment of personality

The Big Five Questionnaire (BFQ; Caprara, Barbaranelli, Borgogni, & Perugini, 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*

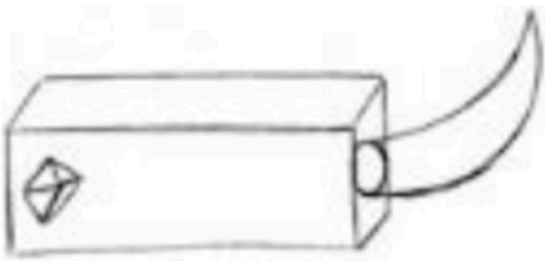

Fig. 3. An example of a creative invention based on the triad n.2. The triad is composed of one parallelepiped, one di-pyramid, and one horn. Category: Furniture; Title: Drawer; Description: This furniture is an exotic drawer set on the wall. The parallelepiped is the drawer, the di-pyramid represents the handle, and the horn has the coat-rock functions.

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 (α = .78), BFQ-E (α = .76), BFQ-N (α = .89), BFQ-C (α = .77), and BFQ-A (α = .79).

4. Results

Statistical analyses were performed using IBM SPSS Statistics version 24. All measures were normally distributed (Kolmogorov-Smirnov Test: $Z_{ToL\text{-}16}$ =.187, ns; Z_{VCST} = .836, ns; $Z_{BFQ\text{-}O}$ = .714, ns; $Z_{BFQ\text{-}E}$ = .290, ns; $Z_{BFQ\text{-}N}$ = .736, ns; $Z_{BFQ\text{-}C}$ = .849, ns; $Z_{BFQ\text{-}A}$ = .805, ns). In order to verify the common method bias (CMB), we used Harman's single factor test (Podsakoff, MacKenzie, & Podsakoff, 2012). Our 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).

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, Cohen, West, & Aiken, 2013, predictors were mean-centered before being entered in the analyses. According to Aiken, West, and Reno (1991), since moderators are continuous variable, their values are computed at -1 SD to +1 SD from the mean (see Fig. 4)

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; < 0.001). 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-16 and BFQ-A, and a significant and negative interaction effect of ToL-16 x BFQ-A on VCST.

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 Fig. 5).

5. Discussion

The current research made two important theoretical contributions. First, we 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, Schultz, & Osburn, 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

Table 1
Means, standard deviation, and inter-correlations amongst all variables.

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

*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.

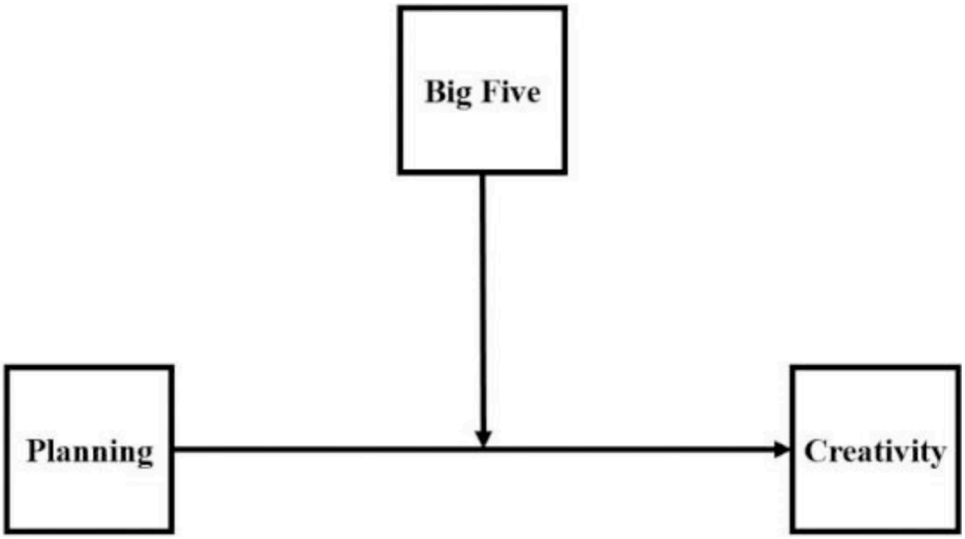

Fig. 4. The path diagram (Model 1) detecting the moderating effect of Big Five personality dimensions on the planning-creativity link.

Table 2
Magnitude and statistical significance of planning and agreeableness on creativity.

	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

ToL-16 = Tower of London; BFQ-A = Agreeableness.

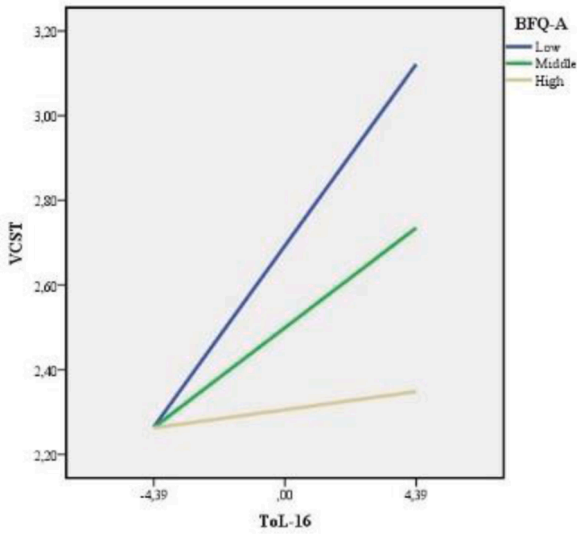

Fig. 5. Simple slopes of the interaction of planning and agreeableness on creativity. ToL-16 = Tower of London; VCST = Visual Creative Synthesis Task; BFQ-A = Agreeableness.

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 and 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, we contributed to explore the joint effect of cognition and personality dimensions on creativity. At this aim, we performed five moderation analyses 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. We found only the moderating effect of agreeableness, confirming the unidirectional hypothesis advanced in H6. In addition, our 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, Pataki, & Carver, 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 our 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. Future studies should explore the weights of the relationships between the FFM dimensions and more specific convergent and divergent processes and subprocesses of creativity. In addition, considering that some people could be more skilled in generating preinventive structures, and others could be more able in evaluating and interpreting such structures, showing different levels of competence within the Geneplore cycle (Finke et al., 1992), future studies could take into account such individual predispositions. Yet, future studies may use different personality frameworks to detect the relationships amongst planning, personality, and creativity. For instance, the Big Two model (DeYoung, 2006), made up of stability (emotional stability, agreeableness, and conscientiousness) and plasticity (openness to experience and extraversion), could provide more consistent results.

In conclusion, our findings 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.

Authors' contribution

Marco Giancola: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing. **Massimiliano Palmiero:** Conceptualization, Methodology, Supervision, Writing-Review-Editing. **Laura Piccardi:** Conceptualization, Methodology, Writing-Review-Editing. **Simonetta D'Amico:** Conceptualization, Methodology, Supervision, Resources, Writing-Review-Editing. All authors have read and approved the final revised version of the manuscript.

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Declaration of Competing Interest

The authors declare that they have no conflict of interest.

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