Creativity in Schizophrenia: Evidence Beyond Anecdotes

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ABSTRACT

Recent meta-analytic work has highlighted lower creativity in schizophrenic patients as compared to control participants, but the cognitive and affective underpinnings of this difference still need to be fully understood. To this purpose, we adopted a multi-measure approach and compared a group of schizophrenic outpatients and a group of demographically-matched controls (N = 34) on the Alternative Uses Test (AUT) and the Remote Association Test (RAT), assessing divergent and convergent thinking respectively. The participants' cognitive status, affective status, and response inhibition skills were also appraised. The results showed a significantly worse performance in patients vs. control participants in both tests of creativity. Performance was also negatively correlated with patients' symptoms, being lower in more severe clinical conditions. The difference between groups in the RAT was no more significant when controlling for individuals' cognitive functioning, in line with previous studies in healthy populations. In contrast, the difference in AUT fluency remained significant even when controlling for cognitive and affective measures. Our findings suggest that creativity reduction in schizophrenic patients involves both convergent and divergent thinking, and that the latter aspect is not simply the consequence of a general cognitive or inhibitory impairment.

Summary

In our study, we compared a sample of schizophrenic outpatients and a group of closely-matched control participants on two main creativity tests, the Remote Association Test (RAT) and the Alternative Uses Test (AUT), collecting also a variety of cognitive, affective, and response inhibition measures.

The results showed a significantly worse performance in patients vs. control participants in both tests of creativity. Performance was negatively correlated to patients' symptoms, showing lower creativity in more severe clinical conditions. Our results suggest that both facets of creativity we investigated, tapping convergent and divergent thinking, are affected in patients with schizophrenia, in contrast with the long-standing myth and anecdotical narrative of a positive relation between creativity and schizophrenia.

The difference between groups in the RAT was no more significant when controlling for individuals' cognitive functioning. However, the difference in the AUT remained significant even when controlling for cognitive and affective measures. Our findings suggest that the processes underlying the difference between schizophrenic patients and control participants are related to cognitive skills if the test relies more on convergent thinking, but the difference in tests mainly requiring divergent thinking is not simply related to general cognitive or inhibitory impairments.

Our findings are theoretically relevant to identify creativity impairments in schizophrenia and the skills underlying different facets of creativity. They are also prospectively relevant for the development of diagnostic instruments and rehabilitative programs aiming at improving patients' creative skills and successful adaptation to the environment.

Introduction

Recent meta-analytic work has highlighted a lower performance in creativity tests for schizophrenic patients as compared to control participants (Acar, Chen, & Cayirdag, 2018), in disagreement with the long-standing, anecdotal idea of a positive relation between schizophrenia and creativity and with the findings of two previous meta-analyses focusing on creativity and psychoticism (Acar & Runco, 2012), and creativity and positive schizotypy (Acar & Sen, 2013). In particular, Acar and colleagues (2018) analyzed 200 effect sizes obtained from 42 studies and found that creativity has

a negative relationship with schizophrenia with a medium effect size, concluding that "certain psychopathological symptoms can only help creativity when they are at the subclinical levels." (p 29). Moreover, they observed that the relationship between schizophrenia and creativity is moderated by type of creativity measure (stronger with semantic-category or verbal-letter fluency tasks than on divergent thinking or associational measures), the content of creativity measure (lower performance on verbal vs. nonverbal measures), the level of schizophrenia (more negative effect size in chronic schizophrenia vs. acute and early onset levels), and patient status (more negative effect size in inpatients vs. outpatients).

However, only a relatively limited number of well-controlled studies on schizophrenia focused on two main tests measuring specific aspects of creative thinking: the Remote Association Test (henceforth RAT; Mednick, 1962) and the Alternative Uses Test (henceforth AUT; Guilford, Christensen, Merrifield, & Wilson, 1978). The former test assesses an insight-like facet aspect of creativity and is assumed to reflect a strong contribution of convergent thinking skills (Lee, Huggins, & Therriault, 2014). The latter test is thought to strongly rely on an exploratory modality typical of divergent thinking (Gilhooly, Fioratou, Anthony, & Wynn, 2007). Moreover, the studies using the RAT and the AUT in schizophrenic patients did not provide fully consistent evidence. For instance, the only study satisfying Acar et al.'s meta-analysis selection criteria (2018) and comparing schizophrenic patients and healthy controls on the RAT (Folley & Park, 2005) found worse performance in schizophrenic patients in comparison to controls. Among the three studies employing the AUT, one reported worse performance in schizophrenic patients (Abraham, Windmann, McKenna, & Güntürkün, 2007), another highlighted better performance in (a subgroup of) schizophrenic patients (Keefe & Magaro, 1980), and the third found no difference between schizophrenic patients and non-psychotic psychiatric patients in conventional uses but did find worse performance of the schizophrenic patients in imaginative uses (Shimkunas & Murray, 1974). Thus, although an overall pattern of lower performance in schizophrenic patients has been reported, a replication of this difference in the RAT and in the AUT could strengthen this evidence.

Moreover, a proper understanding of the reasons why patients and controls differ in their creative performance in these two tests is still needed. Notably, only Abraham et al. (2007) investigated the cognitive underpinnings of creative performance in AUT, relating it with executive control measures (Digit-span backward, Hayling test, Brixton test, Stroop test). They found poorer performance of patients vs. controls in the Digit-span backward and in the Brixton tests but not in the Hayling test nor in the Stroop test. Abraham et al. employed hierarchical multiple regression analyses to understand whether the effects they observed on the creative cognition variables (including the AUT) as a function of the group (patients vs. controls) were mediated by the performance on the executive control tasks on which significant main effects of the group were also found. For what concerns the AUT, their findings showed a partial mediation effect of executive control on the fluency measure (number of valid responses) but no mediatory role of executive control on the AUT uniqueness measure (number of unique responses in the sample).

To summarize, the evidence supporting the postulated performance difference between schizophrenic patients and healthy controls in two main tests like the RAT and the AUT could be strengthened by further studies. Moreover, existing research has not yet identified the cognitive and affective factors underlying this difference in creativity, although some studies provided preliminary evidence that cognitive control may play a significant role (Abraham et al., 2007). The present research, beyond enriching and better qualifying the evidence on the differences in performance between schizophrenic patients vs. healthy controls in convergent and divergent thinking, aims to shed light into the cognitive and affective underpinnings of these postulated differences by examining the relationships between participants' RAT and AUT performance and participants' cognitive, affective, and response inhibition measures; that is, between tasks assessing two different facets of creativity and a set of variables not considered simultaneously in previous studies.

It has been suggested that cognitive factors, including executive control, may partially or totally explain the differences in performance observed in some creativity tests (Abraham et al., 2007). As specifically concerns cognitive control, evidence indicates that executive processes are altered in schizophrenia (Fioravanti, Carlone, Vitale, Cinti, & Clare, 2005; Minzenberg, Laird, Thelen, Carter, & Glahn, 2009), although existing studies expose sizable heterogeneity. Executive function impairments in working memory, set-shifting, and inhibitory control seem to be related both with negative symptoms (e.g., poverty of speech, flat affect) and with positive clinical manifestations of schizophrenia like thought disorganization (cf. Abraham et al., 2007; Williams, 1996), which may be negatively related with creative tasks requiring goal-directed thinking, also considering that schizophrenic outpatients may have experienced years of illness with recurring episodes. Moreover, there is also some

evidence in nonclinical settings that inhibition, as a facet of executive control, may positively support successful creative performance (e.g., Edl, Benedek, Papousek, Weiss, & Fink, 2014; for a discussion, see Cancer, Iannello, Salvi, & Antonietti, 2022). On the opposite side, more lenient inhibition[1] has been considered as a key factor for explaining creative performance, contributing to constraints relaxation, loosened associational thinking, and less bounded idea generation in non-clinical conditions and even in some clinical conditions (Carson, Peterson, & Higgins, 2003; Martindale, 1995; Radel, Davranche, Fournier, & Dietrich, 2015). However, as previously pointed out, this may hold only when psychopathological symptoms are at the subclinical level (Acar et al., 2018). These differing findings and views suggest that the relation between inhibition and creativity in patients with schizophrenia is still in need of more empirical investigation.

As regards the relationship between emotional factors and creativity performance, the picture is also complex. Indeed, although mild and moderate affective alterations seem to inspire and motivate creative work under specific circumstances, severe affective disorders are thought to inhibit creativity (Holm-Hadulla, Hofmann, Sperth, & Mayer, 2021). Furthermore, despite the belief that creativity is related to psychopathology, results are mixed also in the field of mood disorders (Taylor, 2017), since they depend not only on the severity of affective symptoms, but also on the different research approaches (e.g., assessing the creativity in samples with/without mood disorders, or assessing the prevalence of mood disorders in creative/noncreative samples). As concerns non-pathological affective variations, depression and anxiety fluctuations may play a role in creative performance by influencing motivation (Brébion, Gorman, Malaspina, Sharif, & Amador, 2001) or engagement in the task (Lysaker, Davis, Lightfoot, Hunter, & Stasburger, 2005), respectively. However, whereas positive mood seems to reliably improve creativity, the effects of negative mood seem mixed (Baas, 2008). In the context of schizophrenia, these mood aspects have been mostly neglected, with the exception of affective negative symptoms assessed through standard measures of schizophrenia symptomatology, which, however, produced results that are far from being unequivocal, since the most used tools simultaneously measure not only affective but also cognitive alterations in the negative syndrome.

In our study, we adopted a multi-measure approach and compared a group of schizophrenic outpatients and a group of demographically-matched healthy controls on both the AUT and the RAT, while also assessing participants' cognitive status, affective status, and response inhibition skills. We expected to observe a lower performance in both creativity tests in the group of patients, following the results of recent meta-analytic work (Acar et al., 2018) and some of the previous investigations (Abraham et al., 2007). We also expected that patients with more symptoms would show a lower creative performance (Acar et al., 2018). Finally, to identify the underpinnings of the difference between schizophrenic patients and control participants in creativity, we statistically controlled for differences in cognitive, affective, and inhibitory measures. Our hypotheses were that cognitive components (including inhibition) could explain the performance difference in the RAT, a test requiring both analytical thinking (i.e., a continuous step-by-step reasoning process) and insight problem-solving (i.e., a discrete process that involves sudden bursts of awareness). By contrast, the difference in divergent thinking performance (measured through AUT) would be only partially explained by these components, since this test represents a broader proxy of the creative potential (Runco & Acar, 2012), which is defined by a multitude of components of different nature (cognitive, conative, motivational, environmental; Sternberg, 2005; Sternberg & Lubart, 1995).

Material and methods

Participants

Seventeen chronic outpatients with schizophrenia spectrum disorder (11 males, age: $M = 51.94$, $SD = 9.90$) were recruited from mental health services in Northern Italy. Diagnosis was made according to the DSM-IV-TR. The Positive and Negative Syndrome Scale (PANSS) for schizophrenia spectrum disorder was also administered to assess the presence of positive symptoms (i.e., the so-called productive features of mental status, like delusions, hallucinations, and conceptual disorganization), negative symptoms (i.e., impaired functioning in the cognitive, affective, and social realms, manifest as blunted affect, emotional and social withdrawal, apathy, difficulty in abstract thinking, lack of spontaneity and flow of conversation, stereotyped thinking) or general psychopathology symptoms (i.e., symptoms frequently reported in different psychiatric disorders, like anxiety, depression, somatic concerns, motor retardation, poor impulse control, uncooperativeness, and disorientation). All outpatients took antipsychotic medication. Some of them were under anxiolytic medication (n = 12) or other medications (n = 7). Seventeen control participants with no history of psychiatric or neuropsychological illness were matched to schizophrenic outpatients, on gender, age, and education (Table 1). All participants were native Italian

Table 1. Descriptive statistics and t-tests comparing patients and control participants.

Measure	Outpatient group *M* (*SD*)	Healthy controls *M* (*SD*)	*t*-test	Effect Size Hedges' *g*
Demographics				
Gender (M:F)	11:6	11:6		
Age (years)	51.94 (9.90)	51.76 (11.32)	0.05	0.02
Education (years)	10.94 (2.68)	11.29 (2.57)	−0.39	−0.13
Cognitive assessment				
MoCA (score)	21.53 (4.71)	28.18 (1.59)	−5.52***	−1.85
Affective assessment				
BDI-II (score)	9.53 (7.67)	6.06 (5.65)	1.50	0.47
STAI-Y2 (score)	42.71 (9.07)	35.06 (6.69)	2.80**	0.94
Response inhibition				
SART accuracy (% correct)	69.6 (17.6)	88.4 (7.5)	−4.05***	−1.37
SART stop trials accuracy (% correct)	58.8 (21.6)	48.0 (28.6)	1.10	0.41
Stroop accuracy (% correct)	86.9 (11.1)	97.1 (2.1)	−3.72**	−1.25
Stroop effect (ms)	772 (798)	226 (281)	2.66*	0.89
Creativity				
AUT Fluency	8.18 (4.71)	22.00 (7.76)	−6.28***	−2.17
AUT Originality	1.98 (0.28)	2.12 (0.07)	−2.14*	−0.67
AUT Peak originality	2.18 (0.54)	2.70 (0.38)	−3.24**	−1.09
AUT Feasibility	3.95 (0.82)	4.44 (0.14)	−2.43*	−0.81
RAT Accuracy (% correct)	27.7 (15.3)	47.2 (16.9)	−3.52 **	−1.18
RAT Errors	10.94 (9.98)	5.82 (4.08)	1.96	0.66
RAT Nonresponses	20.88 (9.66)	16.59 (5.94)	1.56	0.52
PANSS				
Positive symptoms	20.82 (7.91)			
Negative symptoms	18.59 (8.05)			
General symptoms	48.82 (13.09)			
Total symptoms	88.24 (22.91)			

Abbreviations are as follows: MoCA: Montreal Cognitive Assessment; BDI-II: Beck Depression Inventory-II; STAI-Y2: State-Trait Anxiety Inventory-Y2; SART: Sustained Attention to Response Task, AUT: Alternative Uses Test, RAT: Remote Association Test, PANSS: Positive and Negative Syndrome Scale for schizophrenia spectrum disorder. The Stroop effect is the mean difference in RT between incongruent and congruent Stroop trials. One patient did not complete the SART. Significance levels are as follows: * $p < .05$, ** $p < .01$, *** $p < .001$.

speakers. The study was conducted in accordance with the guidelines laid down in the Declaration of Helsinki and it was approved by the Ethics Committee for Psychological Research of the Padua University. All participants provided their informed consent.

Procedure and measures

The diagnosis of schizophrenia spectrum disorder and the PANSS administration were made by referring psychiatrists, whereas task and self-report questionnaire data have been collected by three trained research assistants supervised by a psychiatrist and by the principal investigators responsible of the research. Participants completed the study in their residential community facilities, during different days to avoid fatigue effects. The cognitive status was appraised with the Montreal Cognitive Assessment Battery (MoCA) (Bosco et al., 2017; Nasreddine et al., 2005), and depression and anxiety levels were measured with the Beck Depression Inventory (Beck, Steer, & Brown, 1996) and the State-Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), respectively. Response inhibition was assessed with the Stroop test and the Sustained Attention to Response Task (henceforth SART), described next. The creativity tests were the AUT and the RAT, applied as specified below.

Stroop

We employed a version of the Stroop task that proved to be sensitive to individual differences in response inhibition (Del Missier, Mäntylä, & Bruine de Bruin, 2010, 2012) and has been used also in clinical settings with schizophrenic samples (Del Missier et al., 2020) and ADHD samples (Mäntylä, Still, Gullberg, & Del Missier, 2012). Participants were presented with a series of 96 word triplets, and they had to respond to the central word, which was printed in color (blue, green, yellow, red) at the center of the computer screen. In half of the trials (congruent trials), the color of the central word matched the meaning of the stimulus word (e.g., the word "green" was printed in green), while in the other half of the trials (incongruent trials) this did not happen (e.g., the word "green" was printed in blue). The other two words of each triple, presented at the left or at the right of the central word and always printed in black, referred to color names as well (blue, green, yellow, red). For each trial, only one of these two side words matched the color of the central word (e.g., "green" and "blue" as side words when the color of the central word

was green), and participants had to indicate the color in which the central word was printed by pressing one of two keys, marked with the left arrow or with the right arrow, corresponding to the side words presented in the left or right side of the screen. Participants were asked to be both as fast and accurate as possible. A short series of training trials with feedback was provided. Stroop accuracy (percentage of items with a correct response) and the Stroop effect (difference between mean reaction times in correctly-responded incongruent and congruent trials) were used as response inhibition scores.

Sustained attention to response task

In the SART (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997), participants were presented with a sequence of digits and instructed to press the spacebar as quickly as possible in response to each digit except for the digit "3," for which they were asked to withhold the response. A total of 225 single digits from "1" to "9" were presented in random order, using the Symbol font in various sizes (48, 72, 94, 100, or 120 points). Each digit appeared at the center of the screen for 250 ms, followed by a mask ("#") lasting 900 ms. The SART assesses both sustained attention and response inhibition, as the task requires the production of the response to the great majority of stimuli, but unfrequently the response needs to be stopped (given that each number was presented 25 times, the stop trials were 11% of the total). SART total accuracy and accuracy in SART stop trials were the measures of response inhibition.

Alternate uses test

The AUT (Guilford et al., 1978) is the most commonly-used measure of ideation ability based on divergent thinking. Participants had to specify as many alternative uses they could for a brick, a staple, and a tire. They had three minutes for each object. Following common practice (Reiter-Palmon, Forthmann, & Barbot, 2019; Wilson, Christensen, Merrifield, & Guilford, 1960), two independent raters classified each verbalization of each participant as a valid response, as a nonresponse (e.g., incomplete, nonunderstandable, or nonsensical ideas; responses that apply to any object such as selling, borrowing, and the like), or as a repetition of a previous response or of the initial example provided in the instructions. Nonresponses and repetitions were very few (3%, and 6% of the total responses, respectively) and the agreement between raters was complete. Then, two different trained raters evaluated the originality and the feasibility of each valid response. All the valid responses were sorted alphabetically within each object, to ensure that the raters were blind to potentially biasing factors such as the response serial position in the set, the total number of responses in the set, and the preceding and following responses. The raters read all of the responses prior to independently scoring them. Each response received both an originality rating on a 1 (not at all creative) to 5 (highly creative) scale, and a feasibility rating on a 1 (not at all feasible) to 5 (highly feasible) scale. The scoring criteria for originality were adopted from Wilson, Guilford, and Christensen (1953). Indeed, the raters considered response uncommonness, remoteness of association, and cleverness when making their ratings, and strength in one facet balanced weakness in another facet. Feasibility was defined as the degree to which the proposed use of the object could represent an actual use, with the lowest rating indicating that the proposed use was impossible to be translated into an actual use, and the highest rating indicating that the object did not require any change or adaptation to be used as proposed. The correlation between raters was r = .76 for originality and r = .81 for feasibility, and the percentage of agreement was 90% for originality and 85% for feasibility. The very few disputed cases (i.e., with a disagreement between raters greater than 2 points) were decided after a discussion between raters. The final scores of originality and feasibility for each response were computed by averaging the ratings provided by the two raters, and these scores were averaged across responses and objects for each participant.[2]

The first criterion measure for the AUT was the fluency score, defined as the number of different valid alternative uses produced by the participants in the time assigned. We computed a cumulative fluency score, summing the fluency scores for the three objects for each participant, considering that all bivariate correlations were positive and significant ($rs \geq .70$, $ps < .001$). The other two criterion measures for the AUT were the average originality and feasibility scores for each participant (mean of originality ratings across the participant's responses for the three objects). For each participant, we also averaged the originality ratings of the most original responses generated for each stimulus object. This latter measure allowed appraising participants' "peak" originality, thus enabling a more comprehensive assessment (see Del Missier, Visentini, & Mäntylä, 2015 for a similar approach in the measurement of response quality). Indeed, while the fluency and average originality measures are standard measures for the AUT, the average feasibility and peak originality measures are less frequently used, but potentially very informative about patients' possible strengths and weaknesses when compared to control participants. Indeed, one could argue that schizophrenic patients produce fewer responses, possibly less original on average, but

they are able to produce very few particularly original responses. On the other hand, it could be argued that schizophrenic patients' responses are somehow less anchored to reality, thus less feasible. The peak originality and average feasibility measures allowed exploring these theoretically and practically interesting possibilities.

Remote association test

The RAT is a widely used creativity test based on the idea that creativity stems also from the ability to activate remote associations between items (Mednick, 1962). The version of the test employed here was designed following the results of a validation study (Salvi, Costantini, Bricolo, Perugini, & Beeman, 2016). In particular, we selected 44 triplets of words from the validation study, each one associated with a target word in the Italian population (e.g., light, birthday, engine: candle). In order to select items varying in difficulty but not being too difficult, we selected RAT items solved by at least 10% of participants in the validation study, with half of the selected items being correctly resolved by more than 50% of the validation sample. Additionally, the selected items were associated with a self-reported "insight" solution (vs. "analytic" solution) by more than 70% of the participants in the validation sample to better tap creativity-related processes rather than analytic thinking. In each trial, participants were presented with three words at the center of the computer screen and instructed to find another word that could be matched with each of the three stimulus words. Participants had 15 seconds to find the solution for each trial and to say it aloud. No feedback on the correctness of the responses was given. Before the test trials, three practice trials with different word triplets were provided. The main criterion measure for the RAT was the percentage of correct responses, but we also computed the number of wrong responses and the number of non-responses within the allotted time.

Results

Differences between groups

Table 1 presents descriptive statistics and t-tests comparing the groups of patients and control participants on all measures.[3] The results clearly show a significantly lower performance in both creativity tests in the group of patients. Patients' performance in the AUT fluency was markedly lower than control participants' performance. Moreover, patients' originality scores and feasibility of responses were significantly lower than those of control participants. Additionally, patients' RAT accuracy was 20% lower than the accuracy of healthy controls. Significant differences were also detected in three of four inhibition measures, consistently showing worse performance in the patients' group. Finally, a lower performance on the cognitive assessment and a higher degree of trait anxiety were observed in patients.[4]

Correlations between creativity tests scores and PANSS scores

Some significant Pearson's correlations were observed in the group of patients between the AUT and RAT scores and the PANSS scores (see Table 1 for PANSS descriptive statistics and Appendix A for full correlation tables: Table A1 and Table A2). In particular, PANSS total scores were negatively correlated with RAT accuracy ($r = -.61$, $p < .05$). PANSS positive symptoms scores were negatively correlated with RAT accuracy ($r = -.52$, $p < .05$) and AUT feasibility ($r = -.50$, $p < .05$). Finally, the PANSS general symptoms were significantly related with RAT accuracy ($r = -.52$, $p < .05$). Errors and missed responses in the RAT, as well as the other AUT measures, did not display significant correlations with PANSS scores. Thus, performance in the RAT accuracy was negatively related with positive, general, and total symptoms, and the feasibility facet of performance in the AUT was negatively associated with positive symptoms.

Predictors of performance in creativity tests

To appraise the role of cognitive and affective variables as factors potentially contributing to the explanation of the observed differences in creativity tests between patients and control participants, we carried out a series of incremental Analyses of Covariance (ANCOVAs) on both the AUT fluency and the RAT accuracy scores. Following a one-way ANOVA to confirm the difference between patients and control participants in creativity test scores, the first ANCOVA tested the same effect while controlling for participants' depression and anxiety levels (BDI-II and STAI-Y2). The second ANCOVA controlled also for participants' global cognitive functioning (MoCA). The final ANCOVA included response inhibition as a further control variable and the analysis was repeated for each inhibition measure.

Table 2 summarizes the outcomes of the analyses. As concerns the AUT fluency, the one-way ANOVA confirmed the significant difference in performance between patients and control participants. The significant difference was confirmed even when controlling for participants' depression and anxiety levels, and additionally

Table 2. Differences between outpatients and controls in the Alternative Uses Test fluency and in the Remote Association Test accuracy when controlling for individual differences in affective status, cognitive status, and inhibition skills.

	Alternative Uses Test Fluency (Number of different valid alternative uses produced)				Remote Association Test (Accuracy)			
Effect	*F* (df)	*MSE*	*p*	η^2_p	*F* (df)	*MSE*	*p*	η^2_p
One-way ANOVA Patients vs. controls	39.42 (1, 32)	41.20	< .001	.55	12.40 (1, 32)	0.03	< .01	.28
ANCOVA Patients vs. controls	29.48 (1, 30)	39.70	< .001	.50	10.25 (1, 30)	0.03	< .01	.25
BDI-II	2.22 (1, 30)	39.70	.15	.07	0.54 (1, 30)	0.03	.47	.02
STAI-Y2	0.15 (1, 30)	39.70	.71	.00	0.04 (1, 30)	0.03	.85	.00
ANCOVA Patients vs. control	11.11 (1, 29)	39.90	< .01	.28	1.46 (1, 29)	0.03	.24	.05
BDI-II	2.77 (1, 29)	39.90	.11	.09	0.10 (1, 29)	0.03	.75	.00
STAI-Y2	0.21 (1, 29)	39.90	.65	.00	0.00 (1, 29)	0.03	.96	.00
MoCA	0.85 (1, 29)	39.90	.36	.03	3.19 (1, 29)	0.03	.08	.10
ANCOVA Patients vs. control	10.68 (1, 27)	31.79	< .01	.28	1.24 (1, 27)	0.03	.28	.04
BDI-II	3.31 (1, 27)	31.79	.08	.11	0.09 (1, 27)	0.03	.76	.00
STAI-Y2	0.80 (1, 27)	31.79	.38	.03	0.00 (1, 27)	0.03	.96	.00
MoCA	1.32 (1, 27)	31.79	.26	.05	2.97 (1, 27)	0.03	.10	.10
SART Stop Trials Accuracy	7.49 (1, 27)	31.79	< .05	.22	0.00 (1, 27)	0.03	.97	.00

controlling for the participants' cognitive status. The size of the effect associated with the patient-control difference, however, was reduced after controlling for the affective and cognitive status (see Table η^2_p). These results did not change when controlling also for inhibition (regardless of the inhibition measure used), although a significant effect of inhibition was detected when using accuracy in SART stop trials (but not Stroop accuracy) as a covariate. As concerns the RAT accuracy, the one-way ANOVA confirmed the significant difference in performance between patients and control participants, which remained significant also when controlling for participants' depression and anxiety levels. Importantly, however, when controlling for participants' cognitive status, the difference between the groups in RAT accuracy was no more significant, and the results did not change when controlling for response inhibition skills.

To address potential limitations of these analyses in relation to the relatively small sample size, we carried out a series of control ANCOVAs. In these analyses, only a single covariate (or set of covariates) was entered in the analysis in order to allow a more powerful test of its effects. Therefore, we repeated the same ANCOVA three times with a single covariate (or set of covariates) entered: affective status only (BDI II; STAI-Y2), cognitive status only (MoCA), or inhibition skills only (SART Stop Trials Accuracy). The results, displayed in Table 3, fully supported the pattern observed in the standard analyses. Indeed, the significant difference between patients and controls in the AUT fluency was confirmed regardless the specific covariate entered into the analysis, and the significant difference in the RAT accuracy was no more significant when entering the cognitive status (whose effect was at the significance threshold) but remained significant when entering either the affective status or the inhibition measure.

We also appraised, via ANCOVA, whether the differences between patients and healthy controls in the AUT average originality, peak originality, and feasibility remained significant when controlling for AUT fluency, given that fluency is usually correlated with originality (e.g., Diehl & Stroebe, 1987; Parnes & Meadow, 1959) and that quantity (fluency) is assumed to breed quality (for reviews see e.g., Nijstad, 2009; Rietzschel, Nijstad, & Stroebe, 2007). Indeed, in our whole sample (patients and control participants), AUT fluency was positively correlated with average originality (r = .53, p < .01), peak originality (r = .70, p < .001), and feasibility (r = .52, p < .01).[5] The ANCOVA on the AUT average

Table 3. Differences between outpatients and controls in the Alternative Uses Test fluency and in the Remote Association Test accuracy when controlling for individual differences in single sets of variables (affective status, cognitive status, and inhibition skills).

	Alternative Uses Test Fluency (Number of different valid alternative uses produced)				Remote Association Test (Accuracy)			
Effect	*F* (df)	*MSE*	*p*	η^2_p	*F* (df)	*MSE*	*p*	η^2_p
One-way ANOVA Patients vs. controls	39.42 (1, 32)	41.20	< .001	.55	12.40 (1, 32)	0.03	< .01	.28
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STAI-Y2	0.15 (1, 30)	39.70	.71	.00	0.04 (1, 30)	0.03	.85	.00
ANCOVA Patients vs. control	17.28 (1, 31)	42.32	< .001	.36	1.50 (1, 31)	0.02	.23	.05
MoCA	0.16 (1, 31)	42.32	.69	.01	4.10 (1, 31)	0.02	.05	.12
ANCOVA Patients vs. control	36.54 (1, 30)	33.28	< .001	.55	10.95 (1, 30)	0.03	< .01	.27
SART Stop Trials Accuracy	9.29 (1, 30)	33.28	< .01	.24	0.04 (1, 30)	0.03	.84	.00

originality did not show a significant effect of the group (patients vs. healthy controls), $F(1, 31) = 0.18$, $MSE = .03$, $p = .67$, $\eta^2_p = .01$, when controlling for the significant effect of the AUT fluency, $F(1, 31) = 7.15$, $MSE = .03$, $p < .05$, $\eta^2_p = .19$. The same analysis on the AUT peak originality showed a similar nonsignificant effect of the group, $F(1, 31) = 0.11$, $MSE = .15$, $p = .74$, $\eta^2_p = .00$, when controlling for the significant effect of AUT fluency, $F(1, 31) = 15.84$, $MSE = .15$, $p < .001$, $\eta^2_p = .34$. Finally, no effect of the group was observed on the AUT feasibility, $F(1, 31) = .01$, $MSE = .31$, $p = .92$, $\eta^2_p = .00$, when controlling for the significant effect of AUT fluency, $F(1, 31) = 4.76$, $MSE = .31$, $p < .05$, $\eta^2_p = .13$. Thus, this set of control analyses showed that the differences between patients and healthy controls in the AUT average originality, peak originality, and feasibility can be possibly traced back to the difference between the two groups in the AUT fluency.[6]

Inhibition and performance in creativity tests within the groups

With the aim of reaching a better understanding of the role of response inhibition in predicting performance in creativity tests *within the groups* of patients and control participants, partial correlations between inhibition measures and AUT and RAT scores were computed while controlling for individual differences in cognitive status, depression, and anxiety variables. In healthy participants, three significant negative correlations were detected: between Stroop accuracy and RAT errors ($r = -.65$, $p < .05$), between SART accuracy and RAT nonresponses ($r = -.55$, $p < .05$), and between accuracy in SART stop trials and AUT fluency ($r = -.70$, $p < .01$). In the group of patients, four significant positive correlations were observed: between the Stroop effect and the number of RAT nonresponses ($r = .56$, $p < .05$), between SART accuracy and RAT accuracy ($r = .61$, $p < .05$), between SART accuracy and AUT feasibility ($r = .56$, $p < .05$), and between Stroop accuracy and AUT feasibility ($r = .55$, $p < .05$). All these correlations, with a single exception in healthy controls, show that better performance in response inhibition tests is associated with better performance, fewer errors, and fewer nonresponses in creativity tests, thus lending consistent support to the idea that more effective inhibition is beneficial for creativity.

Discussion

Our findings show a distinctly lower performance in both the AUT and the RAT in patients suffering from schizophrenia spectrum disorders compared to control participants. Indeed, patients generated fewer viable alternative uses in the AUT, and they also produced less original and feasible responses (although these latter differences could be possibly traced back to the difference in fluency). Patients also produced a lower number of correct responses to word triplets in the RAT. Our findings agree with a recent meta-analysis showing poorer performance in diverse creativity tests in schizophrenia (Acar et al., 2018) and are in line with the results of Abraham et al. (2007), who employed the AUT together with other measures to investigate creativity. Similar to Folley and Park (2005), we observed a lower performance in schizophrenic patients (vs. control participants) also in the RAT. Importantly, our version of the RAT, in keeping with the Italian validation study (Salvi et al., 2016), was specifically designed to tap insight (vs. analytical) solutions, thus representing a purer test of convergent thinking based on remote associations.

In agreement with Acar et al. (2018), we also found that more severe clinical conditions, in our case measured by PANSS scores, were associated with a poorer performance both in the RAT accuracy and in the AUT feasibility measures. Both the RAT and the AUT measures were correlated with positive symptoms, but for the RAT the poorer performance was also related to general and total symptoms. The associations with positive symptoms can be tentatively explained by the adverse effect of the conceptual disorganization and attenuated reality awareness associated with positive symptomatology (Williams, 1996) on the accomplishment of rather structured creativity tests like the RAT and the AUT. Our observation of some patients' bizarre verbalizations in the AUT would also be in line with such an interpretation. No significant relations were instead detected between AUT/RAT performance measures and negative symptomatology. Although the stereotyped thinking and difficulty in abstract reasoning associated with negative symptomatology (Kibel, Laffont, & Liddle, 1993) might have also contributed to the lower productivity of patients in the AUT, the observed correlation between AUT fluency and PANSS negative symptoms was not sufficiently strong in our data ($r = -.43$, $p = .09$).

Beyond consolidating and expanding previous findings, we aimed to shed more light on the underpinnings of creative performance in the AUT and in the RAT. Our results show that the difference in RAT accuracy between schizophrenic patients and control participants can be explained by the differences between these two groups in their cognitive status (and it is not explained by differences in depression and anxiety self-report measures). This conclusion supports the view that the RAT

relies mainly on convergent thinking (Lee et al., 2014), being related to basic cognitive skills, and thus it may not tap particularly well the ideation and divergent components of creativity. Our findings also show that the difference in the AUT fluency between schizophrenic patients and control participants cannot be explained by considering differences in depression and anxiety levels, cognitive status, and response inhibition skills, although controlling for these factors reduced the size of the effect (see Table 2, η^2_p). This result agrees with those reported by Abraham et al. (2007), who showed that the difference between schizophrenic patients and control participants in the AUT fluency remained partly unexplained even after considering the role of executive functioning. Thus, it seems that differences in the AUT performance cannot be completely traced back to dissimilarities in cognitive and executive skills, nor in specific affective variables, but are possibly related to differences in specific abilities underlying creative potential. Besides personality and environmental factors, several processes may be relevant in this regard (Benedek & Fink, 2019; Del Missier et al., 2015; Sternberg, 2005; Sternberg & Lubart, 1995), including the ability to switch to qualitatively different ideas (Acar & Runco, 2015; Goel, 2010; Kenett et al., 2018; Klein & Wolf, 1998; Mastria et al., 2021), strategic modulation of memory search (Benedek et al., 2017; Gilhooly et al., 2007; Keeney, 1994; Keller & Ho, 1988), avoidance of blocking ideas (Camarda et al., 2018; Smith, 2003; Storm & Patel, 2014), analogical reasoning and perspective change (Keller & Ho, 1988; Ward, Suss, Eccles, Williams, & Harris, 2011).

The results of our study suggest also that, although response inhibition does not explain the differences between schizophrenic patients and controls in the kind of creative thinking required by our tasks, individual differences in response inhibition are associated with a better performance in creativity tasks both in patients and healthy controls, thus supporting the view that inhibition can generally play a functional role in creativity, possibly by stopping inappropriate responses and contributing to funnel creative thinking toward the production of ideas and responses complying with task demands and constraints (see also Benedek, Franz, Heene, & Neubauer, 2012; Cheng, Hu, Jia, & Runco, 2016; Radel et al., 2015). However, this may come at a cost, at least in healthy participants with well-preserved inhibitory skills: that is, the potential limitation of creative ideas, as the observed negative partial correlation by accuracy in SART stop trials and AUT fluency seems to suggest.

Like any investigation, our study has some limitations. The case–control design of our research suggests caution in interpreting the results, although an effective control on the demographic features and on error variability was guaranteed by the strict match between outpatients and healthy participants on several important variables (as suggested by Fioravanti et al., 2005). The fact that all of the patients took antipsychotic medications seems not a problem for the purposes of the study given that, unlike conventional neuroleptics, atypical antipsychotics are effective on positive symptoms, without exacerbating negative symptoms, and hence they do not seem to decrease creativity as previously thought (Murry & Torrecuadrada, 1997). Although sample size was relatively small, this did not harm the study power, as we observed the predicted significant differences associated with large effect sizes. Moreover, the general pattern of findings, over different tests and various measures, consistently supported the main conclusions. Although we investigated two main tests of creativity, and we controlled for both affective and cognitive variables, future work may include further tests of creativity (with varying mixtures of divergent/convergent demands) and additional predictors, for instance measures of memory inhibition (Penolazzi et al., 2020; Stramaccia, Penolazzi, Altoè, & Galfano, 2017a; Stramaccia et al., 2017b) and measures of search and thinking strategies specifically related to idea generation (Del Missier et al., 2015; Gilhooly et al., 2007; Keller & Ho, 1988). Further, while the use of standard creativity tests and reliable outcome variables allows for a valid assessment of the investigated constructs, a more fine-grained analysis of the type and of the quality of the responses produced in tests specifically-designed to stimulate the generation of very original ideas may provide a more complete picture. Moreover, the extension of our investigation to nonverbal tests of creativity would represent a particularly interesting avenue for future research, considering that the type of test employed (verbal vs. nonverbal) seems to be a moderator of the relation between schizophrenia and creative performance (Acar et al., 2018). Another important future research direction could involve the design and test of interventions to foster creative skills by relying on the individual strengths and weaknesses that scientific investigations are attempting to delineate.

In conclusion, our findings highlight the importance of adopting a multi-measure approach to investigate creativity. Indeed, the two tasks assessing creativity in our study provided partially different pictures when examined in relation with cognitive measures and patients' performance. Finally, our results also suggest that both facets of creativity we investigated, tapping convergent and divergent thinking, are affected in

patients with schizophrenia, in contrast with the long-standing myth and anecdotical narrative of a positive relation between creativity and schizophrenia.

Notes

1. Several definitions of inhibition have been proposed and inhibitory processes have been investigated with a variety of measures (see e.g., Friedman & Miyake, 2004). In this study, in line with the majority of studies on inhibition in schizophrenia, we focus on response inhibition, which can be defined as the ability to withhold a prepotent response, and is usually assessed by the Stroop task, the Sustained Attention Response Task (SART), or the antisaccade task.
2. In the present study, we did not employ an originality score based on uniqueness of responses, given that this measure is sensitive to sample size (and thus potentially problematic in clinical studies). Moreover, in the very few cases in which a participant did not produce a single valid response for a stimulus object (7 cases overall), his/her score for that object on the originality and feasibility variables was 1 (i.e., the lowest point of the scales). Indeed, not producing any alternative use means failing to produce even a minimally original and feasible response. We also employed a more lenient alternative scoring of these responses, namely assigning to them the lowest values of originality and feasibility among the responses given to the same target object in the group to which the participants belonged (always patients). Substantive differences observed in our results when using these two different scoring criteria are reported in footnotes.
3. Given the a-priori specification of directional hypotheses (schizophrenic outpatients were expected to perform worse than controls on all the creativity, cognitive, and affective measures) these tests were not adjusted for multiple comparisons (e.g., Pagano, 2013; Tucker, 1991).
4. Conclusions did not change when conducting Mann-Whitney tests, with the exceptions of the difference between groups in the RAT nonresponse ($U = 81.5$, $Z = 2.15$, $p = .03$) and in the AUT feasibility measure ($U = 98.5$, $Z = -1.57$, $p = .12$). When using the more lenient criterion for scoring originality and feasibility in the case of nonresponses, the difference between patients and healthy controls was still significant in peak originality, $t(32) = -2.74$, $p < .01$ ($M_{patients} = 2.31$, DS = .43; $M_{controls} = 2.70$, DS = .38), but not in average originality, $t(32) = -0.83$, $p = .41$ ($M_{patients} = 2.09$, DS = .16; $M_{controls} = 2.12$, DS = .07), and in feasibility, $t(32) = -1.95$, $p = .06$ ($M_{patients} = 4.27$, DS = .32; $M_{controls} = 4.44$, DS = .14).
5. With the more lenient scoring of patients' nonresponses, the correlation coefficients were lower but still positive: AUT fluency with average originality ($r = .29$, $p = .09$), peak originality ($r = .63$, $p < .01$), and feasibility ($r = .38$, $p < .05$).
6. An additional set of analyses carried out without controlling for fluency indicated that the affective status did not account for the difference between patients and healthy controls in AUT average originality, peak originality, and feasibility. However, while controlling for the cognitive status did not account for the difference in peak originality, the differences in average originality and feasibility were no more significant when controlling for this factor (cf. Supplementary Materials). This seems to suggest that average originality and feasibility are more related to basic cognitive aspects than peak originality, but this conclusion has to be taken with caution considering that none of the covariates reached significance and that the differences between patients and controls were no more significant after controlling for AUT fluency.

Acknowledgments

The authors thank Vittorio Bortolin and Irene Teresa Florean for their help during data collection and scoring. The findings in the manuscript have not been published elsewhere, even if there is overlap between the predictor variables and the sample used in the present study and the ones employed in a previous study we reported (Del Missier, F., Galfano, G., Venerus, E., Ferrara, D., Bruine De Bruine, W., & Penolazzi, B. (2020). Decision-making competence in schizophrenia. Schizophrenia Research, 215, 457-459). In particular, although the sample and the predictor variables used in the present study are the same as the ones employed in the previous study, the aims of the present study, the criterion variables, the analyses, and the results are entirely different, given that the present study focuses on creativity whereas the previous one focused on decision-making competence.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability

Data are available from the corresponding author upon reasonable request.

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Appendix A

Table A1. Pairwise bivariate correlations between all the measures in the group of outpatients.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Gender (M/F)	–																			
2. Age	−.05	–																		
3. Education	.02	−.24	–																	
4. MoCA	−.19	.09	−.22	–																
5. BDI-II	.20	−.10	−.37	.25	–															
6. STAI-Y	.29	.01	−.20	.09	.71**	–														
7. SART accuracy (%)	−.34	−.23	−.10	.67**	.08	.15	–													
8. SART stop trials acc.	.55*	.19	.13	.05	−.09	.20	−.20	–												
9. Stroop accuracy (%)	.09	−.10	.36	−.01	−.12	.01	.35	−.21	–											
10. Stroop effect	.36	.27	−.42	−.13	.32	.41	−.38	.03	−.27	–										
11. AUT Fluency	−.11	.03	−.05	.22	−.10	.27	.35	.25	.29	−.08	–									
12. AUT Originality	−.15	.29	−.01	.00	−.24	.01	.20	.06	.43	.08	.71**	–								
13. AUT Peak originality	−.21	.28	−.12	−.03	−.22	.01	.06	.22	.20	.04	.69**	.89***	–							
14. AUT Feasibility	−.06	−.05	−.01	.13	.09	.33	.53*	−.16	.53*	.12	.63**	.77***	.52*	–						
15. RAT accuracy (%)	−.19	−.46	.23	.43	.08	.09	.70**	−.20	.18	−.40	.26	.15	−.05	.50*	–					
16. RAT errors	−.14	−.07	.04	−.62**	−.25	−.10	−.34	.16	−.19	−.16	.05	.04	.32	−.25	−.39	–				
17. RAT Nonresponses	.27	.39	−.20	.34	.20	.04	−.14	−.02	.07	.44	−.24	−.15	−.30	−.09	−.30	−.76***	–			
18. PANSS Positive sympt.	−.05	.44	.05	−.17	.09	−.27	−.58*	−.21	.03	−.09	−.37	−.25	−.23	−.50*	−.52*	−.04	.40	–		
19. PANSS Negative sympt.	.31	−.19	.29	−.82***	−.01	.13	−.63**	−.03	−.01	.17	−.43	−.25	−.16	−.26	−.37	.44	−.20	.11	–	
20. PANSS General sympt.	−.11	.43	.04	−.50*	.14	.34	−.54*	−.09	−.04	.19	−.11	−.03	.09	−.13	−.52*	.28	.08	.47	.55*	–
21. PANSS Total sympt.	.03	.33	.14	−.63**	.11	.15	−.70**	−.13	−.02	.14	−.34	−.19	−.09	−.34	−.61*	.30	.11	.65**	.70**	.93***

Significance levels are as follows: * $p < .05$, ** $p < .01$, *** $p < .001$.

Table A2. Pairwise bivariate correlations between all the measures in the group of healthy controls.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Gender (M/F)	–															
2. Age	.13	–														
3. Education	−.24	−.30	–													
4. MoCA	.39	−.23	−.20	–												
5. BDI-II	.51*	−.35	.05	.34	–											
6. STAI-Y	.30	−.42	.32	.32	.73**	–										
7. SART accuracy (%)	.41	−.32	.37	.20	.49*	.54*	–									
8. SART stop trials acc.	.69**	.11	.17	.22	.65**	.61**	.58*	–								
9. Stroop accuracy (%)	−.28	−.43	.09	.01	.00	.09	−.10	−.01	–							
10. Stroop effect	.21	.25	−.35	−.08	−.21	−.20	.10	.12	.05	–						
11. AUT Fluency	−.59*	−.16	−.17	−.14	−.52*	−.56*	−.33	−.80***	.13	.00	–					
12. AUT Originality	−.21	−.04	.29	−.22	−.28	−.19	−.01	−.16	.12	.12	.38	–				
13. AUT Peak originality	−.33	.11	.12	−.25	−.35	−.20	−.09	−.42	−.09	.05	.58*	.77***	–			
14. AUT Feasibility	−.16	.01	−.04	.07	−.40	−.14	−.42	−.19	.04	.16	.31	.46	.24	–		
15. RAT accuracy (%)	.02	−.21	−.07	.28	.26	.09	.49*	.19	.28	.39	.18	.28	.18	−.17	–	
16. RAT errors	.03	.25	−.08	.03	−.08	.18	−.27	−.15	−.56*	−.12	−.13	−.23	.10	.07	−.57*	–
17. RAT Nonresponses	−.16	.07	.04	−.44	−.27	−.32	−.58*	−.24	.20	−.35	−.05	−.03	−.20	.16	−.70**	−.09

Significance levels are as follows: * $p < .05$, ** $p < .01$, *** $p < .001$.