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Imagination links with schizotypal beliefs, not with creativity or learning

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Imagination refers to creating mental representations of concepts, ideas, and sensations that are not contemporaneously perceived by the senses. Although it is key to human individuality, research on imagination is scarce. To address this gap, we developed here a new psychometric test to assess individual differences in imagination and explored the role of imagination for learning, creativity, and schizotypal beliefs. In a laboratory-based (N = 180) and an online study (N = 128), we found that imagination is only weakly associated with learning achievement and creativity, accounting for 2–8% of the variance. By contrast, imagination accounted for 22.5% of the variance in schizotypal beliefs, suggesting overall that imagination may be more indicative of cognitive eccentricities rather than benefit the accumulation of knowledge or production of novel and useful ideas.

Imagination can be broadly defined as the tendency to create 'mental representations of concepts, ideas, and sensations in the mind that are not contemporaneously perceived by the senses [and ranges] from the re-creation of images or sensory perceptions in the mind that were previously seen or experienced in reality [. . .] to crafting images anew independent of prior actual sensory input [. . .]' (Scott & von Stumm, 2017, p. 1). As such, imagination describes a non-pathological trait dimension that is distinct from semantically related constructs, for example, fantasy proneness (i.e., intense vivid fantasies of realistic quality; Wilson & Barber, 1982), absorption (i.e., openness to absorbing and self-altering experiences; Tellegen & Atkinson, 1974), dissociation (i.e., altered state of consciousness, in which normally integrated mental processes become separated; Koffel & Watson, 2009), and daydreaming (i.e., gratifying reverie, usually of wish fulfilment; Singer & Antrobus, 1972). It is also fundamentally different to creativity, which refers to the production of something that is novel and useful (Sternberg & Lubart, 1996), rather than to merely generating mental representations. Like creative thinking, but unlike creative achievement, imagination involves principal cognitive processes, such as perception and memory, that are often automated and only partly subject to effortful control.

Imagination is thought to be a uniquely human attribute and has intrigued scientists since the 19th century (e.g., Freud, 1900; Galton, 1880). Nevertheless, our understanding of the benefits and risks that individual differences in imagination hold for psychological outcomes is currently limited. One reason for the paucity of empirical evidence on imagination lies in the nature of the construct itself. Imagination is traditionally thought of as idiosyncratic, elusive mental processes that are difficult to define and assess

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psychometrically, resulting in numerous, rather heterogeneous research approaches (Naylor & Simonds, 2015; Pearson, Naselaris, Holmes, & Kosslyn, 2015). The second reason is a consequence of the first, because definition and measurement issues have hindered an integrated agenda to evaluating the predictive validity of imagination for many psychological outcomes. To address these lacunae, the current article reviews the theoretical rationale for linking imagination with key psychological phenomena, including learning achievement, creativity, and schizotypal beliefs. We focus on these three domains, because previous studies suggested that they are important outcomes of imagination (see details below). We then report two original empirical studies to substantiate the predictive validity of imagination for these outcomes, using a new psychometric measure for imagination.

Imagination and learning

The investment theory of adult intelligence posits that learning achievement varies as a function of people's cognitive ability and their propensity to invest and apply that ability (Ackerman, 1996). This propensity is referred to as 'investment personality traits', which describe the tendency to seek out and engage in cognitively stimulating learning opportunities (von Stumm, Hell, & Chamorro-Premuzic, 2011). Investment personality traits include a wide number of constructs and measures, ranging from broad trait complexes, like Openness to Experience that refers to the readiness to cognitively engage with perception, fantasy, aesthetics, and emotions (Kaufman *et al.*, 2014), to comparatively narrow scales, for example, those measuring intellectual curiosity that describe individual differences seeking knowledge (von Stumm & Ackerman, 2013). The psychological function that appears to be common to all these traits is the cognitive exploration of the structure of both internal and external experiences (DeYoung, Grazioplene, & Peterson, 2012).

Imagination and in particular fantasy play have been argued to constitute crucial learning mechanisms during childhood, because they provide opportunities to extend the child's thinking beyond their current context (Vygotsky, 1990), although the empirical evidence for this claim is inconclusive to date (Lillard *et al.*, 2013). Similarly, imagination has been proposed to facilitate perceptual learning in adulthood, with several studies demonstrating an association between mental imagery and performance in visual detection and discrimination tasks (Moulton & Kosslyn, 2009; Pearson *et al.*, 2015). For other types of learning, such as abstract information or academic knowledge, the evidence for the role of imagination has been less conclusive. For example, a meta-analytic review found that the facet of Fantasy from the Openness to Experience scale, which captures preferences for daydreaming over thinking along realistic lines (Costa & MacCrae, 1992) and has been used to assess imagination, correlated on average .20 with crystallized intelligence ($n_{\text{studies}} = 3$) and college entry tests ($n_{\text{studies}} = 1$) but was not associated with academic performance ($n_{\text{studies}} = 4$; von Stumm & Ackerman, 2013). Although these findings paint an inconsistent pattern, imagination is a plausible candidate for an investment personality trait, because the creation of mental representations of concepts, ideas, and sensations is central to perception, memory, and consolidating information (Carlson, Moses, & Breton, 2002; Pearson *et al.*, 2015; Schacter & Madore, 2016). However, the role of imagination on the process of learning abstract or academic information has not been previously directly empirically evaluated.

Imagination and creativity

There is no unequivocal definition or measurement of creativity, but a number of theoretical concepts and methodological approaches coexist in the psychological literature (Batey & Furnham, 2006). They converge on the notion that creativity entails the production of something novel and useful (Sternberg & Lubart, 1996) and spans three elements (von Stumm *et al.*, 2011), including creative ability or divergent thinking ability (i.e., the potential to generate original ideas; Silvia *et al.*, 2008), creative ideation (i.e., use, of appreciation of and skill with ideas; Runco, Plucker, & Lim, 2001), and creative achievement (i.e., sum of creative outputs across lifespan; Carson, Peterson, & Higgins, 2005). Although creative ability, ideation, and achievement are recognized cornerstones of creative competence and recommended to be considered in conjunction, they are not necessarily empirically inter-related (Kaufman & Beghetto, 2009; von Stumm *et al.*, 2011).

Imagination is a likely precursor of creative ability, because original ideas may emerge as a result of recombining mental representations of ideas, concepts, and sensations. Creativity involves taking novel approaches to problems (Sternberg & Lubart, 1996) and implies the same perceptual and memory processes as imagination (Moulton & Kosslyn, 2009). Several studies reported positive correlations between Openness to Experience and creative ability (i.e., divergent thinking) of about .30 (Batey & Furnham, 2006; Silvia *et al.*, 2008; Silvia, Nusbaum, Berg, Martin, & O'Connor, 2009; von Stumm *et al.*, 2011), although these studies did not assess Openness to Experience at facet level. Hence, it remains speculative if the relationship between Openness to Experience and creative ability is indeed driven by the Fantasy facet, as a marker of imagination, or if it is primarily due to the other Openness facets.

Imagination is also likely to be positively associated with creative ideation, although the latter focuses specifically on idea generation, while the former does not necessitate producing an idea and could be restricted to the simple re-creation of previous experiences (cf. Immanuel Kant's distinction between productive and reproductive imagination). Creative ideation and imagination are both assessed through self-reports that capture individual differences in typical performance (i.e., what are person will do) rather than in maximum capacity (i.e., what a person can do), which is more accurately reflected by measures of creative ability (Runco *et al.*, 2001; von Stumm *et al.*, 2011). Because of their shared measurement approach, we might therefore expect that imagination is more strongly associated with creative ideation than with creative ability.

Creative achievement differs from creative ability and ideation in the way that it is less of a predictor of creativity but mostly its ultimate outcome (Carson *et al.*, 2005). Although imagination may also be positively associated with creative achievement, we speculate that its effects are mainly indirect and mediated by creative ability and ideation. In other words, we predict imagination to be a more distant predictor of creative achievement than of creative ability and ideation, because we view imagination as more relevant to the process of creative thinking than to translating the latter into a product or achievement.

Imagination and Schizotypal beliefs

Schizotypy describes behavioural, affective, and cognitive eccentricities, which constitute the foundation of psychotic disorders including schizophrenia (Baas, Nijstad, Boot, & De Dreu, 2016; Claridge *et al.*, 1996; Lenzenweger, 2018). One key aspect of schizotypy is the tendency to have atypical perceptual and other cognitive experiences, for example,

hallucinations, which often co-occur with magical and superstitious interpretations of events (Baas *et al.*, 2016). The 'unusual experiences' dimension of schizotypy – in short, schizotypal beliefs – has been shown to be positively associated with other measures of extraordinary beliefs, for example, beliefs in conspiracist ideation, which are false narratives that attribute the ultimate cause of an event to a malevolent plot by an organized superiority (Barron, Morgan, Towell, Altemeyer, & Swami, 2014), and in paranormal beliefs, which adapt supernatural explanations for phenomena, for example, ghosts, extraterrestrial life, and psychic abilities (Mathijsen, 2016). Associations between these extraordinary belief constructs are likely to have a common origin in imagination, which is essential for forming any conscious belief, especially those that build on notions that are distant to our reality. Indeed, previous research has empirically demonstrated that imagination and schizotypal beliefs are parts of the simplex arrangement of the Openness/Intellect domain, which includes intelligence and competence on the positive end and paranormal beliefs and magical ideation at the negative end (DeYoung *et al.*, 2012). The two ends of the simplex represent two behavioural tendencies: the preference to explore abstract information (i.e., learning) versus an emphasis on exploring perceptual information (DeYoung *et al.*, 2012). Imagination falls at the mid-point of the simplex and thus relates to both learning and schizotypal beliefs.

Assessing Imagination

Although various tests of imagination and semantically related constructs (e.g., absorption, fantasy proneness) exist in the psychological literature, no measure comprehensively assesses imagination as the tendency to create 'mental representations of concepts, ideas, and sensations in the mind that are not contemporaneously perceived by the senses' (p. 1, Scott & von Stumm, 2017). For example, the Vividness of Visual Imagery Questionnaire (VVIQ) asks how vividly participants perceive various scenarios, such as the rising sun, that they are prompted to create in their mind (Marks, 1973). Thus, the VVIQ focuses on the visual aspect of imagination but ignores other typical imaginative behaviours, for example, daydreaming. By comparison, the Fantasy facet of the Openness to Experience factor relies on character descriptions to contrast imaginative and realistic thinking (e.g., I have active imagination) but assesses few directly observable behaviours (Costa & MacCrae, 1992). More recently, Naylor and Simonds (2015) introduced the Imaginative Involvement Questionnaire (IIQ) that captures negative fantasy (e.g., traumatic past experiences), sensory imagery (i.e., intense perceptions of previous sensory experiences), daydream novelty (i.e., creative, non-repetitive daydreams), and positive fantasy (i.e., pleasant daydreaming). That is, the IIQ focuses on imagination as extreme emotional experiences or as creative processes but ignores many value-free imaginative behaviours that are essentially reproductive (e.g., revisiting fantasies).

To develop a measure of imagination that overcomes these earlier limitations, we conducted a thorough literature review and interviews with expert psychometricians[1] to identify domains of imagination that (1) refer to typical, observable imaginative behaviours, (2) mark individual differences in imagination, and (3) have been assessed in previous studies. We found consensus for the existence of seven domains, including imaginary childhood friends, daydreaming, dreams, thinking styles, transportation,

[1] *The expert panel included four professors of personality and individual differences (Phillip Ackerman, Adrian Furnham, Bob Hogan and Robert Plomin), who commented twice in detail on the item pool. Items were revised in line with the feedback received.*

imaginative responsiveness, and fantasies. While six of these domains focused on current behaviours, we also included retrospective reports on having imaginary friends in childhood, because they have been demonstrated to predict imagination in adulthood (Kidd, Rogers, & Rogers, 2010). For each domain, we created an initial item pool to assess the frequency, permanency, and intensity of corresponding imaginative behaviours, resulting in the Imaginative Behaviour Engagement Scale (IBES; the full scale can be found in the Appendix; details on the scale's validation and its psychometric properties are reported below and in the Supporting Information).

The current research

We conducted the current research to explore the associations of imagination with learning, creativity, and schizotypal beliefs. Specifically, we sought to substantiate the role of imagination, as assessed by the IBES, for learning achievement in study 1, and to test its association with creativity and schizotypal beliefs in study 2. Data for the IBES development and our two studies came from independent samples that did not overlap. In study 1, participants studied three scholarly texts in three weekly sessions, each of about 2,000 words length. After completing various other measures, they were asked to respond to exam-style multiple-choice questions (MCQs) to assess their learning. In weeks 2 and 3, participants also completed MCQs pertaining the previous weeks' texts, so that we derived scores for immediate recall and 1-week delayed recall. We predicted that imagination was positively associated with immediate and delayed recall, although we expected small effect sizes, in line with previous studies on the relationship between imagination and learning (von Stumm & Ackerman, 2013; von Stumm, 2018). We also assessed general cognitive ability and Openness to Experience, which are established predictors of learning (e.g., von Stumm *et al.*, 2011), to test whether they attenuated associations between imagination and learning achievement.

In study 2, participants were assessed on creative competence, including measures of creative ability, creative ideation, and creative achievement, as well as measures of schizotypal beliefs, including broad measures of schizotypy, conspiracist ideation, and paranormal beliefs. We predicted that imagination was positively associated with both creativity and schizotypal beliefs. However, we made no predictions about the comparative strength of association of imagination with creativity and schizotypal beliefs.

Methods

Study 1

Sample

Overall, 233 participants were recruited for this study, with 226 participating in week 1, 206 in week 2, and 197 in week 3, resulting in 180 participants with complete data who were included in the subsequent analyses. About 81% of the participants were undergraduate students at Goldsmiths University of London; the others were adult volunteers, who were recruited through newspaper advertisements and flyers in local businesses, and who included 1 school student, 23 full-time employees, 8 unemployed people, and 3 participants who preferred not to declare their status.

In the analysis sample, 44 participants identified as male, 135 as female, and 1 preferred not to state their gender. Age ranged from 18 to 76 years (M = 26.48, SD = 10.21). The sample included 72% native speakers of English.

Measures

Imaginative Behaviour Engagement Scale. This instrument was designed to broadly sample typical imaginative behaviours that were not aimed at improving performance outcomes or achievement. Through extensive literature reviews and repeated expert interviews, we identified seven core domains of imaginative behaviour engagement, including transportation, daydreaming, thinking styles, fantasies, dreams, imaginative responsiveness, and imaginary friends.

We developed an initial item pool of 42 behaviours across the seven domains that was completed by 219 participants (173 females; age ranging from 18 to 58 years), who rated the items either remotely online (N = 110) or in the laboratory (N = 109). In a first analysis step, behaviours were excluded if fewer than 25% of the sample reported to have engaged in them. Next, exploratory factor analysis was applied for each behavioural domain to the retained behaviours in the laboratory-based sample, and the factor solution was then confirmed in the data from the remotely online assessed sample. For each of the seven behavioural domains, we retained the two items with the highest factor loadings, which consistently emerged across the laboratory-based and remotely online assessed sample. Thus, the final IBES consisted of 14 self-report items (see Appendix for items, and Supporting Information for further details on the item analyses).

Lettersets. The lettersets test was used as a time-effective measure of logical reasoning, which is at the centre of general cognitive ability (McGrew, 2009). The test was taken from the ETS testing kit (Ekstroem, French, Harman, & Dermen, 1976) and consisted of five sets of letters with four letters in each set. For each group of five letter sets, four were alike based on a logical rule. The participant had to work out what the rule was and mark the odd one out in the set. This test included of 12 items, displayed together on one page, and timed at 3 min.

Personality. The 60-item NEO five-factor inventory (NEO-FFI; Costa & MacCrae, 1992) was used to assess the Five Factors of personality, herein the Big Five, with 12 items per factor, which were scored on 5-point Likert scales that ranged from 'strongly disagree' to 'strongly agree'. That is, the NEO-FFI assesses the Big Five at factor, rather than at facet level.

Information recall. Each week, participants completed 8 exam-style MCQs on the current week's text. In addition, they also completed 8 exam-style MCQs on the previous weeks' texts in week 2 and 3 (i.e., 16 questions overall in week 2 and 24 questions in week 3). Half of the questions pertaining to the previous weeks' texts had also been administered in the previous week, and half were not-before-seen questions. For each text, half the questions assessed factual and half conceptual knowledge. Each question had 5 answer options, including one correct answer and one that read 'I don't know'.

Procedure

Testing took place in designated laboratory spaces on desktop computers with speakers at a London university between March 2016 and January 2017. Participants left all personal items (e.g., mobile phones) with a research assistant outside their cubicle. In week 1, they

were randomly allocated to either read or listen to each week's 2,000 words text, which had been specifically written for this study and featured three different scholarly topics, including history (i.e., the Cuban Missile Crisis), science (i.e., CRISPR), and economics (i.e., the Dotcom bubble). Participants were instructed that they could win £50 if they achieved a top score in a set of exam-style MCQs that they were to complete after the study period. This ensured that participants were motivated to engage with and learn about the texts. In the listening condition, participants heard via headphones the 20-min-long digital recordings of the texts that were read out by a professional speaker (i.e., a male priest). In the reading condition, participants viewed the text on screen.[2] Participants received pens and notepaper to take notes on the text or recording, if they wanted, and they were allowed to reread or relisten to the texts as long as they wished. Precautions were taken to avoid participants copying the study materials.

In week 1, after the participants finished studying the current week's text and a research assistant had removed any notes, participants then completed measures of personality and imagination before they answered the exam-style MCQs. In weeks 2 and 3, participants completed other self-report measures, including again the IBES in week 3, before answering the MCQs. After completing week 3, each participant received £40 compensation as well as prize money of up to £150 for the highest scorers. The scholarly tests and corresponding MCQs are available at the Open Science Framework (https://osf.io/d85wy/); however, the current analyses were not formally preregistered.

Analysis

Immediate recall was operationalized as participants' total correct score in the MCQs that pertained to the current week's reading (i.e., 3 weeks with eight questions each). By comparison, 1-week delayed recall was operationalized as participants' total correct score from the questions that referred to the previous week's questions (i.e., 2 weeks with eight questions each). Linear regression models tested the predictive validity of imagination for immediate and delayed information recall, respectively. All models were adjusted for age, gender, study condition, having been diagnosed with dyslexia versus not, and being a native English speaker versus not. Imagination (i.e., IBES score) was entered in a first step. In a second and third step, cognitive ability (i.e., lettersets) and the Big Five were added, respectively, to test whether they attenuated associations of imagination with immediate and delayed recall.

Results

This study had a power of 78% to detect a correlation of .2 and a power of 98% to detect an association at .3 (based on the analysis sample of $N = 180$). Table 1 shows the descriptives for the variables in study 1. All scores were reliable and normally distributed (i.e., within ± 1.5 for skew and kurtosis), and means and *SD*s did not differ significantly compared to those from other samples.

Table 2 shows the correlations between the study variables. The test–retest correlation for the imagination measure IBES from week 1 to week 3 was $r = .88$,

[2] *The conditions reading versus listening were not of primary interest for the current study and thus, condition status was merely dummy-coded and controlled for in all analyses.*

Table 1. Descriptives for measures of imagination, cognitive ability, personality, and learning in study 1 (N = 180)

	n_{items}	Mean	*SD*	Min	Max	Kurt	Skew	α
IBES week 1	14	26.73	9.89	5	49	−0.67	0.06	.77
IBES week 3	14	25.99	10.83	3	55	−0.49	0.19	.82
Lettersets	12	6.65	2.27	1	12	−0.30	−0.04	–
Neuroticism	12	3.17	0.66	1.42	4.75	−0.27	−0.22	.82
Extraversion	12	3.24	0.54	1.50	4.67	−0.03	−0.11	.77
Openness	12	3.66	0.50	2.08	4.67	−0.38	−0.42	.70
Agreeableness	12	3.58	0.52	1.92	4.83	0.38	−0.32	.76
Conscientiousness	12	3.44	0.63	1.75	4.92	−0.51	0.05	.86
Immediate recall	24	15.4	4.51	3	23	−0.49	−0.48	–
Delayed recall	16	8.56	2.95	0	15	−0.15	−0.39	–

Note. IBES = Imaginative Behaviour Engagement Scale. α refers to Cronbach's alpha.

Table 2. Correlations between measures of imagination, cognitive ability, personality, and learning in study 1 (N = 180)

	1	2	3	4	5	6	7	8	9
1 IBES week 1	–								
2 IBES week 3	.88	–							
3 Immediate recall	.11	.08	–						
4 Delayed recall	.07	.07	.74	–					
5 Neuroticism	.29	.29	.00	−.04	–				
6 Extraversion	−.08	−.09	−.07	−.06	−.39	–			
7 Openness	.41	.43	.31	.24	.03	−.01	–		
8 Agreeableness	−.16	−.16	.14	.11	−.31	.18	−.02	–	
9 Conscientiousness	−.21	−.23	−.14	−.11	−.50	.25	−.10	.12	–
10 Lettersets	−.02	.00	.29	.22	−.07	−.08	.19	.06	.00

Note. IBES = Imaginative Behaviour Engagement Scale.

suggesting high stability. Furthermore, the IBES correlated strongly with Openness to Experience (r = .41 and .43), confirming that both tapped a related, albeit distinct construct space. Imagination also correlated relatively strongly with Neuroticism (r = .29) but less so with immediate and delayed recall (r-values ranged from .07 to .11). By comparison, cognitive ability and Openness correlated from .22 to .31 with immediate and delayed recall (cf. von Stumm, 2018), suggesting that imagination was at best a distal determinant of learning achievement.

Table 3 shows the outcomes of the first series of regression models that tested the predictive validity of imagination for immediate information recall. The first model step accounted for 2.2% of the variance (i.e., adjusted R^2) with IBES being significantly associated with immediate recall (β = .16, p = .043). This association remained largely unchanged (β = .16, p = .032) after adding cognitive ability (i.e., lettersets scores; β = .30, p < .001), with the model accounting for 10.9% of the variance in immediate recall. After adding the Big Five, the model accounted for 15.7% of the variance, with cognitive ability (β = .24, p = .001) and Openness to Experience (β = .23, p = .003)

emerging as significant predictors and the latter attenuating the previously significant association with IBES.

Table 4 shows the results of the regression analyses for delayed recall. Imagination was not a significant predictor across all three modelling steps. However, the associations of cognitive ability and Openness to Experience with delayed recall resembled those with immediate recall, with both predictors accounting for 9.3% of the variance in delayed recall in the third model step.

Table 3. Imagination, cognitive ability, and the Big Five as predictors of immediate information recall

	Est	SE	β	t	p
Step 1					
IBES	0.07	.03	.16	2.04	.043
Step 2					
IBES	0.07	.03	.16	2.16	.032
Lettersets	0.60	.14	.30	4.23	.001
Step 3					
IBES	0.02	.04	.04	0.50	.614
Lettersets	0.49	.14	.24	3.40	.001
Neuroticism	−0.06	.63	−.01	−0.09	.930
Extraversion	−0.28	.60	−.04	−0.47	.638
Openness	2.14	.72	.23	2.99	.003
Agreeableness	0.95	.68	.11	1.41	.161
Conscientiousness	−0.93	.57	−.13	−1.64	.104

Note. IBES = Imaginative Behaviour Engagement Scale. Models were adjusted for age, gender, dyslexia status, English native speaker status, and study condition. Corresponding coefficients are not shown. The final model's fit statistic was $F(167) = 3.79$, $p < .001$.

Table 4. Imagination, cognitive ability, and the Big Five as predictors of delayed information recall

	Est	SE	β	t	p
Step 1					
IBES	0.03	.02	.11	1.39	.166
Step 2					
IBES	0.03	.02	.11	1.44	.151
Lettersets	0.29	.10	.22	3.03	.003
Step 3					
IBES	0.00	.02	.02	0.20	.841
Lettersets	0.22	.10	.22	2.26	.025
Neuroticism	−0.37	.43	−.08	−0.86	.392
Extraversion	−0.33	.41	−.06	−0.81	.418
Openness	1.14	.49	.19	2.36	.020
Agreeableness	0.28	.46	.05	0.61	.543
Conscientiousness	−0.61	.39	−.13	−1.59	.114

Note. IBES = Imaginative Behaviour Engagement Scale. Models were adjusted for age, gender, dyslexia status, English native speaker status, and study condition. Corresponding coefficients are not shown. The final model's fit statistic was $F(167) = 2.15$, $p = .016$.

In summary, study 1 showed that imagination predicted immediate information recall, accounting for 2.2% of the variance. While this association was independent of cognitive ability, it was fully attenuated by Openness to Experience. We observed no significant associations between imagination and delayed information recall. Overall, the results of study 1 suggested that imagination was only weakly associated with learning achievement.

Study 2

Study 2 tested associations between imagination and creativity and schizotypal beliefs. In addition, we assessed the Openness facets Fantasy and Ideas, as well as an overall measure of the factor Openness to Experience. We tested whether associations of imagination with creativity and schizotypal beliefs could be attenuated by the two Openness facets, which are the most theoretically relevant facets to imagination (Costa & MacCrae, 1992).

Sample

Using Prolific Academic (www.prolific.ac), an international participant recruitment online platform that registers mainly British individuals, 128 participants were recruited for this study. Participants were eligible if they had over an 80% satisfactory completion rate in previous studies. Participants received £6 in compensation for completion of the survey, which took 40 min on average.

The sample included 54 females and 74 males, with age ranging from 18 to 61 years (M = 29.51, SD = 8.60). Seventy-three per cent of the participants identified as native English speakers. Sixty-three per cent had previously obtained a university degree. Of the sample, with 25% were still in education and 57% reported to be in employment.

Measures

Imaginative Behaviour Engagement Scale. The same scale as described in study 1 was used.

Openness to Experience. This Big Five trait was assessed in three ways, including the NEO-FFI measure for Openness of Experience like in study 1, and the facets Fantasy and Ideas from the NEO-PIR. The facets Fantasy and Ideas consisted of eight items each (Costa & MacCrae, 1992).

Schizotypal Personality Questionnaire (SPQ). Schizotypal personality was measured in two ways, using subscales of the full SPQ and the short SPQ assessment tool (SPQ-B; Raine, 1991; Raine & Benishay, 1995). The SPQ was designed to assess schizotypal personality disorder based on the DSM-III diagnostic criteria for schizophrenia but is now more commonly used as a measure of schizotypy (Asai, Sugimori, Bando, & Tanno, 2011).

From the full SPQ measure, three subscales with binary yes/no items were administered that assess different dimensions of schizotypal beliefs, including odd beliefs or magical thinking (SPQ-OBMT; seven items), unusual perceptual experiences (SPQ-UPE; nine items), and suspiciousness (SPQ-SUS; eight items). The SPQ-B consisted of 22 binary

yes/no items and assessed three factors of schizotypy: cognitive-perceptual deficits (eight items), interpersonal deficits (eight items), and disorganization (six items).

Creative Ideation Scale (RIBS). This 23-item measure assesses creative thinking in relation to creative behaviours, activities, and achievements, focusing on a creative frame of mind. Answers ranged from 'never' to 'very often' on a 5-point scale (Runco et al., 2001). Due to an error, participants completed only 22 of the 23 items. The missing item was 'I would take a college course that was based on original ideas'.

Creative Achievement Questionnaire. This scale assesses 'the sum of creative products generated by an individual in the course of his or her lifetime', spanning 10 domains of creative achievement, including visual arts, music, dance, architectural design, creative writing, humour, inventions, scientific discovery, theatre and film, culinary arts (Carson et al., 2005). Each domain comprises of seven items with a weighted scoring system, whereby higher levels of creative achievement are exponentially heavier weighted that lower levels of creative achievement. For example in music, 'My composition has been recorded' gets a score of 1 while 'My composition have been critiqued in a national publication' gets score of 7.

Guilford Alternative Uses Test. This test measures divergent thinking, with participants writing down as many different uses as they could think of for an everyday object in 60 s (Guilford, 1959). The three objects included here were a ping-pong ball, a plank of wood and a paperclip (i.e., 60 s for each). Answers were scored for fluency (i.e., number of different valid responses) and originality (details below).

Paranormal Belief Scale. This measure includes 26 self-report items assessing seven dimensions of paranormal beliefs, including traditional religious belief, psi, witchcraft, superstition, spiritualism, extraordinary life forms, and precognition (Tobacyk, 2004). Responses are given on a 7-point rating scale from 'strongly disagree' to 'strongly agree'.

Generic Conspiracist Beliefs Scale. This 15-item scale measures the extent of an individual's conspiracist ideation without being reliant upon specific conspiracy theories (Brotherton, French, & Pickering, 2013). The scale describes five factors, including government malfeasance, extraterrestrial cover-up, malevolent global conspiracies, personal well-being (i.e., concerns about health and liberty), and control of information, on a 5-point scale ranging from 'definitely not true' to 'definitely true'.

Procedure

Data were collected between May and June 2017. Participants completed the study via the online survey platform at a time and location that suited them. Informed consent was obtained prior to completion of the test battery, administered in the order that they are presented above. Two enforced breaks of 60 s each were added one- and two-thirds into the survey, to ensure that participants maintained their concentration. Five quality control

questions (e.g., 'Please select the third option below') were included at random points throughout the survey to ensure high data quality and participant adherence. In cases where participants failed a quality control item, the survey closed early. A research assistant preliminarily checked participants' responses for validity and completeness, before compensating participants, typically within 2–3 days.

Analysis

To score creative fluency, a research assistant coded the responses to the alternate uses test as nonsense responses with a value of 0; sensible precise responses with a value of 1; and responses that were vague and allowed interpretations beyond a definite use (e.g., 'eat') with a value of 2. A second research assistant independently coded the responses of a random selection of 10 participants. The agreement between the two coders was 96%, 93%, and 97% across the 3 tasks (i.e., ping-pong ball, plank, and paperclip), respectively.

To score creative originality, one research assistant mapped all participants' responses into logical main themes (i.e., 63 for ping-pong ball uses; 53 for plank; 40 for paperclip). The first author reviewed and revised the map, before a second research assistant coded all responses in line with the map's themes. Responses were then recoded according to their frequency, differentiating themes that occurred once or twice (2; about 1% of responses per task) from those that occurred three to eight times (1; about 5% of responses per task) to those that occurred more often (0). Scores were summed across items and responses to mark creative ability in terms of fluency and originality.

For the factor and facets of Openness to Experience, we computed an overall factor score without items from the Fantasy and Ideas facet, for which we computed separate composites. Thus, we obtained three distinct Openness scales.

Next, we computed correlations between the IBES, Openness scales, creative ability (i.e., fluency and originality), creative ideation, schizotypy scales, conspiracist ideation, and paranormal beliefs. Because creative achievement scores were not normally distributed (skew = 10.04; kurtosis = 104.80), which is common for this scale (Carson *et al.*, 2005), we used a median split to create two groups of low and high creative achievers, which were used in subsequent analyses. We conducted a series of *t*-tests, with a Bonferroni correction of the *p*-value to adjust for multiple comparisons (i.e., .05 divided by 8) to evaluate whether the two groups differed on the study's measures. Subsequently, we built separate summary composites for creative competence following von Stumm *et al.*'s (2011) recommendation to combine creative ideation, ability, and achievement to produce a comprehensive operationalization of creativity. We took a similar approach to operationalize, schizotypal beliefs, by *z*-transforming their respective continuous indicators and summing them with any dichotomous indicators (i.e., the creative achievement scores). For schizotypal beliefs, we excluded items from the SPQ-B that featured in the SPQ subscales ($n = 5$), so that each item was once included in the schizotypal beliefs composite. We then tested to what extent imagination explained individual differences in creative competence and schizotypal beliefs in two separate sets of regression models that were adjusted for the confounders age, gender, and being a native speaker versus not. In a first modelling step, we added imagination and confounders, while in a second and third step we also included the Openness Experience factor and Ideas facet. We did not add the Fantasy facet to our models, because of its high correlation with the IBES (i.e., collinearity).

Results

This study had a power of 65% to detect a correlation of .2 and a power of 95% to detect an association at .3 (based on the analysis sample of $N = 137$). Table 5 shows the descriptives for all study variables, which were reliable and normally distributed with skew and kurtosis not exceeding values of ±1.5, with the exception of creative achievement (median = 5).

Table 6 reports the study's variables' correlations. The IBES was most strongly associated with the Fantasy facet of Openness ($r = .64$), confirming that both scales mapped a similar construct space, but less so with the Openness factor and the Ideas facet. The IBES was also strongly associated with creative ideation ($r = .51$) but its links with creative ability (i.e., fluency and originality) were much smaller (i.e., $r = .01$ and .12). This difference in association is likely to be due to the fact that IBES and the measure creative ideation share common methods variance (i.e., both are based on self-reports of typical behaviours), while creative ability was assessed by a maximum performance test. By comparison, IBES correlated more strongly with the schizotypal belief scales, ranging from $r = .20$ (i.e., with the Generic Conspiracist Beliefs Scale [GCB]) to $r = .47$ (i.e., for the SPQ-UPE). Creative ability and ideation correlated weakly, while the schizotypal belief scales were more strongly intercorrelated, suggesting that the construct was more coherent than creativity in the current study. Creative ideation was positively associated with schizotypal belief scales with modest to large effect sizes, but the creative ability markers showed negative associations with five out of six schizotypal belief scales. Overall, the correlation pattern suggested weaker associations for the creative ability measures than for all other scales, which are likely to be due to the differences in

Table 5. Descriptives for measures of imagination, openness, creativity, and schizotypal beliefs in study 2

	n_{Items}	Mean	SD	Min	Max	Skew	Kurt	α
IBES	14	29.46	10.30	10	57	0.42	−0.50	.82
RIBS	22	3.10	0.71	1.18	4.82	0.02	−0.36	.94
CAQ	70	9.50	34.48	0	383	10.04	104.80	.92
AUT originality	3	0.89	0.91	0	4.33	1.28	1.30	.55
AUT fluency	3	4.22	1.81	0	8.67	0.14	−0.36	.66
SPQ-B	22	11.76	4.42	2	21	−0.16	−0.75	.78
SPQ-OBMT	7	1.45	1.80	0	7	1.37	1.19	.76
SPQ-UPE	9	2.16	2.02	0	7	0.68	−0.57	.77
SPQ-SUS	8	1.74	1.40	0	4	0.22	−1.22	.79
GCB	15	2.84	0.92	1	4.73	−0.11	−0.78	.94
PBS	26	2.64	1.22	1.19	5.58	0.57	−1.00	.90
Openness	8	3.35	0.61	1.88	4.62	−0.07	−0.63	.68
Fantasy facet	8	3.55	0.73	1.75	5	−0.07	−0.69	.85
Ideas facet	8	3.71	0.66	2	5	−0.23	−0.18	.82
Creativity composite	–	0.37	2.25	−4.61	6.83	0.38	−0.03	–
Schizotypy composite	–	0.00	4.07	−7.86	8.14	0.08	−0.75	

Note. IBES = Imaginative Behaviour Engagement Scale; RIBS = Runco Ideational Behavior Scale; CAQ = Creative Achievement Questionnaire; SPQ-B = Schizotypal Personality Questionnaire – Brief; OBMT = Odd Beliefs & Magical Thinking; UPE = Unusual Perceptual Experiences; SUS = Suspiciousness; GCB = Generic Conspiracist Beliefs; PBS = Paranormal Beliefs Scale; α = Cronbach's alpha.

Table 6. Correlations between imagination, creativity, and schizotypal beliefs in study 2

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 IBES	–												
2 Openness	.26	–											
3 Fantasy facet	.64	.41	–										
4 Ideas facet	.27	.61	.30	–									
5 RIBS	.51	.35	.43	.55	–								
6 AUT (original)	.01	.23	.07	.15	.07	–							
7 AUT (fluency)	.12	.21	.19	.17	.12	.54	–						
8 CAQ	.12	.19	.07	.20	.30	.11	–.03	–					
9 SPQ-B	.41	.12	.37	.22	.44	.11	.13	.15	–				
10 SPQ-OBMT	.29	.19	.23	.17	.34	–	–	.20	.22	–			
11 SPQ-UPE	.47	.23	.38	.16	.47	–	–	.17	.44	.49	–		
12 SPQ-SUS	.19	–	.13	.09	.30	–	–	.03	.50	.12	.34	–	
13 GCB	.20	–	.14	.11	.32	–	–	.26	.27	.34	.32	.36	–
14 PBS	.25	.00	.09	.01	.22	–	–	.17	.16	.64	.37	.11	.57

Note. IBES = Imaginative Behaviour Engagement Scale; RIBS = Runco Ideational Behavior Scale; CAQ = Creative Achievement Questionnaire; SPQ-B = Schizotypal Personality Questionnaire – Brief; OBMT = Odd Beliefs & Magical Thinking; UPE = Unusual Perceptual Experiences; SUS = Suspiciousness; GCB = Generic Conspiracist Beliefs; PBS = Paranormal Beliefs Scale.

measurement approach (i.e., self-report or typical performance vs. ability assessment or maximum performance).

When testing for differences between the high and low creative achievement groups (i.e., median split at 5), we observed two significant effects ($p < .00625$ in both cases). The group of high creative achievers scored on average higher on creative ideation ($M = 3.38$) than the group of low achievers ($M = 2.93$; $t(92) = -3.5, p < .001$), and they also scored higher on GCB ($M = 3.15$ vs. 2.66; t (100) $= -3$; $p = .004$). No other meaningful differences between the two groups were observed, suggesting that creative achievement was overall only weakly associated with imagination, measures of creativity, and schizotypal beliefs.

The composite indices for creative competence (i.e., creative ability, creative ideation, and creative achievement) and schizotypal beliefs (i.e., SPQ-Brief, SPQ-SUS, SPQ-OBMT, SPQ-UPE, GCB, and Paranormal Belief Scale) were normally distributed (Table 3). In a model controlling for age, gender, and being a native English speaker versus not, IBES accounted for 8% of the variance in a composite of creative competence ($\beta = .30$; $p < .001$; Table 7). After adding the Openness factor, the model accounted for 19.4% of the variance, and Openness ($\beta = .35; p < .001$) and imagination ($\beta = .20; p = .019$) were both significant predictors. After adding the Ideas facet, the association between imagination and creativity was further attenuated but remained significant ($\beta = .17$; $p = .046$), with the model accounting for 22.8% of the variance.

In the regression model with the schizotypal beliefs composite as outcome (Table 8), imagination was a significant predictor ($\beta = .47; p < .001$), with the model accounting for 22.5% of the variance. This finding remained largely unchanged after adding the Openness factor and also after adding the Ideas facet to the model. Both Openness factor and Ideas

Table 7. Imagination, openness, and ideas as predictors of creative competence

	Est	SE	β	t	p
Step 1					
IBES	0.07	.02	.30	3.45	<.001
Step 2					
IBES	0.04	.02	.20	2.37	.019
Openness	1.33	.31	.35	4.23	<.001
Step 3					
IBES	0.04	.02	.17	2.01	.046
Openness	0.75	.38	.20	1.95	.054
Ideas	0.90	.35	.26	2.54	.012

Note. IBES = Imaginative Behaviour Engagement Scale. Models were adjusted for age, gender, and English native speaker status. Corresponding coefficients are not shown. The final model's fit statistic was $F(121) = 7.26$; $p < .001$.

Table 8. Imagination, openness, and ideas as predictors of schizotypal beliefs

	Est	SE	β	t	p
Step 1					
IBES	0.19	.03	.47	5.95	<.001
Step 2					
IBES	0.19	.03	.48	5.80	<.001
Openness	−0.19	.56	−.03	−0.34	.734
Step 3					
IBES	0.19	.03	.47	5.60	<.001
Openness	−0.51	.70	−.08	−0.74	.461
Ideas	0.50	.64	.08	0.78	.436

Note. IBES = Imaginative Behaviour Engagement Scale. Models were adjusted for age, gender, and English native speaker status. Corresponding coefficients are not shown. The final model's fit statistic was $F(121) = 6.85$; $p < .001$.

facet were neither significant predictors of schizotypy nor did they attenuate the association between imagination and schizotypy.

Discussion

Imagination, an attribute unique to humans and key to understanding the mind, has intrigued researchers across disciplines since the 19th century. Notwithstanding, the construct and its associations with affect, behaviour, and cognition remain poorly understood until today. The current study sought to address this lacuna by developing a new measure of individual differences in imagination, and empirically testing a broad theoretical nexus of the associations between imagination, learning, creativity, and schizotypal beliefs.

By contrast to previous scales of imagination (e.g., Marks, 1973; Naylor & Simonds, 2015), our new measure broadly spanned seven domains of imaginative behaviours that

people typically engage in, including having imaginary friends, daydreaming, dreams, thinking styles, transportation, imaginative responsiveness, and fantasies. Based on extensive validation analyses, our final IBES consisted of 14 self-report items, two per domain, and had excellent concurrent and test–retest reliability. Thus, we produced a new, valid instrument for researchers to study individual differences in imaginative behaviour engagement (see Appendix for the items).

We showed here that imagination, as assessed by the IBES, was only weakly related to cognitive ability factors and processes, such as acquiring new information and generating alternative ideas. This finding is in line with previous research that suggested imagination may be more relevant to processing perceptual information rather than abstract knowledge and reasoning (DeYoung *et al.*, 2012; Pearson *et al.*, 2015). Furthermore, our findings add to the existing body of empirical evidence that highlights the discrepancy between tendencies for imagination and demonstrated creative ability and achievement (Kaufman & Beghetto, 2009; Moulton & Kosslyn, 2009). By contrast to its associations with learning and creativity, we found that imagination was closely linked with the tendency to engage in unusual perceptual experiences and thus, to have creative ideation and schizotypal beliefs. In terms of effect sizes, individual differences in imagination explained about 2% and 8% of the variance in learning and creativity, respectively, but they accounted for more than 22% of the variance in schizotypal beliefs. This finding can be interpreted in two ways. For one, it is possible that imagination is indeed less relevant for learning and creativity than for the tendency to engage in unusual perceptual experiences. The strong association between imagination and schizotypal beliefs even invites to speculate that the tendency to create mental representations may potentially hinder learning and creativity, because the latter require the realistic perception and processing of information. By contrast, schizotypal beliefs follow from interpreting experiences in unusual ways that – at times – may be too removed from the reality to inspire learning and creativity. It is important in this context to consider the role of executive control or the extent to which thinking processes can be wilfully regulated: learning and creativity require effort and focus, while schizotypal beliefs are often involuntary and beyond the reach of conscious control. Our conceptualization of imagination resulted in a measure that captured behavioural tendencies under varying degrees of executive control, for example, having had an imaginary friend in childhood (low control) or revising and developing further specific fantasies (high control; Kidd *et al.*, 2010). That said, the majority of IBES items viewed imagination as a natural, uncontrolled thinking process, akin to schizotypal beliefs that are typically also beyond an individual's control (Lenzenweger, 2018). We propose here that the shared lack of executive control in imagination and schizotypal beliefs gives rise to their association and differentiates them from effortful, more regulated cognitive processes like learning and creativity.

A second, alternative explanation of the current findings lies within the differences in the measurement approach taken to assess imagination, learning, creativity, and schizotypal beliefs. Specifically, learning and creative ability were assessed through maximum performance tests that capture what a person *can* do at their best (Ackerman, 1996). By contrast, imagination and schizotypal beliefs were assessed as typical performance, that is, what a person is most likely to or *will* do. It is possible that the pattern of empirical associations observed in the current study between imagination, learning, creativity, and schizotypal beliefs can be fully attributed to the differences between typical or maximum performance measures. Our scale-level observations further support this second interpretation of the findings: For example, imagination was strongly

associated with creative ideation, which were both assessed in terms of typical performance, but not with creative ability and creative achievement that were operationalized by maximum performance measures. Many studies have reported negligible associations between maximum and typical performance measures, for example, between personality traits and cognitive ability (von Stumm *et al.*, 2011). Future research must explore alternative methods for assessing imagination, for example, through implicit tests, to confirm if the empirical associations observed here and in other studies are meaningful at the conceptual or the measurement level, or both (von Stumm *et al.*, 2011).

Limitations on generality

Our research has some noticeable strengths; for example, our studies were well powered with sizeable samples and established measures to assess the variables of interest. That said, our research also suffers two key limitations. For one, schizotypal beliefs were only assessed through self-reports and not through more direct observations, as was for the example the case for creative ability (i.e., alternate uses test) and learning (i.e., MCQ assessments of learning content). Thus, the composite of schizotypal beliefs may have included more measurement error than the other constructs in this study. Our second key limitation was that we did not explore any of the behavioural mechanisms that underlie the association between imagination and other constructs, in this case learning, creativity, and schizotypal beliefs. Thus, any discussions of why imagination may or may not be associated with other constructs remain speculative, and future research will have to explore its biopsychological underpinnings. Finally, our samples were not representative of the general population.

Conclusion

Our findings suggest that at least some forms of individual differences in imagination are more closely associated with schizotypal beliefs than with creativity or learning. This discrepancy in association suggests that imagination enhances the processing of perceptual, rather than abstract information, which differ in the extent to which they require effort and control. Because the current study only allows for speculation about the causes of this pattern of association, we highlight the need for future research to explore the behavioural and biopsychological mechanisms that underlie associations between imagination and other constructs.

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Supporting Information

The following supporting information may be found in the online edition of the article:

Data S1. Validating the Imaginative Behaviour Engagement Scale.

Appendix: Imaginative Behaviour Engagement Scale (IBES) Items with scoring

1. Did you have one or more imaginary friend(s) as a child?
a) No* b) One c) Two d) Three or more e) I don't remember*
a)0 b)1 c)2 d)3 e)0
2. How long did the friendship(s) last?
a) Days b) Weeks c) Months d) Years e) Still with me f) I don't remember
a)1 b)2 c)3 d)4 e)5 f)0
3. When you daydream, do you clearly see images emerging in your mind?
a) Never b) Occasionally c) Frequently d) Often e) All the time
a)0 b)1 c)2 d)3 e)4
4. In your daydreams, do you perceive the smell or taste of things as if they were real?
a) Never b) Occasionally c) Frequently d) Often e) All the time
a)0 b)1 c)2 d)3 e)4
5. Do you ever revisit specific fantasies in your thoughts and develop them further?
a) Never b) Occasionally c) Frequently d) Often e) All the time
a)0 b)1 c)2 d)3 e)4
6. Do you regularly find time in your life for engaging in fantasies, perhaps during a walk or workout?
a) Never b) Occasionally c) Frequently d) Often e) All the time
a)0 b)1 c)2 d)3 e)4
7. Are you able to imagine events so vividly that they grip your attention like a good book or film?
a) Never (b) Occasionally (c) Frequently (d) Often (e) All the time
a)0 b)1 c)2 d)3 e)4
8. If you wished, could you imagine that you had an additional arm so much that you would feel the limb and its movements?
a) Yes, without any difficulty b) Easily c) With some difficulty d) With great difficulty e) No
a)4 b)3 c)2 d)1 e)0
9. When you have experienced emotions like fear or joy in your dreams, do they continue to affect you after you have woken up?
a) Never b) Occasionally c) Frequently d) Often e) All the time
a)0 b)1 c)2 d)3 e)4
10. Do the memories of your dreams influence your behaviour and actions when you are awake?
a) Never b) Occasionally c) Frequently d) Often e) All the time
a)0 b)1 c)2 d)3 e)4
11. Do you ever play around with ideas just for fun?
a) Never b) Occasionally c) Frequently d) Often e) All the time
a)0 b)1 c)2 d)3 e)4
12. Do you find that you get so interested in a new idea that you forget about other things that you should be doing?
a) Never b) Occasionally c) Frequently d) Often e) All the time
a)0 b)1 c)2 d)3 e)4
13. When you watch a good movie, do you become immersed in the story as if you were part of it?
a) Never b) Occasionally c) Frequently d) Often e) All the time
a)0 b)1 c)2 d)3 e)4
14. When you read a good book, do you start thinking and feeling like its characters?
a) Never b) Occasionally c) Frequently d) Often e) All the time
a)0 b)1 c)2 d)3 e)4

*Skip question 2.