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Synaesthesia, creativity and art: What is the link?

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It has been suggested that individuals with synaesthesia may show heightened creativity as a result of being able to form meaningful associations between disparate stimuli (e.g. colour, sound). In this study, a large sample ($N = 82$) of people with various kinds of synaesthesia were given two psychometric tests of creativity (Remote Associates Test, Alternate Uses Test) and were also asked about the amount of time engaged in creative arts (visual art, music). There was a significant tendency for synaesthetes to spend more time engaged in creative arts and this was, at least in part, dependent upon the type of synaesthesia experienced. For example, synaesthetes experiencing vision from music were far more likely to play an instrument than their other synaesthetic counterparts. There was no relationship between this tendency and the psychometric measures of creativity, but synaesthetes did outperform controls on one of the two psychometric measures (Remote Associates). We conclude that the tendency for synaesthetes to be more engaged in art is likely to have a different mechanism to psychometric measures of creativity, and that there is no direct link between them. Although synaesthetes may well perform better on some measures of creativity, we suggest that synaesthetes have better bottom-up access to certain associations, but are not necessarily better able to use them flexibly (in divergent thinking).

Creativity is typically defined as the ability to generate novel associations that are adaptive in some way. Random associations may be novel but they need not be useful, meaningful or appreciated by others. What makes some people more creative than others? There are many factors that appear to be relevant (for a review see Sternberg & Lubart, 1999). However, the present study will concentrate on one particular claim that has recently been made. Namely, that there is a link between synaesthesia and creativity (Ramachandran & Hubbard, 2001; Ramachandran & Hubbard, 2003). Ramachandran and Hubbard (2003) sum up their position by stating that: 'synesthesia causes excess communication amongst brain maps . . . Depending on where and how widely in the brain the trait was expressed, it could lead to both synesthesia and to a propensity towards linking seemingly unrelated concepts and ideas – in short, creativity. This would explain why the apparently useless synaesthesia gene has survived in the

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population' (page 58). Whilst we cannot easily measure differences in brain connectivity or gene expression in humans, it is more straightforward to examine differences in creativity between synaesthetes and others.

People with synaesthesia have anomalous perceptual experiences that are triggered by activity in another sensory modality (e.g. sounds triggering colours as well as auditory experiences) or by other cognitive activity (e.g. numbers triggering colours). These novel associations are automatic (e.g. Mattingley, Rich, & Bradshaw, 2001; Mills, Boteler, & Oliver, 1999), reliable over time (e.g. Baron-Cohen, Harrison, Goldstein, & Wyke, 1993) and, by definition, consciously perceived. Although they were once believed to be random, this is now no longer commonly accepted. Whilst individual synaesthetes disagree about the colour of any given stimulus, trends can be found. Thus, synaesthetes tend to agree about the lightness and saturation of musical notes (Marks, 1975; Ward, Huckstep, & Tsakanikos, 2006) and also on the colour of digits and letters (Rich, Bradshaw, & Mattingley, 2005; Simner *et al.*, 2005). Interestingly, non-synaesthetes tend to generate similar associations even if they do it in somewhat different ways (i.e. not automatically, reliably or consciously perceived). Thus, synaesthetic associations can be considered meaningful insofar as they may reveal the structure that underpins sensory–sensory and sensory–cognitive associations more generally.

What evidence, if any, points to a link between synaesthesia and creativity? First, some researchers have noted that synaesthesia is found in a number of famous creative individuals (Mulvenna & Walsh, 2005). A common list of gifted synaesthetes includes the composers Messian (Bernard, 1986) and Scriabin (Peacock, 1985), the painters Kandinsky (Ione & Tyler, 2003) and Hockney (Cytowic, 2002), the physicist Feynman (1988) and the author Nabokov (1967). However, without a comparison of the prevalence of synaesthesia in such gifted individuals relative to the general population these claims are not convincing. It has also been claimed that synaesthesia is more common in creative artists – poets, musicians, visual artists, etc. However, the evidence is equivocal. Domino (1989) assessed subjective reports of synaesthesia in 358 fine arts students and reported a prevalence of 23%. Domino found a difference between the self-reported synaesthetes and matched controls on four measures of creativity. However, there was no objective measure of synaesthesia employed. Contemporary researchers use a wide variety of objective tests that discriminate between synaesthetes and other individuals such as measures of consistency (Baron-Cohen *et al.*, 1993), Stroop-like interference in colour naming (e.g. Mattingley *et al.*, 2001; Mills *et al.*, 1999), functional imaging (Nunn *et al.*, 2002) and psychophysical measures (e.g. Hubbard, Manohar, & Ramachandran, 2006; Palmeri, Blake, Marois, Flanery, & Whetsell, 2002). Other prevalence studies that have relied on subjective reports alone have found similar levels of self-report even though they did not restrict the sample to fine arts (e.g. Calkins, 1895; Karwoski & Odbert, 1938; Rose, 1909). A recent prevalence study that did use an objective measure found a prevalence of 4.4%, although around 25% of participants initially reported synaesthesia-like experiences (Simner *et al.*, 2006).

A more recent study also compared creativity in self-reported synaesthetes vs. controls (Sitton & Pierce, 2004). The presence of synaesthesia was assessed by a checklist (termed 'test of synesthesia') but without any objective measure of synaesthesia. Many items on the checklist did not refer to synaesthesia at all (e.g. 'can you read road maps accurately?') and one item on their test-of-synesthesia was 'please rate your creative ability'. Perhaps unsurprisingly, the authors report a significant correlation between their test-of-synaesthesia and two further measures of creativity.

Dailey, Martindale, and Borkum (1997) took a somewhat different approach to Domino (1989) and Sitton and Pierce (2004). Their participants were initially grouped according to a measure of creativity and then assessed for synaesthesia-like traits (rather than grouped by reports of synaesthesia and assessed on creativity). The creativity measure used was the Remote Associates Test (RAT, Mednick, 1962; Mednick, 1967) in which participants are given a triplet of words (e.g. elephant – lapse – vivid) and required to find a linking fourth word (e.g. memory). High and low scoring participants were then given a series of tones, vowel sounds and emotion words and for each they were required to decide how well a given colour went with that stimulus. The high creativity group showed a higher degree of consensus about which colour should go with which stimulus.

It is important to note that not all theories of creativity would predict a difference between synaesthetes and controls. For example, some recent cognitive neuroscience-based theories of creativity postulate an important role for prefrontal cortical processes in developing retrieval strategies, holding options in mind, and verifying whether novel associations have any validity (e.g. Dietrich, 2004; Heilman, Nadeau, & Beversdorf, 2003). These flexible, goal-driven processes are very different from the automatic, inflexible (i.e. consistent), stimulus-driven processes that characterize synaesthesia.

These models of creativity also suggest that non-prefrontal regions are also important in creativity insofar as they represent the knowledge upon which creative acts are based (e.g. Dietrich, 2004). A certain level of knowledge may be needed for creativity to occur, but knowledge itself does not guarantee creativity. It is possible to expand one's knowledge base in a given domain without ever generating novel and adaptive insights. Synaesthetes may access a different knowledge base insofar as they have atypical experiences and stimulus-driven access to certain 'meaningful' associations (e.g. between visual and auditory properties). These atypical experiences may then endow them with a richer knowledge base of associations.

The atypical experiences of synaesthesia may also provide a source of inspiration for creative acts (e.g. visual art). However, claiming that synaesthesia provides a source of inspiration for certain creative acts is a more indirect claim than assuming that synaesthesia and creativity have a common neural or genetic basis. The present study will also explore this possible indirect link between synaesthesia and a tendency to engage in creative arts.

Studies within the general population have investigated factors associated with artistic creativity. Nettle and Clegg (2006) measured the association between schizotypy measures and a tendency to engage in the creative arts (e.g. poetry, visual arts). Not all dimensions of the schizotypy scale predicted level of engagement with creative arts. However, the 'unusual experiences' dimension in particular was positively associated with the level of artistic engagement. It is to be noted that factors such as these may bias the way in which creativity is expressed (e.g. scientific v. artistic creativity) rather than affect psychometric measures of creativity (e.g. divergent thinking). O'Reilly, Dunbar, and Bentall (2001) also found an association with the unusual experiences dimension of schizotypy and the level of engagement in art but this did not predict performance on a test of divergent thinking. Similar to the claims made about synaesthesia (e.g. Ramachandran & Hubbard, 2003), it has been suggested that schizotypy has been evolutionarily selected to enable creativity. The unusual experiences of synaesthetes may make them more inclined to be artistic (as is the case for the unusual experiences in schizotypy) and open to new experiences (which is also linked with artistic inclination; Furnham & Chamorro-Premuzic, 2004).

Perhaps the presence of unusual perceptual experiences in synaesthetes biases them towards the creative arts, and perhaps this artistic bias has been mistaken by others as reflecting enhanced creativity? There is more convincing evidence for an artistic bias in synaesthetes than enhanced creativity. Rich *et al.* (2005) noted the occupations and hobbies of a large sample of synaesthetes. They found that 24% of synaesthetes were involved in artistic professions when compared with a 2% population average. Synaesthetes were also more likely to be actively engaged in art (painting, drawing) as a hobby, although they were not more actively involved in crafts or in playing music.

The present study investigates creativity of synaesthetes using two measures: Alternate Uses Test (ALT; Guilford, Christensen, Merrifield, & Wilson, 1978) and Remote Associates Test (Mednick, 1967). The RAT was chosen because it had been employed in previous studies on self-report synaesthetes, and the ALT was chosen as a measure of divergent thinking to contrast it with the RAT (convergent thinking). Different types of synaesthetes are considered, given the claim that the level of creativity may depend 'on where and how widely in the brain the trait was expressed' (page 58, Ramachandran & Hubbard, 2003). Some people experience synaesthesia in a very restricted set of situations (e.g. colours for days and months only, or numbers in spatial forms), others experience synaesthesia for many stimuli but in a single sensory modality (e.g. lexical-gustatory synaesthesia), whereas others experience synaesthesia induced from many stimuli and experienced in multiple senses. Furthermore, we investigate their level of engagement in art and music according to their occupation and hobbies. Again, by considering different types of synaesthesia we can assess whether engagement in visual art is promoted in those synaesthetes who experience visual sensations, or whether playing music is promoted in those individuals in which music acts as a trigger of their synaesthesia. Both of these would imply a motivational or aesthetic bias linked closely to the phenomenology of their synaesthesia.

Method

Participants

The participants consisted of 82 synaesthetes (19 males, 63 females; age range = 14–83) and 119 controls (43 males, 76 females; age range = 17–62). The control participants were recruited via acquaintances of the researchers and via acquaintances of these acquaintances. An effort was made to include a wide variety of ages and occupations drawn from both sexes. Rather than attempt to match on a one-to-one basis, our approach was to statistically eliminate any effect of these variables by entering them as regressors during the analysis. This approach is commonly used in similar studies (e.g. Nettle & Clegg, 2006). However, for some of our analyses, we do consider a more carefully matched subset of synaesthetes and controls. It is to be noted that the number of controls and synaesthetes that were included in each analysis was not always the same. This was because a few of the synaesthetes and controls only took one of the two creativity tests (as the tests were not administered concurrently with each other), and other information was not always available (e.g. if a participant was schooled overseas then it was not possible for us to compare these participants with those who took grades under the UK system). The size of the sample is therefore reported separately for each test and analysis.

The synaesthetes had previously volunteered for general research into synaesthesia, rather than creativity *per se*. Synaesthesia was elicited by a range of stimuli (termed here as 'inducers') in a number of sensory modalities and submodalities (termed here as 'concurrrents'). An effort was made to include a number of different subtypes of synaesthesia including those whose experiences are limited to spatial forms induced by ordinal sequences (days, months, numbers, alphabets); colours induced by days and months alone; colours induced by other kinds of verbal material and/or music; taste experiences and synaesthetes who reported many different varieties. As such our sample represents the diversity of synaesthesia, although it is not a proportional representation of the synaesthetic population (for prevalence estimates see Sagiv, Simner, Collins, Butterworth, & Ward, 2006; Simner *et al.*, 2006). However, the diversity of our sample enables us to link different profiles of synaesthesia with different creative/artistic outcomes. Each synaesthete was coded in terms of whether he/she has experiences of colour (72.0%), taste (19.5%) or spatial forms (82.9%). These numbers do not add up to 100% because synaesthetes may have more than one type of experience. We also categorized synaesthetes in terms of whether music was an inducer of synaesthetic experience (which it was in 26.8%) because we were interested in how this might affect engagement with art. Although other types of synaesthesia were not specifically considered, we made some effort to quantify how many different types of synaesthesia each person has. Synaesthetes specified their experiences by joining lines between a list of 22 potential inducers (letters, numbers, words, music, taste, etc . . .) with a list of 8 potential concurrents (colour, shape, taste, smell, etc.). Counting the number of lines drawn between them offers a crude estimate of how extensive a given individuals synaesthesia is. This number varied between 1 and 162, with a mean of 9.8 ($SD = 18.0$). These five indices of synaesthesia (presence/absence of forms; presence/absence of synaesthetic taste; presence/absence of synaesthetic colour; presence/absence of music as an inducer; number of types of synaesthesia) were used as independent variables in order to predict individual differences in objective measures of creativity and reported levels of engagement in art.

Each synaesthete was given a 'test of genuineness' consisting of test–retest reliability over an interval of at least 2 months (mean = 9.73 months). This was performed for at least one type of synaesthesia in each and every individual, but it was not possible to do this for each and every variety of synaesthesia. Fifty-eight of our synaesthetes were tested on colour associations for days ($N = 7$), months ($N = 12$), letters ($N = 26$), numerals ($N = 10$) and nouns ($N = 80$) depending on the stimuli reported to elicit synaesthesia (an average of 49.5 items tested per person). Their mean consistency was 92.3% (range = 56–100%), and previous research has shown that control participants retested over 2 weeks have a consistency of 33.4% ($SD = 14.3$) using similar stimuli (Sagiv *et al.*, 2006). The 11 synaesthetes in whom tastes tended to be the dominant concurrent were given 80–88 words over a period of 8.8 months. The average consistency was 84% (range = 76–94%) when compared with a control group consistency of 10.1% (range = 5.5%) over a 2-week test–retest period (Simner & Ward, 2006). Thirteen of our synaesthetes experienced spatial forms for ordinal sequences without any other known types of synaesthesia. The descriptions of these forms were noted to be very similar over at least 2 months although this was not quantified. However, a subset of this sample had taken part in a recent fMRI study providing further evidence for their authenticity.

Procedure

The Alternate Uses Test (AUT) followed a very similar procedure of administration and scoring to the original (Guilford *et al.*, 1978). The only significant difference was that the six objects were presented as one group, rather than two groups of three. At the start of the test, participants were told that they would be given a list of common objects and asked to find up to six alternate uses for each object. They were given the example of a newspaper, told its conventional use (for reading), and were told six possible alternate uses (e.g. start a fire, make up a kidnapping note). They were made aware that all the different uses were very different from each other and from the conventional use. They were then given the six objects and their conventional uses. Beside each object was a list of six blank frames for participants to type in alternate uses. They were told that the test would end after 8 minutes and that they could do the items in any order. The participants were given a score based on the number of acceptable alternate uses generated (out of 36). In order to be acceptable, a use must not only differ from the conventional use but must also differ from other responses given. For example, 'using a pencil to stir paint' and 'using a pencil to stir coffee' would be counted only once. Similarly, if participants also said 'spectacle frames to stir coffee' then this would not count. The number of unacceptable and repeated uses was also noted and analysed separately.

The Remote Associates Test (RAT) was adapted from the original test (High School 1 version, Mednick, 1967) by removing some of the original items and incorporating some new ones. This was done in order to make the items more culturally appropriate for a UK sample living in 2006. Twelve out of thirty of the original items were used together with a further eight items taken from an updated version (Bowers, Regehr, Balthazard, & Parker, 1990). The time taken to complete the test was adjusted from 40 to 25 minutes in proportion to the reduced number of items. The participants were informed that they will be presented with three words in each question, and are asked to find a fourth word which relates to all three in one way or another. They were given the example, base-snow-dance and told that the word that is related in various ways is 'ball' and two further examples were given. They were instructed of the time limit, and told that they may answer questions in any order and come back to previously attempted questions. The participants were told that they could guess or leave it blank if unsure. Each participant was awarded a score out of 20.

Each participant was asked about their level of engagement in art. Specifically, they were asked the following three questions: (1) How much time do you devote to *producing* visual art? (2) How much time do you spend *playing* a musical instrument? (3) How much time do you devote to *looking at* visual art? The first two questions were focused around active engagement in art production rather than level of interest in art. They gave their response on a six-point scale: as main occupation; more than 5 hours per week on average; more than 1 hour per week on average; more than 1 hour per month on average; a couple of times per year and never.

In addition, information relevant to the scholastic ability and occupation of the participants was obtained. We are interested in knowing whether the presence of synaesthesia predicts the level of creativity over and above other potentially confounding variables. Participants were asked how many grades at A to C they had obtained during the state exams for 16 year olds (i.e. GCSE, O-Level or CSE in the UK system). They were also asked to state their occupation, in detail, from which we inferred their socio-economic status using the National Statistics Socio-Economic Classification, or NS-SEC, eight-point system (Rose & Pevalin, 2005).

Results

A simple comparison between the group of synaesthetes and controls revealed a significant difference between groups on the RAT (means [S.D.]: syn = 13.4 [3.5], control = 11.6 [3.2]; $t(149) = 3.32$, $p < .001$) but not for number of appropriate uses on the ALT (means [*SD*]: syn = 18.1 [6.2], control = 16.6 [6.0]; $t(161) = 1.59$, *ns*). The two groups did not differ in the proportion of ALT inappropriate uses (means [*SD*]: syn = 1.6 [1.9], control = 2.1 [2.2]; $t(161) = 1.63$, *ns*) or repeated uses (means [*SD*]: syn = 1.4 [1.8], control = 1.2 [1.6]; $t(161) = .73$, *ns*). The same pattern was found when a more carefully matched subset of 40 synaesthetes and 40 controls were compared (matched for occupation and number of A–C grades). Similar effects are found when potentially confounding variables are entered as regressors, as described next.

In order to determine the factors that predict performance on the two creativity measures, a number of different independent variables were entered into a multiple regression. The independent variables were age, sex, socio-economic class, scholastic ability (number of A to C grades obtained), presence/absence of synaesthesia as a binary variable and number of types of synaesthesia. The results are summarized in Table 1. For the RAT, the only significant predictors on this creativity measure were number of A–C grades ($p < .01$), and the number of types of synaesthesia ($p < .05$; with control participants given values of 0 for this variable). For the ALT, there were no significant predictors although socio-economic status approached significance ($p = .054$; note that the negative beta coefficient reflects the fact that higher socio-economic status is given a lower numerical value). When age and sex are entered as regressors first it made no difference to the pattern of significance in Table 1. As such, our results provide only partial support for the hypothesis that there is a relationship between synaesthesia and creativity. There was a significant relationship between the number of types of synaesthesia and objective performance on one creativity measure (of convergent thinking), but not on another creativity measure (of divergent thinking). This pattern is considered in more detail in the General Discussion.

Table 1. Standardized regression coefficients (β) for performance on two measures of creativity as a function of six independent variables

	RAT ($N = 106$)	ALT ($N = 92$)
Presence/absence synaesthesia	.140	.019
Number of types of synaesthesia	.209*	.021
Age	.136	.193
Sex	−.008	−.078
Social-economic class (NS-SEC)	−.029	−.213 ($p = .054$)
# A to C grades at Year 11	.293**	.123

*$p < .05$; **$p < .01$.

It has previously been found that synaesthetes are more likely to be employed in artistic professions (24%) than expected (2%, Rich *et al.*, 2005). A UK estimate of the number of people employed in the 'creative industries' sector is provided by the Department for Culture, Media and Sport (Creative Industries Economic Estimate Statistical Bulletin, September 2006). This includes the 10 categories of advertising;

architecture; art and antiques; crafts; design and designer fashion; video, film and photography; music and the visual and performing arts; publishing; software, computer games and electronic publishing; and radio and TV. It is estimated that about 1.87 million people are employed in these sectors in the UK (around 7.25% of employees). Applying this occupational criterion to our sample of synaesthetes suggests that the corresponding figure is 19.5% (16/82; $\chi^2(1) = 18.24$, $p < .001$). It is to be noted that several other art-related occupations were not included (e.g. art history lecturer/student falls under the education sector), thus our results give a conservative estimate. In sum, synaesthetes tend to be more likely to be involved in the so-called 'creative industries' sector than expected from population estimates.

Occupation aside, it is possible to compare the level of art and music engagement in the synaesthete and control samples from the ratings of the amount of time spent in these pursuits. A simple comparison between the entire group of synaesthetes vs. controls revealed that synaesthetes report spending more time engaged in producing visual art (Mann–Whitney U, $p < .001$), playing music ($p < .05$) and looking at visual art ($p < .001$). This data is summarized in Table 2. In order at ascertain whether this is due to the occupational bias already noted, individual synaesthetes were matched to individual control participants closely in terms of their occupations (e.g. biology teacher to biology teacher; graphic designer to graphic designer), and matched at a group level for average number of A–C qualifications and sex. It was possible to obtain 40 such pairings. This enables us to determine whether, say, synaesthetic lawyers and secretaries are more likely to be engaged in creative arts than non-synaesthetic lawyers and secretaries. A Wilcoxon matched pairs test revealed that synaesthetes reported significantly more time producing ($Z = 3.11$, $p < .005$) and looking at visual art ($Z = 2.24$, $p < .05$) than their occupation and education matched counterparts, but spent no more time playing a musical instrument than controls ($Z = 1.12$, *ns*).

Table 2. Distributions of time spent engaged with producing visual art, playing a musical instrument or looking at visual art (% of respondents)

		Occupation	> 5 hours/ week	> 1 hour/ week	> 1 hour/ month	Few times/ year	Never
Produce visual art	Syn	3.8	10.1	16.5	19.0	26.6	24.1
	Control	2.9	4.8	6.7	10.5	24.8	50.5
Play instrument	Syn	6.3	7.6	13.9	8.9	17.7	45.6
	Control	1.0	4.8	8.6	6.7	21.0	58.1
Look at visual art	Syn	2.5	17.7	20.3	26.6	25.3	7.6
	Control	2.9	8.6	11.4	17.1	46.7	13.3

The analyses above are based upon contrasts between synaesthetes and controls. A more fine-grained approach is to consider different subgroups within the synaesthetic population itself. Perhaps certain subgroups may score higher on creativity measures or perhaps certain types of synaesthetic experience results in a bias towards artistic interests. For example, experiences of colour may be more likely to increase engagement in visual arts than synaesthetic experiences of taste. Synaesthetes were grouped according to the presence/absence or taste, colour, and spatial forms and according to whether or not musical sounds act as an inducer of synaesthesia.

Independent sample analyses were conducted on the creativity measures (*t* tests) and the amount of time devoted to art (Mann–Whitney U test). In addition, correlations were performed between the number of types of synaesthesia reported against each dependent variable. The results of this analysis are shown in Table 3.

Different subtypes of synaesthesia were not associated with increased or decreased levels of creativity on the RAT or ALT, and the only trend was a non-significant relationship between number of types of synaesthesia and performance on the RAT (the effect was previously shown to be significant when control participants were additionally incorporated into the analysis). However, different subtypes of synaesthesia may be associated with different levels of engagement in music and art. Figure 1 shows data from the sample of synaesthetes divided into those that do or do not have music as an inducer of synaesthesia. The trend for synaesthetes to be more likely to play a musical instrument can be almost entirely attributed to those who have synaesthetic experiences elicited by music. This subgroup is also the most likely to be engaged in visual art, although there is a trend for other types of synaesthetes to be more engaged than their control counterparts. This is the first evidence to suggest that the often reported link between synaesthesia and art is directly related to the phenomenology of the particular synaesthesia that is experienced, rather than to synaesthesia *per se*. A tendency to be engaged in creative arts is at least partly linked to the nature of the synaesthetic experiences themselves and this appears to be independent of psychometric measures of creativity. There were no significant correlations between the two psychometric measures of creativity and the level of engagement in music and art (Spearman's rho, *ns*), either within the synaesthete sample or the combined synaesthete and control sample.

General discussion

Synaesthesia has often been reported to be associated with heightened creativity, although the empirical evidence for this claim has, to date, been scant and unconvincing. The aim of this study was to empirically explore this claim with a verified sample of synaesthetes. One line of evidence that has been used to support the link between synaesthesia and creativity is the observation that many synaesthetes are artists, musicians and poets (Mulvenna & Walsh, 2005; Ramachandran & Hubbard, 2001). Our study also provides evidence for this trend, but we suggest that this has little or nothing to do with individual differences in ability on more cognitive measures of creativity. Instead, we argue that the tendency to be engaged in arts is related to the particular phenomenological characteristics of the synaesthesia. Individuals experiencing vision from music have particularly rich experiences (movement, textures, colour, shapes) and this may provide a source of motivation. We did find some evidence to support a link between synaesthesia and psychometric measures of creativity. Synaesthetes outperformed controls on the Remote Associates Test, and this appeared to be related to the number of types of synaesthesia experienced. However, no such difference was found on a measure of divergent thinking – the Alternate Uses Test. It is unlikely that the RAT is merely a more sensitive measure than the ALT, as other research has shown that the complementary profile can be obtained in certain populations – people with attention-deficit/hyperactivity disorder have better performance than controls on the ALT but worse performance on the RAT (White & Shah, 2006). A more satisfactory explanation is that the tests are tapping somewhat different abilities and the

Table 3. The relationship between the particular characteristics of synaesthesia and performance on measures of creativity and artistic engagement

	RAT (mean score)	ALT (mean score)	Visual art production (mean rank)	Music playing (mean rank)	Looking at visual art (mean rank)
Presence/absence of syn colour ($N = 54 + 22$)	$t(74) = .63$ *ns*	$t(74) = 1.82$ *ns*	$U = 534$ *ns*	$U = 639$ *ns*	$U = 490$ *ns* ($p = .088$)
Presence/absence of syn taste ($N = 15 + 61$)	$t(74) = .14$ *ns*	$t(74) = .07$ *ns*	$U = 477$ *ns*	$U = 384$ *ns*	$U = 438$ *ns*
Presence/absence of spatial forms ($N = 62 + 14$)	$t(74) = .09$ *ns*	$t(74) = .66$ *ns*	$U = 391$ *ns*	$U = 350$ *ns*	$U = 352$ *ns*
Presence/absence of music as an inducer ($N = 21 + 55$)	$t(74) = 1.84$ *ns*	$t(74) = .63$ *ns*	$U = 516$ *ns*	$U = 457$ $p < .05$	$U = 387$ $p < .01$
Number of types of synaesthesia	$r = .203$ *ns* ($p = .079$)	$r = .045$ *ns*	$\rho = -.047$ *ns*	$\rho = -.114$ *ns*	$\rho = -.301$ $p < .01$

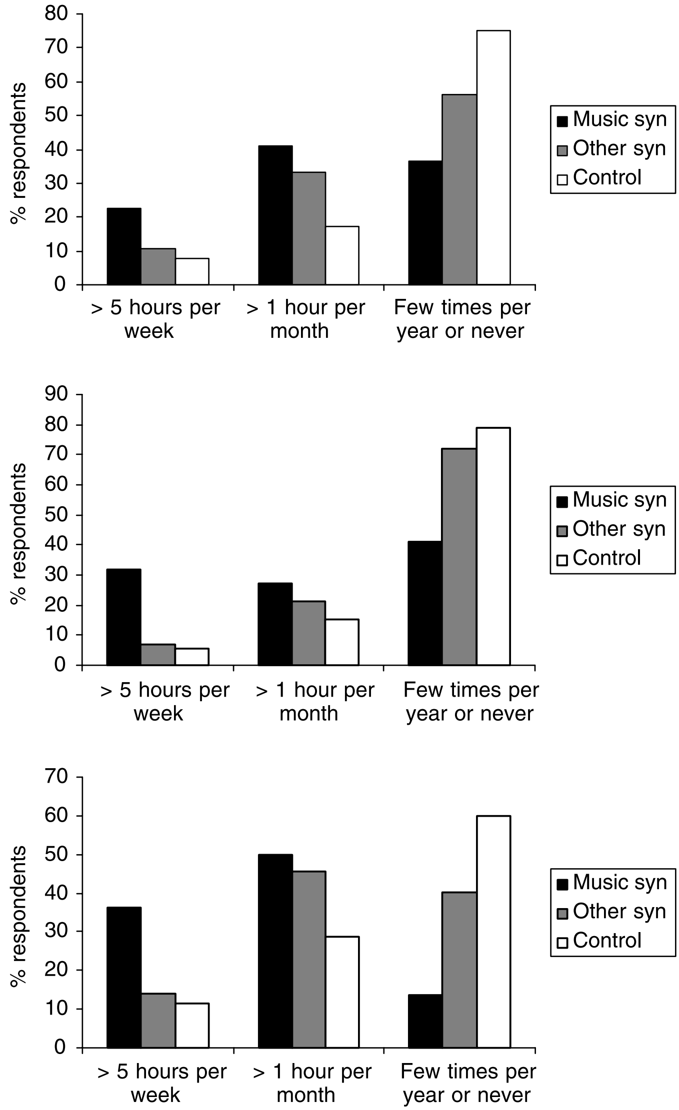

Figure 1. The trend for synaesthetes to be engaged in visual art or music depends partly upon whether music acts as a trigger of synaesthetic experiences. From top to bottom: amount of time producing visual art; amount of time playing a musical instrument and amount of time looking at visual art. The original six-point Likert scale was collapsed into three points by combining adjacent pairs.

claim that 'synaesthetes are more creative' is too simple. Synaesthesia may result in certain cognitive strengths and this may give them a benefit on *some* measures of creativity. However, this is a much weaker claim than the notion that synaesthesia and creativity are two different outcomes of a single genetic/neurodevelopmental mechanism (Ramachandran & Hubbard, 2003).

Many contemporary models of creativity make a distinction between the knowledge base that supports creativity, and the ways in which such knowledge is accessed and evaluated. In the model of Finke (1996), for example, he distinguishes between different reciprocal phases of creativity termed 'generate' and 'explore'. The generation phase involves the retrieval of associations between disparate stimuli. Tests such as the RAT are assumed to tap this (Finke, 1996). The explore phase, on the other hand, is involved with the consideration of a variety of interpretive possibilities including those that would not be directly associated with the stimuli. The Alternate Uses Test may possibly place stronger demands on this aspect of creativity. This distinction also fits with Boden's (1992) framework. She describes different types of creativity that involve exploring a knowledge space (e.g. producing art or music within an established style) and transforming it (e.g. developing a novel style of art or music). The RAT is probably more related to the former type of creativity than the latter.

Why might synaesthesia be associated with an enhanced ability to notice remote associations? One possibility is that it reflects some artifact that has little to do with either synaesthesia or creativity. Although we attempted to minimize this by taking into account other potentially relevant factors (e.g. age, education), it was not possible to take into account every single factor. Other factors that could be considered in future studies are levels of vocabulary knowledge, personality and the use of particular strategies (e.g. visual imagery). Another possibility for why the synaesthetes performed better than controls on the task is that some associations are cross-modal in origin (e.g. the association between cheese and sharp in the test stimulus: 'mouse, sharp, blue'). Future research is needed to delineate between associations based on 'synaesthetic metaphor' from pure lexical associations (e.g. 'widow, bite, monkey' = spider). A final possibility is that synaesthetes have higher propensity to form and/or notice associations between disparate concepts *per se*, both for concepts related and unrelated to their synaesthesia. This is clearly within the spirit of Ramachandran and Hubbard's claims that the neurobiological basis of synaesthesia is to form links between different brain maps representing different concepts. This may indeed be the case, although further research is needed to discount the alternative explanations. However, we wish to note that there is far more to creativity than this. The cardinal feature of creativity is to think beyond the boundaries of existing associative knowledge (Boden, 1992; Heilman *et al.*, 2003). At present, there is no convincing evidence that synaesthetes are more capable of doing this than other individuals.

It is interesting to note that the ability to generate cross-modal associations in the general population (who lack synaesthesia) appears to be associated with higher performance on measures such as the RAT. The Dailey *et al.* (1997) study assessed performance on the RAT and divided the sample into two groups based on a median split. That is, the sample was grouped according to this measure of creativity rather than presence of synaesthesia. The more creative group were subsequently shown to have higher inter-subject agreement on tests such as sound–colour association and emotion–colour association (note: they were not tested for intra-subject agreement which is the hallmark of synaesthesia). As such, this study can be construed as a measure of the association between the ability to generate cross-modal associations (or synaesthetic metaphor) and the ability to notice remote associations between other concepts. The same appears to be true of the study of Domino (1989) even though his procedure was somewhat different. Domino grouped participants according to subjective reports of synaesthesia-like associations, but this group could well be dominated by those who are adept at producing synaesthetic metaphors (rather than true synaesthetes). As already noted, those who are adept at producing synaesthetic metaphors tend to be good at certain tasks of creativity.

As well as making a distinction between convergent thinking (e.g. remote associations) and divergent thinking, many models also make a distinction between the processing mode in which such operations take place: namely, the extent to which they occur strategically as a result of conscious effort vs. the extent to which such ideas emerge spontaneously (e.g. Dietrich, 2004). People both with and without synaesthesia may have the same knowledge of cross-modal associations (e.g. correspondences between pitch and lightness) but the way in which this knowledge is interrogated and re-experienced differs substantially between synaesthetic perception and metaphor/imagery in non-synaesthetes. Synaesthetic perception is automatic, inflexible and inevitable, whereas synaesthetic metaphor requires setting up appropriate searches of different domains and verifying the outcome of the search. People of low creativity would presumably possess, say, pitch-lightness correspondences but these may be more apparent in indirect tests of these associations (such as those used by Marks, 1987; Melara, 1989) than in tasks requiring strategic generation/verification of such correspondences (such as those used by Dailey *et al.*, 1997). That is, people with low creativity may possess knowledge of synaesthesia-like mappings between, say, sound and vision but lack the cognitive capacity to generate them or reflect upon them. People with high creativity may be more able to generate synaesthesia-like associations and verify them as 'appropriate' in some way. Thus, we make at least one testable prediction: direct tests of synaesthetic metaphor generation should correlate highly with creativity in the general population (in tests such as RAT) but indirect tests of these associations will not.

To summarize the results of this study, we return to the opening question: what is the link between synaesthesia, art and creativity? This study demonstrates that people with synaesthesia are more likely to be engaged in the creative arts (e.g. music, visual art) and they score higher on some, but not all, measures of creativity. However, we suggest that there is no direct link between these two observations. The level of engagement of synaesthetes in art may be related directly to their unusual experiences (as in the case of schizotypy, Nettle & Clegg, 2006) and the exact nature of the synaesthesia they experience (with a particular tendency in those experiencing vision from music). In addition, synaesthetes may be more able at generating remote associations between disparate concepts although the mechanism by which they do so is not clear. Intriguingly, previous research conducted on the non-synaesthetic population also shows a relationship between generating 'meaningful' cross-modal associations and performance on the Remote Associates Test. Although synaesthetes appear to show a benefit on one aspect of cognition related to creativity, there is presently no convincing evidence to suggest that synaesthetes are more able to use their knowledge flexibly (in divergent thinking). As such, the claim that synaesthesia has evolved to permit creativity *per se* is probably an over-statement.

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