Puzzles of vision and art. Are we all synaesthetes?

Liliana Albertazzi

The meaningful appearances of natural forms, intrinsically provided with meaning, are primary ecological facts for humans and non-human living beings. Only in recent years, however, perception studies have developed research pointing to the qualitative, and multimodal aspects of the experience. Specifically, the debate is now moving to the field of cross-modality, studying the connections between any given sensory feature in one modality (for example, color) and a sensory feature in another modality (for example, sound). Initially prompted by interest in the field of synesthesia, studies have begun to explore similar phenomena occurring in the general population and asking whether there are other ways to experience that associations. A recent review of the field has drawn a distinction among structural correspondences (due to neural correlates, hence potentially universal), statistical correspondences (due to learning, hence potentially influenced by different environments), and semantic correspondences (due to language influence, hence potentially different among cultures). A growing number of researchers explains associations in terms of patterns of qualitative similarity present in different sensory modalities and perceived as such: for example, hot and cold, sad and happy, and pleasant and unpleasant, are connotative properties of both sounds and colors, something about which the arts have always been aware. This means that what is at stake is not semantic information projected top-down into other domains, but qualities intrinsic to perceived phenomena. This position obviously does not preclude investigation of correlations at neural level or the presence of cognitive dimensions due to language, learning, and human symbolic activities. My contribution presents a survey of the results of recent studies in cross-modality. Specifically, I show the existence of cross-modal associations between geometric shape (and parts of, such as angles) and color, morphological shapes and color, matric paintings and classical Spanish music, abstract paintings and virtual tactile perception. These findings shed light on our relationship with the environment, and on the correspondences between perceptual and pictorial space.

Keywords: cross-modality, perceptual and pictorial spaces, qualities.

1. Can we trust our eyes?
The question is apparently odd, after centuries of vision studies. However, among the most intriguing challenges of current vision science there is the development of an observer-dependent science. A science of visual phenomena as subjectively and consciously experienced, in fact, would undermine the well-established assumption of veridicalism which rules the mainstream research, and in so doing go beyond the Galilean-Newtonian idea of science based on metric properties alone (Albertazzi, 2013a, b; Albertazzi, van Tonder, Vishwanath, 2010; Koenderink, 2010). Among the reasons for a radical change of viewpoint is the awareness that the space and the shapes that we subjectively experience are highly “illusory” if compared with the underlying physical stimuli. Although there is extensive evidence in the experimental literature about behaviors of shapes and surfaces in visual space, that do not conform to their metric dimensions, only recently has the question of the nature and the intrinsic geometry (or, the geometries) underlying visual appearances been explicitly addressed in science (Albertazzi, 2015; Albertazzi, Louie, 2016; Wagner, 2006; Wackermann, 2010). The visual objects analyzed in classical psychophysics and neurophysiology, in fact, have been mainly understood and represented in terms of Euclidean geometry, starting from primitives such as points, lines, and surfaces as defined in that specific framework. It is generally assumed, for example, that points have neither dimensions nor color, that there are Euclidean surfaces in the visual field, and that shapes have geometrical properties replicable in cross-modalities and perceived as such: for example, hot and cold, sad and happy, and pleasant and unpleasant, are connotative properties of both sounds and colors, something about which the arts have always been aware. This means that what is at stake is not semantic information projected top-down into other domains, but qualities intrinsic to perceived phenomena. This position obviously does not preclude investigation of correlations at neural level or the presence of cognitive dimensions due to language, learning, and human symbolic activities. My contribution presents a survey of the results of recent studies in cross-modality. Specifically, I show the existence of cross-modal associations between geometric shape (and parts of, such as angles) and color, morphological shapes and color, matric paintings and classical Spanish music, abstract paintings and virtual tactile perception. These findings shed light on our relationship with the environment, and on the correspondences between perceptual and pictorial space.

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1. Possiamo fidarci di quello che vediamo?
Dopo secoli di scienza della visione la doman- da sembrerebbe fuori luogo. Peraltro, uno dei più interessanti sollevato di recente in questo campo di ricerca, consiste nello sviluppo di una scienza dipendente dall’osservatore. Una scienza dei fenomeni visivi, quali sono in modo soggettivo e concienati percepiti, interpretati come qualità intrinseche agli stessi fenomeni visivi. Questa posizione non esclude ovviamente la ricerca delle correlazioni a livello neurale o della natura intrinseca delle dimensioni cognitive e dei processi cognitivi che governano la tendenza nel dominio visivo. In questo modo, si collocherebbe oltre la semplice idea gianitza- na-neurotiica di scienza, che è fondata unicamente sulle proprietà metriche degli stimoli (Albertazzi, 2013a, b; Albertazzi, van Tonder, Vishwanath, 2010; Koenderink, 2010). Fra le ragioni che motivano un cambiamento radicale del punto di vista, vi è la consapevolezza che lo spazio e le forme che esperiamo soggettivamente sono fenomeni altamente “illusori”, se confrontati con gli stimoli fisici sottostanti. Sebbene la letteratura sperimentale offra am- pia evidenza del fatto che lo spazio e le forme nello spazio visivo non si conformino alle loro dimensioni metriche, solo di recente in ambito scientifico si è esplicitamente posto il proble- ma della natura intrinseca della geometria (o delle geometrie) alla base dei fenomeni visivi (Albertazzi, 2015; Albertazzi, Louie, 2016; Wagner, 2006; Wackermann, 2010). Gli oggetti analizzati nella ricerca psicofisica ed neurofisiologica infatti, sono stati quasi esclusivamente connessi e rappresentati in termini di Euclidei, a partire da primi (quali punti, linee e superfici), nei termini in cui sono stati definiti in quella specifica geometria. Ad esempio, si assume che i punti non abbiano né dimensione né colore, che nel campo visivo esistano super-
putational terms (Albertazzi, 2015; Koenderink et al., 2010; Marr, 1982). Therefore the inconsistencies of visually deformed shapes in space have been labeled "odd" perceptions (Gregory, 2009), and explained as "illusions", i.e. hallucinations of our senses; although it is a fact that we subjectively perceive much more and differently from what is given in the mental reality. Among the widespread so-called "illusions" of our experience there are particularly surprising ones. Consider the visual behaviour of the simple drawing of a parallelepiped on a sheet of paper (Michotte, 1948). Looking from a particular vantage point, it appears "to stand up" (fig. 1). The readers are invited to test themselves that this happens when viewing with either one or both eyes. With both eyes, one has to look at the paper from an extreme angle, in which case the disparity information for the paper surface is very weak or disrupted (disparity gradient limit), so that one loses awareness of the paper surface, and the pictorial information dominates. This happens even more readily with one eye, because there is no conflicting binocular information. The impression of three-dimensionality is so strong that the observer readily accepts an invitation to insert a thin rod into the 3D figure without considering the task meaningless, as it would be if she were looking at a normal 3D picture drawn on a similar sheet of paper. The "qualitative" salience of the percetion has been explained as being due to changes in assignment of egocentric distance information. Because the paper surface’s presence has been disrupted, the distance information from accommodation may accrue to the perceived object, and allow a scaling of the depth from an "egocentric" point of view, thus giving it the quality of "touchable" (Vishwanath, 2011). What we see is literally a "solid shape" that seems capable of being grabbed. The same does not happen, for example, if one draws a cube on a piece of paper that is viewed binocularly or only with a slight slant, where distance information specifies the distance of the visual paper surface. The "metric two-dimensionality" of figures therefore does not necessarily coincide with a "perceived three-dimensionality" and may even potentially provoke motor actions such as virtually grasping the so-called illusory object. Similar so-called illusions are widespread in visual space, perceptual and pictorial as well: consider, for example, superb anomalies such as Andrea Pozzo’s painted ceiling in the Church of St. Ignazio in Rome (and his perspective in the trompe-l’œil dome), or Edgar Mueller’s spectacular meta-anamorphic (stereogram) street paintings, which indeed challenge our vertical sense of reality (figs. 2, 3, 4 and 5). As to the three-dimensionality of artistic objects, sculptures appear to manifest specific and distinct properties with respect to whose of paintings, such as tactile and volumetric dimensions. However, an analysis of the third dimension as a product of the mind of the observer that idiosyncratically expands or contracts it (Vishwanath, Hibbard, 2013), peraltro, invece delle dimensioni tattili e vocali, si considerino, ad esempio, alcune superbe anomalie come il soffitto dipinto di Andrea Pozzo nella Chiesa di Sant’Ignazio a Roma (e la prospettiva trompe-l’œil della cupola) o gli spettacolari meta-anamorfici (stereogramm) dipinti di strada di Edgar Mueller che realmente pongono una sfida al nostro veridico senso di realtà (figg. 2, 3, 4 e 5). Quanto alla tridimensionalità delle opere d’arte, le sculture sembrerebbero presentare proprietà specifiche e distinte da quelle dei dipinti, ad esempio le dimensioni tattili e volumetriche. Un’analisi della terza dimensione come prodotto della mente dell’osservatore che idiosincraticamente la espande o la contrae (Vishwanath, Hibbard, 2013), peraltro,
also to be measured in terms of their ability to render at a distance the three-dimensional volumetric qualities with a two-dimensional surface effect (Hildebrand, 1893/1969). The awareness of the intrinsic relationship among space, shape and touch, is also described by architectural studies (Pallasma, 2005; Holl, Pallasma, 2007), and is experimentally verifiable regards to abstract art (Albertazzi et al., 2016a). Over the centuries, in fact, the history of art shows the presence and the application of the so-called illusions as aesthetic and perceptual devices. They are widely represented, from the entasis of the Doric columns to painting, to stereo kinetic effects of images in rotation (see Duchamp’s Rotoreliefs, fig. 6), to the drawing of cartoons (it is well known the effort put by Walt Disney’s designers to render the perceived movement and the impact on the ground of two dimensional drawings).

These examples allow us to conceive the space we “see in” (Hecht, Schwartz, Atherton, 2003) as intrinsically imaginative, observer dependent, and very apparent if compared with metric stimuli. Between the two basic characteristics of visual space – convexity (the space outside) and concavity (the space inside) – there may in fact be an entire phenomenology of spatial variations and behaviors. Consider, for example, a cylinder seen from the inside as concave or seen from the outside as convex (a problem that also occupied Fehner in his studies on experimental aesthetics (Fechner, 1879/1960)).

Figures 4 and 5
Emmanuel Maigman, San Francisco di Paolo in preghiera (1642), convent of SS. Trinità dei Monti, Rome. Photograph by Agostino De Rosa.

Figure 6

Figure 7

mostra come vedere e toccare non siano modalità separate. La percezione delle sculture, quindi, dovrebbe essere misurata anche nei termini della loro capacità di rendere a distanza le qualità tridimensionali e volumetriche con un effetto di superficie bidimensionale (Hildebrand, 1893/1969). La consapevolezza dell’intrinseca relazione tra spazio, forma e percezione tattile è descritta anche negli studi di architettura (Pallasma, 2005; Holl, Pallasma, 2007) ed è verificabile sperimentalmente nei confronti dell’arte astratta (Albertazzi et al., 2016a). Nei secoli, la storia dell’arte ha esibito la presenza e l’impiego delle costruzioni come strumenti estetici e percepivoli: sono infatti ampiamente rappresentati, dall’ento la presenza delle colonne doriche alla pittura, agli effetti stereocinetici delle immagini in rotazione (si vedano i Rotoreliefs di Duchamp, fig. 6, come la Chinêsiche Lanterne), al disegno dei cartoons (è molto nota la ricerca fatta dai disegnatori della Walt Disney per riuscire a render l’impressione di movimento e l’impatto sul terreno di figure bidimensionali).

Questi esempi permiscono una concezione dello spazio “entro cui vediamo” (Hecht, Schwartz, Atherton, 2003) come uno spazio intrinsecamente immaginativo, dipendente dall’osservatore e molto apparente, se confrontato con gli stimoli metrici. Tra le due caratteristiche fondamentali dello spazio visivo – conversità (lo spazio esterno) e concavità (lo spazio interno) – può esistere, infatti, un’intima fenomenologia di variazioni e di comportamenti spaziali delle forme percepite. Si consideri, ad esempio, un cilindro visto dall’interno come concavo o visto dall’esterno come conveso (un problema di cui si era occupato anche Fehner, nei suoi studi di estetica sperimentale (Fechner, 1860) il comportamento visivo di cubi, prismi e conchiglie a forma conica in fase di inversione prospettica (Deregowski, 2014; Kopfmann, 1930; Neck, 1832).

Che ogni superficie, ogni forma nello spazio visivo abbia il suo “punto centrale di direzione” (Arnheim, 1988) e che l’osservatore sia situato “all’interno” di questa geometria visiva delle forme percepite, da Cezanne in poi è una consapevolezza che pervade i movimenti artistici di quel periodo. Nel raffigurare come “triangolari” o “coniche” le forme dimensionali (percepito, siano esse il dinamismo di un uomo, di lancieri o di cavalli, come in Boccio ni) o nel sostenere che gli angoli acuti siano “caldi” e quelli ottusi “freddi” (Kandinsky, 1912), i pittori delle avanguardie tra la fine dell’Ottocento e l’inizio del Novecento non hanno fatto altro che rappresentare con grande esattezza alcune componenti della nostra esperienza soggettiva diretta. Per esempio, nel percepire certe configurazioni come “quadrate”, cioè che percepiamo esattamente non è una figura euclidea, ma una specifica qualità dell’“intrinseca relazione tra spazio, forma e percezione tattile” (Fechner, 1893/1960).

Liliana Albertazzi – Rebus di arte e visione. Siamo tutti sinesteti?
di coloro che lavorano

tensions are neither restricted to 5% of the popu

a certain sound or grapheme simultaneously

sia (for example between a certain colour and

Ward, 2006; Spence et al., 2010; Spector, Mau

general population (Crisinel, Spence, 2010; Sagiv,

synaesthesia (Cytowic, 1995; Melara, O’Brien,

perceptual illusions, the focus of attention has

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phenomenologically "objective".

2. Are we all synaesthetes?

In recent years, after the large amount of studies

is broad consensus and statistically consistency

among people as regards these phenomena, which

are shared and perceived as “natural”.

In scientific research, the question was initial-

ly put in terms of the tendency for a sensory feature, or attribute, in one modality to be matched with a sensory feature in another mo-
dality (Dematté, Sanabria, Spence, 2006; Lai

et al., 2011; Ludwig, Simner, 2013; Simner et

al., 2005; Ward, Huckstep, Tsakanikos, 2006).

Most of the initial research was conducted on

rather simple stimuli (colour/grapheme, co-

loz/sound, note/odor, taste/flavour/sound, etc.), and

only recently has inquiry been ex-

tended to stimuli of higher order complexity.

It has been shown that humans tend to asso-
ciate colors and shapes, sounds and shapes, or
taste and music. In natural language, in fact,

we make wide use of expressions such as “bit-
ter” or “rough” sounds, and “acid” or “vivid”
colors, or speak in terms of a “falling” minor and a
“rising” major in music; the triangle is
generally associated with yellow and the squa-
re with red, zigzag shapes are associated with
sharp sounds, and curvilinear shapes with soft
ones. More than this, complex paintings are

associated with specific music, faster mu-
sic in the major mode produces color choices
that are more saturated, lighter, and yellower,
whereas slower, minor music produces the
opposite pattern (Palmer et al., 2013); even
abstract concepts such as “impairability” seem
to be blue-green (Albertazzi et al., 2013);

because the association is shown even with highly

complicated stimuli, rather than being treated as

curiosity it should be considered an essential

feature of perception. The research on these

aspects has been recently extended to associa-
tions between matic painting and classical

Spanish music (Albertazzi, Canal, Micciole,

2015), abstract painting and touch (Albertazzi

et al., 2016a), and even classical music and

poetic texts (Albertazzi et al., 2016b). In other

words, research is now extending to stimuli as

perceived and experienced in daily life, and

in so doing attracting the attention of people

working in apparently very different domains,
such as graphic interior designers, fashion de-
signers, people working in virtual reality, urban

and environmental architecture, museums, in-

tenzione si è spostato su associazioni apparente-
temente altrettanto “curiose”, percepite fra

fenomeni appartenenti a modalità sensoriali
differenti. A partire dall’interesse suscitato

dagli studi sulla sinestesia (Cytowic, 1995; Me-

lara, O’Brien, 1987; Simner et al., 2006), la ri-

cerca ha poi considerato fenomeni simili che si

verifica nella percezione del particolare stimolo

e brani musicali. Nel linguaggio naturale, in
di effetti, facciamo ampio uso di espressioni qua-
di somi, e in modo simbiotico con percorsi visivi
ad apprendimento oppure a corrispondenze di
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persino concetti astratti come “designers” di grafica e di interni

o fashion designers, di coloro che lavorano

nell’ambito della realtà virtuale, in architettura
urbana e ambientale, nei musei, nelle industrie
di produzione e distribuzione di prodotti ali-
mentari (food commerce) ed in ambito pub-

correlations substru-
turali che si verificano tra correlati neuronal;

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clicato. Questi fenomeni forniscono anche
molte informazioni sulla natura dello spazio
visivo, che appare “intrinsecamente cross-mo-
dale” e rivelano la presenza di “un’unità dei

senso” (Cytowic, 1995), che viene percepita

dalla popolazione generale.

di arti e di visualizzazione. Siamo tutti sinesteti?

1860), or the visual behaviour of cubes, pri-

smi, and conical shells undergoing perspective-

vocal reversal (Deregowski, 2014; Kopfermann,

1998). That every surface, every shape in visual

space has its “central point of direction” (Arneheim,

1988), and that the perceiver is “internal” to

this visual geometry of perceived forms, was

first suggested by Cezanne onwards an awareness perva-
ding the artistic movements of that period. By
depicting the perceived dimensional sha-
pes and dynamism of a man, lancers, horses,
as “triangular” or “conical” (Boccioni), or

maintaining that acute angles are “warm” and

obtuse ones are “cold” (Kandinsky, 1912),

tese painters were re–presenting components of

our direct and subjective experience in exact

manner. For example, in perceiving certain con-

figurations as “squared”, we do not per-

cieve a Euclidean figure but a specific quality

(say, “squareness” or “squaroid”), that covers a

variable but always small number of varia-

tions (Albertazzi, 2015). The same holds for

the connotative properties of colours, which

humans perceive as warm, cold, bright or dull,

shill or mute (Albertazzi, Koenderink, van Doorn, 2015).
The representations of our perceiving in art products are understood and

shared by general population, because they are

phenomenologically “objective”.

Liliana Albertazzi – Puzzles of vision and art. Are we all synaesthetes?
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The Poem of Fire
The Vowels

For centuries, odd questions of the kind have been permitted only in the realm of the arts: consider, for example, Rimbaud’s *The Poem of Fire*, or Skrjabin’s *The Poem of Fire*, on the natural association between musical notes and coloured lights. One may object, however, that the three artists were synaesthetes, so that their experiences are not generalizable. However, the impossibility of raising such questions in science is essentially due to the strict constraints imposed by Galileo on what is or has to be considered a “scientific” inquiry. As well known, Galileo conceived the universe as written in mathematical language, where characters are triangles, circles and other geometric (i.e., Euclidean) shapes, without which it would be impossible to understand even a single word of that language, leaving us wandering in an obscure labyrinth (Galilei, 1963/1957, ch. VI). Galileo was perfectly aware of the existence of so-called “secondary qualities”, but he maintained that we have only names for those subjective experiences pertaining to consciousness. Recently, however, those apparently odd questions have been considered eligible, and consequently experimentally tested. Here I present the results of some recent studies, two of which relate to Kandinsky’s claim that there exist a natural association between shapes and colours. The first study (Dadam et al., 2012) expanded Kandinsky’s classic ABC (consisting of three shapes to be associated with three colours by his Bauhaus students at Dessau) to include more complex set of stimuli. Kandinsky (1912), already mentioned, according to which suoni e forme ci porterebbe a vagare in un oscuro labirinto (Galilei, 1623/1957, cap. VI). Galileo era perfettamente consapevole dell’esistenza delle cosiddette “qualità secondarie” come suoni, colori o colori, ma sosteneva che per queste esperienze soggettive, pertinenenti alla coscienza, si avessero solo nomi. Recentemente, però, queste domande apparentemente curiose sono state considerate scientificamente ammissibili e ci sono interesi d’interazione tra forme e colori. L’ipotesi formulata era che forme con caratteristiche percepite differenti inducessero associazioni tra colori e forme, e non, come scritto in linguaggio matematico, i cui caratteri sono triangoli, cerchi, e altre figure geometriche (ovvero euclidee), senza le quali a suo parere sarebbe impossibile comprendere

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of three-dimensional shapes (cone, pyramid, truncated cone, truncated pyramid, fig. 8). The hypothesis was that shapes with different perceptual characteristics lead to consistent associations with colours or chromatic groups. The research was divided into two parts. The first part, verified the existence of a natural—by—based associations between the NCS Hue Circle, the specific hue, or groups thereof. The second part explored the relationship between the colour and the spatial dimensions of the shapes, i.e. their size, area, perimeter and stability, the purpose being to verify that the results obtained in the first part were independent of these spatial characteristics of shapes. For each basic geometric shape studied, participants were asked to indicate the colour perceived as most closely related to it, choosing from the NCS Hue Circle. The results show that the choices of colour for each shape were not random, i.e., participants systematically established an association between shapes and colours when explicitly asked to choose the colour which, in their view, without any presupposition or reference to past experience, they saw as the most naturally related to a series of given shapes. It is noteworthy that none of the participants showed perplexity or difficulty in understanding the task; the concept of “natural association” seems to have been intuitively clear to all participants. The concept of “natural association” sembra essere stato intuitivamente chiaro. L’analisi dei risultati ha mostrato che tra colori e forme esistono relazioni non casuali in modo sistematico. Inoltre, si sono verificate sia associazioni positive che negative: per esempio, in ambedue le sessioni sperimentali, tra il cerchio ed il rosso, tra l’escagone e il rosso—blu e tra la piramide e il giallo. L’analisi delle corrispondenze ha spiegato le associazioni rinvenute tra forme e qualità del colore in termini di alcune proprietà connesse, ovvero le dimensioni caldo/freddo e chiaro/sfocato. In altre parole, le forme bidimensionali si estendono lungo un “continuo di colore” (identificato dalla prima dimensione), dalla somma delle parti. Questi studi trovano ancora un correlato nelle analisi condotte da Kandinsky in campo artistico. L’analisi tra for—ma e colore, ovvero non si sono verificate interazioni significative con l’area, il perimetro e la stabilità percettiva delle forme. Come già ricordato, abbiamo anche verificato se dimensioni quali perimetro, area e stabilità percettiva nello spazio visivo potessero giocare un ruolo nella correlazione (fig. 9). Anche in questo caso abbiamo ottenuto risultati simili rispetto alle associazioni tra le variabili “for—ma” e “colore”, ovvero non si sono verificate interazioni significative con l’area, il perimetro e la stabilità percettiva delle forme. Come risultato collaterale dello studio, le associazioni personali di Kandinsky (peraltro, un sinesteta) sono state parzialmente confermate: il triangolo è giallo e il quadrato è rosso. La popolazione generale, invece, percepisce il cerchio come rosso chiaro. Lo studio, con gli stessi stimoli e la stessa metodologia è stato ri—petuto in Giappone portando a risultati simili, nonostante la differenza culturale (Chen, Tanaka, Matsuosy, Watanabe, 2013). 4. Qual’è il “colore naturale” degli angoli? I risultati dello studio condotto sulle associazioni naturali tra forme geometriche e colore, hanno permesso di avanzare delle previsioni: per esempio, ci si aspetterebbe di trovare una correlazione non solo tra colore e tipo di for—ma, ma anche tra colore e parti di una forma, sia per l’estensione relativa delle parti coinvolte sia per la caratterizzazione generale dell’intero. In principio, però, il colore di una forma per—cepita non deve essere necessariamente dato dalla somma delle parti. Questi studi trovano ancora un correlato nelle analisi condotte da Kandinsky in campo artistico. L’analisi tra for—ma e colore rientrava infatti in un’indagine più ampia sugli elementi dello spazio pittorico in termini di punti, linee e superfici (Kandinsky 1926) e sulle loro caratteristiche cross—moda—li. Kandinsky, per esempio, considerava caldo visivo, volendo verificare se i risultati ottenuti nella prima parte del test dipendessero o meno da queste caratteristiche spaziali degli oggetti. Per ogni forma geometrica di base pressa in considerazione, ai partecipanti si chiedeva di indicare il colore che percepivano come ad essa naturalmente associato, scegliendolo dal Cer—chio (CX), dalla somma delle parti e dalla Piramide (PM). Le proiezioni bidimensionali delle forme tri—dimensionali (piramide,cono,tronco di cono e piramide) variano essenzialmente nella seconda dimensione (chiaro/sfocato) e sono generalmente neutrali rispetto alla prima dimensione (caldo/freddo). La piramide e, in misura minore, il cono sono percepiti come le forme più chiare. Le relazioni più forti si sono trovate tra il trian—golo e i gialli, e tra il cerchio e il quadrato e i rossi. Per confronto, il parallelogramma è stato pochissimo associato ai gialli e la piramide ai rossi. L’analisi della corrispondenza suggerisce che le forme presentano una serie di dati che determinano queste relazioni, la “tempe—ratura” e il “grado di “chiarezza naturale” (Spil—lmann, 1985) delle tinte. Come già ricordato, abbiamo anche verificato se dimensioni quali perimetro, area e stabilità percettiva nello spazio visivo potessero giocare un ruolo nella correlazione (fig. 9). Anche in questo caso abbiamo ottenuto risultati simili rispetto alle associazioni tra le variabili “for—ma” e “colore”, ovvero non si sono verificate interazioni significative con l’area, il perimetro e la stabilità percettiva delle forme. Come risultato collaterale dello studio, le associazioni personali di Kandinsky (peraltro, un sinesteta) sono state parzialmente confermate: il triangolo è giallo e il quadrato è rosso. La popolazione generale, invece, percepisce il cerchio come rosso chiaro. Lo studio, con gli stessi stimoli e la stessa metodologia è stato ri—petuto in Giappone portando a risultati simili, nonostante la differenza culturale (Chen, Tanaka, Matsuosy, Watanabe, 2013). 4. Qual’è il “colore naturale” degli angoli? 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ness” (Spillmann, 1985) of hues. We also tested whether dimensions such as perimeter, area, and stability/instability in visual space might have a role in correlation (fig. 9). Also in this case, however, quite similar results were obtained with respect to both the significant association between the variables “shape” and “angle”, and the non-significant interactions occurred with size, area/perimeter, stability. As a by-product of the study, Kandinsky’s personal associations (he was a synesthete) were partially confirmed: the triangle is yellow and the square is red. The general population, instead, perceives the circle as light red. The study, with the same stimuli and the same methodology, has been repeated in Japan, leading to similar results, notwithstanding the difference in culture (Chen, Tanaka, Matsuyoshi, Watanabe, 2013).

4. What is the “natural colour” of angles? The results of the study conducted on the natural associations between geometrical shapes and colour, and colour, some predictions to be made: for instance, one would expect to find a correlation not only between colours and type of shape but also between colour and the parts of a shape, in regard to both the relative extension of the parts involved and the overall characterization of the whole. In principle, the colour of a perceived shape is not necessarily given by the sum of the colours of its metric parts. These studies again find a correlate in the analyses conducted by Kandinsky in the artistic field. In fact, Kandinsky’s shape/colour analysis between specific geometric angles formed by lines into the elements of pictorial space in terms of points, lines, and surfaces (Kandinsky, 1926) and their cross-modal characteristics. For example, Kandinsky considered an acute angle to be warm and tending to yellow, and an obtuse angle to be cool and tending to blue.

In a second experiment (Albertazzi et al., 2014), the existence of a natural association between determined angles, geometrically defined by two line segments with different colors, was tested. Because it was hypothesized that there may be some kind of interdependence between these two parameters, a total of 48 presentations. The same stimuli were presented in random orientation (i.e., the colors to the north of the screen was not always the same). Between one presentation and the next, the angles of each width were presented in random orientation in each of the eight possible orientations (22.5°, 45°, 90°, 135°, 157.5°, 180°), in a total of 48 presentations. The same stimuli were presented first in the version with a white background and then in the version with a black background, or vice versa.

The results of the study confirmed previous findings (Albertazzi et al., 2014; Dadam et al., 2012; Spector, Maurer, 2008, 2011), further extending his broader investigation (fig. 10). The results of the study confirmed previous findings (Albertazzi et al., 2014; Dadam et al., 2012; Spector, Maurer, 2008, 2011), further extending his broader investigation (fig. 10). The results of the study confirmed previous findings (Albertazzi et al., 2014; Dadam et al., 2012; Spector, Maurer, 2008, 2011), further extending his broader investigation (fig. 10). The results of the study confirmed previous findings (Albertazzi et al., 2014; Dadam et al., 2012; Spector, Maurer, 2008, 2011), further extending his broader investigation (fig. 10). The results of the study confirmed previous findings (Albertazzi et al., 2014; Dadam et al., 2012; Spector, Maurer, 2008, 2011), further extending his broader investigation (fig. 10).
gles were mainly associated with cool colours (Fig. 11). Kandinsky (1912), in fact, called this relationship “invariable”! The choice of a colour to combine with a shape (or of an image or a poetic quatrain with a musical clip), in fact, was made by the participants to the mentioned experiments merely according to an association perceived as “natural”. In the case of angles, then, a top-down association was less likely than that which can be supposed between shapes and colours (such as, for example, the association between a circle and the colour red). The effect therefore seems to be due to the presence of a sort of “generalized synaesthesia” in the normal population as a pattern of properties perceived as intricately connected, more than to a synaesthesia induced top–down or “ideasthesia” (Jürgens, Nikolić, 2012; Myles et al., 2003; Nikolić, 2009). Nevertheless, this research field is in full expansion, requiring different competences for its development, and the potential applications of the results, concerning the nature and the use of images in science and art.

5. Conclusions

From a systematic point of view, and on the basis of the results obtained, we may assume that the association between colour and form is intrinsic to the meaning of a perceived shape in nature and artifacts as well (Albertazzi et al., 2014). Kandinsky (1912), in fact, called this relationship “invariable”! The choice of a colour to combine with a shape (or of an image or a poetic quatrain with a musical clip), in fact, was made by the participants to the mentioned experiments merely according to an association perceived as “natural”. In the case of angles, then, a top-down association was less likely than that which can be supposed between shapes and colours (such as, for example, the association between a circle and the colour red). The effect therefore seems to be due to the presence of a sort of “generalized synaesthesia” in the normal population as a pattern of properties perceived as intricately connected, more than to a synaesthesia induced top–down or “ideasthesia” (Jürgens, Nikolić, 2012; Myles et al., 2003; Nikolić, 2009). Nevertheless, this research field is in full expansion, requiring different competences for its development, and the potential applications of the results, concerning the nature and the use of images in science and art.

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