The cube pattern with strong colour contrast on the ceiling of the Chapel of the Cardinal of Portugal

Luca della Robbia, Ceiling Decoration, enamelled terracotta and tiles, 1461-1462, San Miniato al Monte, Florence.

Name: Zongyue Cao
Student number: s2235854
Umail address: z.cao.4@umail.leidenuniv.nl
Supervisor and first reader: Dr. A.K.C. Crucq
Specialization: Arts and Culture: Art, architecture and interior before 1800
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Introduction

In 1013, Bishop Alibrando commissioned the establishment of a basilica on the south hillside of Florence to memorized Saint Minias, a legendary Christian martyr in the third century.[1] The basilica was named San Miniato al Monte. With the fact that the reliquary of basilica holds the remnants of Saint Minias as well as his relics, the establishment is considered as one of the most sacred facility across the city of Florence and the Emperor Henry II was also one of the patrons for its construction. Decorated with dark green and white ornamentations on either the inside or the outside, the basilica is also regarded as an architecturally finest Romanesque building across the Tuscany region. In the north-west side of the basilica of San Miniato, there situates the Chapel of the Cardinal of Portugal.[2] With such high degrees of sacredness, the Cardinal James of Portugal opted for this basilica to house his body after his death.

The planning and construction of the Chapel of the Cardinal of Portugal started in 1459 right after the cardinal's death under the commission of the Bishop of Alfonso.[3] The other patrons include the mother of James of Portugal, Princess Isabella, and Isabella of Portugal, as well as the Empress of Eleonora, who were all the cardinal's relatives.[4] Cardinal James of Portugal had passed away at a young age, barely 26 years old, yet he lived a life of the most incessant holiness, which attracted significant respect from Pope Nicholas V and Pope Pius as well as others.[5] As a child to Prince Peter who was the founder of the house of Aviz, James acquired his education through a manner which was somewhat familiar to that his father, learning public and clergyman law. James, as were the expectations of his father, became the most unique and extraordinary scholar in this specific niche. His life, however, hit a turning point while he was fourteen years old. After his father's defeat during the war between Portuguese, he was captured as a prisoner.[6] Fortunately, James eluded his captives fleeing with his sister and brother to Burgundy where they lived under the protection provided by their aunt, Isabella of Portugal. She soon afterwards began noticing her nephew's gift and attraction towards

[1] Hartt, *The Chapel of the Cardinal of Portugal*, 19.
[2] Ibid.
[3] Pope-Hennessey, *Luca della Robbia*, 48.
[4] Hartt, *The Chapel of the Cardinal of Portugal*, 42-43.
[5] Ibid., 27.
[6] Ibid., 33.

the monastic field and when James turned 17 years of age, she directed him to Rome.[7] His succession to become a cardinal was in 1456, while he was merely in his 20s, as well as his promotion to the position of pope barely two years afterwards was an evidence that he was truly among the most truthful and focused priests in the Christian church. James even retained his virginity until he passed on in 1459 and as a result of his sanctity, self-discipline and great virtue, he was greatly admired and respected and even acknowledged in the Portuguese hagiography.

In the letter written by the Signoria of Florence to the royal family of Portugal after the young cardinal's death, the Signoria of Florence described the young cardinal as "… one of the people who refuse all the temptations and who only live with the sweetness of the divine. He meditates only on the mortal things. He is worthy of all the glory of the divine and even has lived a better live than those wise men older than him".[8] From the letter sent by the royal family of Portugal, back to the Signoria of Florence, the Empress Eleonora said: "he was always with us not just because of the proximity of our blood but also for the unique and most endeared qualities he owns as well as his witness he got during his lifetime. We are so sad and upset for his death and at the same time moved by your and the Roman Church's care for the cardinal".[9] From these two letters, it has been proven that the young cardinal had high respect for his high virtue and nobility, and for his family. He was also a very beloved family member as well as a respectful man.

The young cardinal had decided to set his tomb in San Miniato al Monte and started making arrangement for the construction of the chapel soon after he felt his decreasing health condition. After he passed away in Florence in the year of 1459, the construction of the chapel started instantly.[10] Important architects and artists during the era, such as Antonio Manetti, Antonio and Piero Pollaiuolo, Antonio and Giovanni Rossellino, as well as Luca della Robbia, were welcomed to take part in the

[7] Hartt, *The Chapel of the Cardinal of Portugal*, 32.
[8] Ibid., 132. The original texts are "quos inter si qui sunt qui aspernentur suavitatem mortalium rerum nil nisi altum aut divinum meditentur, eos maiore gloria dignos quam provectioris etatis homines sapiens quisque ret."
[9] Ibid., 133. The original texts are "Qui cum nobis, tum ex propinquitate sanguinis, tum etiam pro singularíbus eius virtutibus maxime carus esset, nimirum ex illius obitu, ut par erat, multum et turbate et contristate sumus; considerantes quantum decoris ac spei in illius vita tam Romane Ecclesie quam etiam inclytae familiae nostrae regiae Portugallensi repositum fuerit, que omnia illius interitu deciderunt."
[10] Pope-Hennessy, *Luca Della Robbia*, 48.

establishment and adornment of this building.[11] The artists must have contributed their excellent skills to build up the chapel to commemorate this noble cardinal, as Frederick Hartt comments that: "the chapel utters a kind of prophecy of the joys of the heavenly realm into which the youthful cardinal may be imagined having entered".[12]

The Chapel of the Cardinal of Portugal is located in the north side of San Miniato. The design of the whole structure of this chapel was made by Antonio Manetti, a student of Brunelleschi, who also followed his teacher to build pure and simple designs for architecture.[13] When approaching the chapel in San Miniato al Monte, the first thing that can be seen was the tomb of the young cardinal located in the east of the chapel (Fig.1), which was designed and built by Antonio and Giovanni Rossellino; when entering the chapel, we are facing the north side of it, which shows the spandrels made by Alesso Baldovinett and the altarpiece painted by Antonio and Piero del Pollaiuolo (Fig.2); the west side of the chapel shows the Throne which was designed and completed by Antonio and Giovanni Rossellino, as well as the painting, *Annunciation*, painted by the Baldovinett brothers who also painted the altarpiece for the chapel (Fig.3); the floor which featured marble geometrical motifs was made by Stefano di Bartolommeo (Fig.4).[14] When looking up to the dome of the chapel, the dome design by Luca della Robbia can be found (Fig.5).[15]

The object which would be mainly discussed in this thesis is the vaulted ceiling, which is designed and constructed by the famous Italian sculptor known as Luca della Robbia, being the pioneer of the Della Robbia workshop, he was initially educated as a goldsmith and learnt the process of carving marble and bronze before he lastly ventured to clay craft.[16] He not only came up with the method of enamelled terracotta but went ahead to use pleasant and varied colours in his artistic works. Besides, Giorgio Vasari, whose texts recorded the biographies of important Renaissance artists, acclaimed Della Robbia as one of the best artists during Renaissance who has disclosed a method that rendered the eternity of the durability of the colour and clay of the sculpture.[17] His arts were hence unique at this time and had been sought by a number of patrons from the

[11] Hartt, *The Chapel of the Cardinal of Portugal,*22-26.
Cao, *The cube pattern with strong colour contrast*, 4.
[12] Pope-Hennessy, *Luca Della Robbia*, 20.
[13] Hartt, *The Chapel of the Cardinal of Portugal*, 20-25.
[14] Ibid., 24.
[15] Ibid., 24.
[16] Pope-Hennessy, *Luca della Robbia*, 12.
[17] Vasari, *Lives of the Most Eminent Painters*, 122.

upper class, like the Medici Family. Coincidentally, one of his pieces of work, which was commissioned by Piero de Medici is the enamelled terracotta roof and ceiling of the Cappella del Crocifisso at San Miniato al Monte (Fig.6).[18] The roof of the Cappella del Crocifisso is decorated with sectorial tiles in white, green and brown (Fig.7). The ceiling is decorated with twenty-four octagons, which are coloured in blue in a regular and neat order and they are framed with white mouldings (Fig.8). The centre of each octagon is decorated with a white terracotta flower. The roof and ceiling designed for the Cappella del Crocifisso in San Miniato might be the answer to why Della Robbia was chosen by the patrons to accomplish the ceiling design of the Cardinal's Chapel, or maybe even appointed by the cardinal himself, but since the young cardinal's will is lost, there is no way to find out.

The ceiling design of the Chapel of the Cardinal of Portugal is a striking part of the chapel; it reflects the theme of the tomb of the church leader and acknowledges his honorable qualities. Five white and blue medallions in enameled terracotta depict the Holy Spirit as well as the Four Cardinal's Virtues: temperance, fortitude, justice and prudence (Fig.5).[19] Such decorations are all established in typical style of Luca della Robbia with white terracotta to depict the motif, with blue as the background; their incorporation is a unique manner of showing chastity and great virtue. The background of the roof is established around the five medallions: a pattern of multiple cubes in green, yellow and black that had an intense colour distinction (Fig.9). With regards to Hartt, this eye-catching and captivating decoration has been substantially unique during the era and even seems disharmonious in this chapel.[20]

Luca della Robbia, is not only famous for his enameled terracotta technique, but also his delightful way of using colour.[21] In the Renaissance era, there arguably existed no other workshops that delt with the production of sculpture works as attractive and captivating as those that were being produced in the Della Robbia Workshop.[22] It seems common for Luca della Robbia to apply delightful colours like blue and yellow to his designs, however the cube design seen on the roof of the Cardinal's Chapel has never appeared in his previous work and there is no document available which recorded the

[18] Pope-Hennessy, *Luca della Robbia*, 42.
[19] Hartt, *The Chapel of the Cardinal of Portugal*, 24.
[20] Ibid., 75.
[21] Cambareri, *Sculpting with Colour in Renaissance Florence,* 13-15.
[22] Ibid., 7.

attempt for using this kind of ornament. Thus, it is not possible for us to know exactly why this kind of rare design was made and such pattern was chosen. However, it is intriguing to find that such design has not only once been commented as "striking" and "attracting" by the scholars, but this pattern has barely been studied and discussed in detail.[23]

Although it is no longer possible to figure out the true intention why it was chosen without enough literatures and documents, with the comments of scholars, it must have exerted some effects within the chapel and on the spectators. Thus, in this thesis, the main research question regards the possible function of the cube pattern with strong colour contrast on the ceiling of the cardinal's chapel. To arrive at possible answers, in the first chapter of this thesis, it will first be necessary to find the origin and tradition of the application of this certain pattern and the likely inspiration for Luca della Robbia's use of colour in this case. In the second chapter, it will be discussed the importance of ceiling design from the context of the sacred buildings. Examples like churches and chapels during the Medieval and Renaissance period will be given to help to figure out the expected function of the ceiling design in the Cardinal's Chapel and how the cube pattern would help to achieve the expectation of this specific design. In the final chapter, contemporary psychological theories will be applied to analyse how the cube pattern might affect the viewers, in order to examine if the cube patterns could really help to reach the expectation which was hypothesized in the second chapter as well as whether the effect of such pattern on the viewers might provide other possible explanations for why this kind of design was adopted.

At the end of this introduction, it is needed to state the meaning of some terms clear in advance, or it might be confusing for the readers. In the following chapters, the term 'cube pattern' refers to the whole repetitive ornament being used to decorate the intervals of the five medallions; 'cube' refers to the single three-dimensional cube which consists of three lozenges; 'the main motif' indicates the five medallions on the ceiling which depicts the Four Cardinal's Virtues and the Holy Spirit Dove.

[23] Hartt, *The Chapel of the Cardinal of Portugal*, 73.
Vasari, *Lives of the Most Eminent Painters*, 124.

1. The Background of the Pattern and the Colour Combination

1.1 The possible origins of the pattern

Luca della Robbia used the cube pattern with a three-dimensional effect to fill the interspace among the medallions. Each cube is made up of three tablets which are coloured in yellow, green and black respectively and in the same order (Fig.9). Such a cube pattern is not regularly used as an ornament for ceiling designs; in fact, this could be the first one of its kind, while the only other one is located in the Church of San Giobbe's Martini's Chapel in Venice (ca.1475) (Fig.10). The latter was created by the Della Robbia Workshop after Della Robbia's death and is an imitation of the one in the Cardinal's Chapel. The only difference between these two is that the one in the Martini's Chapel is depicted with the Four Evangelists instead of the Four Cardinal's Virtues.

Despite being a unique choice for decorating a ceiling, the pattern itself is actually much older. Its use goes back at least to Greece's Archaic period. The ancient Greeks had formed an idea of solid geometry, and the cube pattern was known among philosophers and the elite. The earliest record of the concept of 'cube' in Pythagoras's (570 B.C.- 495 B.C.) theories, as he was the first to have identified the five basic solids including the cube.[24] However, it was not until Euclid's (325 B.C.- 265 B.C.) *Elements* that the cube had finally been applied to a formal system of geometry, before that the not just the cube pattern but also other solid geometric pattern could just been found in the mosaic designs as a kind of ornament which were usually formed in a repetition and rotation. The earliest example for such cube pattern being used as ornamentation for the mosaic floor derives from the Archaic period in the ruin of Temple of Juno, in Sicily, which was built around 450 B.C when ancient Greeks occupied this island (Fig.11). The mosaic floor design of this temple is decorated with perspectival cube patterns consisting of white, grey, and dark grey lozenges. There was no other example found during the Classical Greece time, but later during the Hellenistic Period, floor and pavement designs that contain an ornamentation of cube patterns could be found. On the Island of Delos, several ruins were discovered which possess mosaics designed with cube patterns. One such example was found in the ruin of the Theatre Quarter of Delos,

[24] Kahn, *Pythagoras and the Pythagoreans*, 1-2.

which was built around 300 B.C. One of the floors is decorated with perspectival cube patterns, with each cube consisting of three lozenges in red, white and black (Fig.12). Not far from the Theatre Quarter, another similar example was found in the ruins of a personal villa – this pavement is also decorated with a mosaic design of cube patterns made up of red, white and grey lozenges (Fig.13). Furthermore, the cube pattern was found at thirteen different locations on the Island of Delos, which all could be chased down to the Hellenistic Period. As such, the cube pattern consisted of one of the most common motifs of ornamentation for floor and pavement designs during the Hellenistic Period.[25]

As time went on and regional trading increased, this pattern continued to spread both within and outside of Greece, to countries such as Italy. In fact, long before the Romans conquered ancient Greece, the cube pattern had already been used to decorate the pavement and floors of later Italian cities. The cube pattern mosaic design in the Temple of Juno in Sicily which have mentioned above is a good proof for the spreading of the pattern. The temple was built few decades after when the concept of 'cube' was first raised by Pythagoras, and since Pythagoras had lived in the Ionia Area of Archaic Greece, it is quite probable that the pattern was derived from the Ionia Area and later spread to Sicily.[26] The spreading of the cube pattern could also be found in the ancient city of Pompeii, which is located in Naples, Italy. Although the city was disastrously buried by the volcanic dust by an explosion in 79 A.D., it was re-discovered in 1738 by a Spanish army engineer known as Rocque Joaquin de Alcubierre.[27] The mosaic designs in the ruins were also excavated. In Pompeii's House of the Faun, cube patterns were found that have been applied to pavement and floor design as well (Fig.14). During the period of the Roman Empire, mosaic designs and techniques were adopted from Greeks and improved by Roman designers, which led to an increase in the popularity of cube patterns. Due to the special waterproof nature and appealing decorative effect of mosaic, they became especially prominent among public bath houses as well as private villas, which were of great significance to the Romans. For example, a cubic-patterned mosaic was adopted as a decorative motif in one of the most well-known bath house ruins, the Bath of Diocletian (Fig.15). Cube-patterned mosaics thus spread first throughout the Hellenistic period in ancient Greece and then throughout Italy, featuring prominently

[25] Dunbabin, *Mosaics of the Greek and Roman World*, 23.
[26] Ibid., 38-39.
[27] Ozgenel, *A tale of two cities*, 13.

as a style of ornamentation among architectural buildings of significance to the Romans. The cube pattern could be found from devout reservations to community facilities and from housing apartments to private houses.[28]

As the mosaic design spread throughout the Roman Empire, not only did it reach Sicily, Naples and Rome, but also the area of Tuscany. In 2015, an ancient ruin of a personal villa was discovered in Florence, and according to archaeologists, the mosaic panels of a floral and geometric motif found in this ruin could be dated back to about the 5th century A.D.[29] Despite the fact that the exact same cube pattern as those had been found in the Greek and Roman ruins has not been found in this ruin and it is not certain whether the people during the Renaissance time had ever seen this mosaic design, this case could at least prove that mosaic decoration had spread to the area of Tuscany at that time. Presently, no discovery has proven that the cube pattern was also a popular mosaic before the eleventh century in Tuscany, but it is quite certain that the cube pattern made an appearance there no later than the medieval era. In the city of Lucca, the cube pattern once again appeared, which could be located in the Cathedral of Lucca, of which the construction started in 1063 (Fig.16). The latter is of the same colour combination as it was in the Hellenistic period, made up of white, grey and black lozenges. In addition, the cube pattern has been used as a floor decoration in the Church of San Michele, which was first built in the eighth century and later rebuilt in the eleventh century (Fig.17). Though it is not sure whether the floor with cube pattern as ornament was made, as least it is for sure that in the eleventh century the cube pattern also could be found in the Tuscany area. Moreover, Luca della Robbia had visited this church and had created a *Madonna* piece for it in the fifteenth century, which makes it highly possible that Luca had an opportunity to see this pattern in this church.[30] More examples can be found in Tuscany as well. In the Santa Maria del Fiore, or to say, the Florence Cathedral, a part of the hall's floor is decorated with the cube pattern coloured in white, red, and black (Fig.18). Lorenzo Ghiberti, Della Robbia's teacher, had participated in designing and constructing this cathedral and this cathedral located in Florence, where San Miniato al Monte is also located in and Della Robbia spent his whole life. Therefore, there is the likelihood for Della Robbia seeing the cube pattern

[28] Dunbabin, *Mosaics of the Greek and Roman World*, 46.
[29] Lorenzi*, Ancient Roman Mosaic Found in Tuscany.*
[30] De-Nicole, *A Recently discovered Madonna by Luca della Robbia,* 49.

in the Florence Cathedral. Based on all of these examples, the cube pattern appears to have been used regularly in churches and might also have been a popular decorative motif in the Tuscan region.

Deriving from the Greek Archaic period, the solid cube was used to symbolize the concept of 'earth' first by Pythagoras in his theory. Later this theory influenced Plato's concept that the world was formed through four basic elements: earth, air, water and fire, with the solid cube symbolizing "earth". In his work titled *Timaeus*, Plato thus stated that "Earth is the most unyielding of the four (elements); therefore, to it we assign the cube as its constituent; for this is the most stable solid, being formed of the rectangular isosceles".[31] As the solid cube stood for the element of 'earth' it therefore seems more likely that this motif was applied to the floor and pavement designs, and the examples during the Ancient Greece, the Roman Empire Period and in the late Medieval time seem to have proved it, since in all the cases found in Ancient Greek and Roman ruins the cube pattern were applied to floor decoration. It appears that ancient artists have known the representative meaning of this pattern so well that it became a tradition to apply the cube pattern to the floor design. During the Renaissance Period, Pythagoras and Plato's theories were greatly appreciated by the intellects and scholars, and the symbolization of such cube pattern were supposed to be known by intellects and artists at that time. If Della Robbia had ever heard about this symbolic meaning, it is not likely for him to apply something represented for 'earth' to the ceiling design. Thus, in this case, it is more likely for Della Robbia to have seen this pattern in the chapels or churches in the Tuscany area without knowing its symbolization and then applied it to the ceiling design in the Cardinal's Chapel; or perhaps the symbolic meaning of the cube pattern was changed or weakened when it spread to the Tuscany area, then this pattern became more decorative than representative so Della Robbia simply picked this one to decorate the ceiling.

Another possible inspiration for Della Robbia's design was proposed by Frederick Hartt in his book, which is the only book focused on this specific chapel. He qualified the application of this pattern as being "rare" and also offered a possible origin for this ornament. Hartt argues that:

> "This pattern, striking enough but relatively rare, was used at least twice by Piero della Francesca, once in the distant architecture visible between the youthful

[31] Plato, *The Timaeus*, 198.

> barefoot figure and the bearded man toward the right of the *Flagellation* in Urbino, once at the rear wall of the Virgin's room into which one can just peer in the Arezzo *Annunciation*" (Fig.19&20)".[32]

However, whether these two examples possess the same kind of cube pattern is in great doubt. The "similar" description which mentioned by Hartt in *The Flagellation of Christ* is applied to a distant wall, which appears to be vague and too difficult to identify what kind of pattern that really is. What's more, the pattern which Hartt refers to with respect to *The Annunciation* lies on a wall behind the Virgin's room. In this case, the pattern is indeed similar, but not the same. The pattern mentioned by Hartt is on the right side behind the Blessed Virgin Mary in *The Annunciation* (Fig.21&22). The pattern is consisted of a square in white and two lozenges in brown and black, which is more likely a combination of three-dimensional columns and creates a visual effect such that there appears to be more space behind the Virgin's room, but the pattern being used in the Cardinal's Chapel is the perspectival cube pattern, so this pattern mentioned by Hartt is still not the same pattern with the one in the chapel. Since there is no reliable reference Hartt has referred, this statement is his own opinion. With the analysis about, his own opinion towards Della Francesca's paintings is no longer persuasive.

1.2 The possible origins of the colour combination

From the examples provided in the last section, it is easy to determine the traditional colour combinations being applied to the cube pattern throughout the history. The four main colours used for forming the cube includes: white, grey, black, and red. Two principle combination were used: the cube decorating with red, white and black (Fig.17), or the cube formed by white, grey, and black lozenges (Fig.14). To form the three-dimensional visual effect, the darker colour like black or grey was usually used for creating the solid cube's shadow (Fig.14&15). However, in Luca della Robbia's ceiling design for the Chapel of the Cardinal of Portugal, a very different combination for the cube pattern was chosen instead: yellow, green and black, creating a strong visual effect. There are different opinions towards the dark colour being used in the pattern here, the

[32] Harrt*, The Chapel of the Cardinal of Porgual*, 75.

majority of scholars including Hartt, Cambareri, Kupiec regard it as black, while scholars like Koch and Pope-Hennessey regarded it as purple.[33] It is indeed difficult to distinguish the colour from a distant but when looking at the pattern closely it is black. The purple seen by the scholars is due to the fading of the pigment or to the illusion created by the mixture of three colours. When enlarging the picture of the cube pattern, it is quite clear that it is black (Fig.23). Moreover, the staff members in San Miniato al Monte also confirmed that the colour on the cube pattern is black.[34]

For the colour combination of the cube pattern, Hartt has made comments in the following way:

> "But of all the unexpected aspects of the tile ornamentations, perhaps the most striking is the colour contrast…Luca's colouring, generally based on blue and white with a few discreet additions of harmonizing primary and secondary colours, never jars and frequently might be accused of excessive mildness. Not so in our ceiling, where a rather harsh yellow, bright green, and black provide a sharply dissonant background for the blue and white of the medallions, as if the pure and harmonious essence of the cardinal virtues were really pitted against hostile colouristic forces in a Psychomachia taking place in the 'celo' of the vault".[35]

According to his comment, Della Robbia's use of colour on this ceiling is not in accordance to his usual way of colouring. Thus, this colour combination differs from the two principle combinations as discussed at the beginning of this section, nor it is a normal case in Luca della Robbia's designs. This raises the question as to what the reference for such a use of colour could be.

The first possible origin for Della Robbia's choice of colour combination may have come from the ornaments in the basilica of San Miniato al Monte, where the Chapel of the Cardinal of Portugal is located. The construction of the basilica of San

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[33] Hartt, *The Chapel of the Cardinal of Portugal*, 75.
Cambareri, *Sculpting with Colour in Renaissance Florence,*13.
Pope-Hennessey*, Luca della Robbia*, 48-49.
Koch, *The Early Christianity Revival at S.Miniato al Monte,* 531.

[34] The author went to the San Miniato al Monte and checked this problem with the staff members. According to the staff members, the controversial colour in the cube pattern is black.

[35] Hartt, *The Chapel of the Cardinal of Portugal*, 75.

Miniato al Monte started from 1014 and was finally completed in about the 1290s; the church was built to honour and store the relics of Saint Minias, an Early Christian martyr.[36] Linda A. Koch analyses the Early Christian revival of the cardinal's chapel in her article, and in which she explains that San Miniato may have had a crucial influence on the early Christian approach to decoration in the Cardinal's Chapel.[37] The colour combination used in the basilica of San Miniato is actually very familiar from Early Christian Byzantine art.

San Miniato al Monte is a Romanesque piece of architecture. 'Romanesque' refers to the medieval arts and architectures that appears to have inherited some ancient Roman styles made or built between about 1050 and 1200 in western Europe.[38] Romanesque architecture in Western Europe was significantly influenced by local Roman relics and indirectly influenced by the art of Constantinople, Byzantine art.[39] Thus, due to these two influences, Romanesque architecture combines Western and Eastern cultural forms. Romanesque architecture differs between Western European countries in various respects in terms of its relative proportions of Western and Eastern elements. In Italy, Romanesque architecture did not exist in religious buildings until the early ninth century, and the styles differed a little between parts of Italy.[40] In southern Italy, most of which was colonized by Byzantium from the sixth century to the ninth century, Romanesque churches barely existed, because the art and architecture there were predominantly in the Byzantine style; in northern Italy, Romanesque architecture was fully developed with a mixture of Roman and Eastern styles.[41] In Tuscany at that time, some Romanesque architecture could be found, but the Eastern influence was extremely strong, mainly due to the large volume of trading and frequent communication with the Eastern Byzantine regions.[42] Hence, across medieval Italy, religious buildings like chapels and churches were more or less decorated or built in a Byzantine style, and San Miniato al Monte was no exception.

In San Miniato al Monte, many Byzantine-style elements can be found in the colour combination used to decorate the ceiling. The design of the ceiling of San

[36] Koch, *The Early Christianity Revival at S.Miniato al Monte,* 552-553.
[37] Ibid.
[38] Kleiner, *Gardner*'s *Art Through Ages*, 431.
[39] Stewart, *Early Christian, Byzantine and Romanesque architectur*e, 110-112.
[40] Ibid.
[41] Ibid.
[42] Ibid.

Miniato is not typically Byzantine but rather Early Christian; it is made from wood instead of bricks (Fig.24).[43] The ornaments used to decorate the ceiling are mainly in geometrical patterns, such as lozenges and circles. Other patterns are in the shape of eagles; some are animal patterns; and some have human faces (perhaps representing Jesus). These ornaments are mainly in green, black, red, and yellow, the colours most frequently used for Byzantine ornaments.[44] The term 'Byzantine ornament' refers to a relatively complex concept, because Byzantium's broad territories covered many races and religious faiths. Byzantium had conquered the western Mediterranean coast, including Rome, Sicily and North Africa, as well as Islamic regions such as Syria and Arabia.[45] On becoming colonies of the Byzantine Empire, all of these places had an impact on the formation of Byzantine art.[46] Nevertheless, the colours of the ceiling of San Miniato are similar to those of many Byzantine ornaments and artworks. For instance, the main colours of *Icon with Saint Eudokia* (Fig.25), which was created in the early tenth century in Constantinople, are yellow, green, black and red, very similar to the colours of the ceiling of San Miniato. The lozenges used as ornaments in this piece are also arranged similarly to those in San Miniato. Another case found in Constantinople is *Fragment of a Mosaic with the Virgin* (Fig.26), made in the late tenth century. The frame surrounding the Virgin is black; her face is depicted in green and brown; and her halo behind her is yellow and green. In addition, floor tiles with a similar colour combination can be found in Bulgaria, which once belonged to the Byzantine Empire. These tiles date back to the tenth century (Fig.27). These are just a few examples; indeed, the colour combination of yellow, green, black, and red appears so frequently in Byzantine artworks that it can be considered typical of Byzantine ornaments. Accordingly, given the Byzantine impact on Romanesque architecture and the frequent appearance of this certain colour combination, the ornaments on the ceiling of San Miniato can be identified as Byzantine ornaments.

Another possible reason for the Byzantine use of colour is linked to the purpose of constructing the basilica. This Romanesque building was built to memorialize the martyr Saint Minias. According to legend, Saint Minias was an Armenian prince or king who first served in the army of the Roman Empire, later made a penitential

[43] Stewart, *Early Christian, Byzantine and Romanesque architectur*e, 18, 53.
[44] Jones*, The grammar of ornament*, 152-153.
[45] Haldon, *Warfare, state and society in the Byzantine World*, 47.
[46] Jones, *The grammar of ornament* ,141-142.

pilgrimage to Rome and finally became a hermit in Tuscany.[47] He is recorded to have died in 250 A.D., which means that he lived in the Early Christian period. As San Miniato was built to honour this foreign prince, it may have been designed with exotic elements. It seems that Byzantine ornaments from Saint Minias's hometown were chosen.

In the interior side of the basilica of San Miniato, the Byzantine influence is significant. Coincidentally, Luca della Robbia, the creator of the roof of the Chapel of the Cardinal of Portugal, had also worked in San Miniato and created the ceiling and roof design for the Cappella del Crocifisso inside the basilica (Figs 6 & 7). His choice of colours to decorate the roof and ceiling included white, green, brown and blue – similar not only to the Byzantine ornaments on the ceiling of San Miniato but also to his design in the Cardinal's Chapel. To ensure the stylistic unity of the Cappella del Crocifisso and San Miniato, Della Robbia very probably chose from elements of the basilica to decorate the roof and ceiling of the Cappella del Crocifisso. Therefore, a similar colour combination might have been used to ensure the unity of the basilica and the Cardinal's Chapel. Hence, the use of Byzantine ornaments to decorate the ceiling of San Miniato al Monte probably accounts for Luca della Robbia's decision to use a similar colour combination in the Chapel of the Cardinal of Portugal.

In addition, Luca della Robbia's choice for the colour combination could relate to the Islamic impact on the Latin West. In the book titled *The Grammar of Ornament*, author Owen Jones presents readers with a lot of manuscripts which have recorded all kinds of ornaments from different time periods and various regions. The colour combination used by Luca della Robbia shares a great similarity with some Islamic ornaments like the Moorish ornament which feature a blend of bright colours, especially yellow and green.[48]

Luca della Robbia, being a sculptor with a high reputation, had also been trained as a craftsman and a painter, while at the same time being a potter who possessed exquisite technical skills in working with terracotta.[49] Despite having been immersed in Western traditions during his training with masters such as Lorenzo Ghiberti and Piero di Giovanni Tedesco, his interest shifted from bronze to marble first and later to

[47] Brucker, *Florence: The golden age*, 194.
[48] Jones, *The grammar of ornament*, 152, 220, 227, 233.
[49] Vasari, *The lives of artists*, 66.

terracotta[50]. As the proprietor of the method of enamelled terracotta, his connection with the Islamic world was far greater than people have recognized.[51]

In fact, the Islamic influence on his art can be seen in the use of colour on his first officially recorded enamelled-terracotta piece, the *Tabernacle*, created under the commission of the Parrocchia Santa Maria a Peretola (Fig.28).[52] This piece is a combination of bronze, marble and terracotta. The Holy Dove representing the Holy Spirit is casted as a medallion in bronze, and beneath this roundel, there is a bronze panel depicting the image of Christ with a crucifix. The whole body of the tabernacle is in marble, including the image of God at the top, the scene of the Death of Christ with some angels supporting Christ in the arch, as well as the two angels' image holding up the Holy Spirit roundel. The terracotta sections in this art are all glassy with colour. At the upper part of this piece, there are three angels coloured in blue and white respectively; between each angel, greens cirruses with blue and white floral patterns serve as ornament. At the bottom, the flower and leaf pattern applied as decoration is arranged in a strict order and also featured in green and blue. The typical blue background which can always been seen in Della Robbia's later works can also be found in the *Tabernacle.* What is worth mentioning here is that it seems to be the first time that the typical della Robbia blue background and other bright colours were adopted in Luca's work because referring to his art pieces which had been found chronologically, this is the first one being decorated with a blue background. The question thus becomes what could have triggered Luca della Robbia's use of bright colours at this time.

To find the answer to this, the background story of this tabernacle must be taken into account. The tabernacle, which is now being stored in the Church of Saint Michele, was made for and commissioned by the Hospital of Santa Maria Nouva which is next to della Robbia's family house.[53] The patrons of the Hospital of Santa Maria Nouva actually requested that Luca della Robbia adopt some elements from the hospital in order to emphasize their connection and its function.[54] Coincidentally, from 1420 to 1433, the Hospital of Santa Maria Nouva had ordered almost a thousand works of

[50] Pope-Hennessey, *Luca della Robbia*, 13.
[51] Solon, *History and Description of Italian Majolica*, 34-35.
[52] Pope-Hennessey, *Luca della Robbia,* 34.
[53] Ibid., 11.
[54] Ibid., 34-35.

pottery from a local potter named Giunta di Tugio, requesting a specifically Damascene style. The Damascene style is a kind of pottery imported from Syria or Egypt featuring the use of white and blue colours or the blue and white pottery made in Damascus (Fig.29). [55] Although di Tugio was a local Italian, the pottery he made mostly followed this specific style. In the case of the tabernacle, an Islamic influence has been clearly adopted. Given the prevalence of such exotic pottery and Della Robbia's efforts with ceramics, such kinds of pottery were very likely what he referred to in his application of colour on the tabernacle. However, this is not the only possibility. The green floral style decorations featured at the lower side of this work and the leaf ornament on the spandrels are also reminiscent of Iznik pottery.[56] Although the blue and white colour and wide application of floral patterns respective to Iznik pottery share a great similarity to the ornamentation on Luca's *Tabernacle*, Iznik pottery only started being imported to Italy from the second half of the sixteenth century.[57]

During the fourteenth and fifteenth centuries, the ceramic industry in Italy encountered a remarkable growth.[58] Being a city which possessed various trading routes with different regions, there were various types of pottery and earthenware being imported to Florence from Arabia, Persia, Ottoman Turkey, Mongolia, etc. Many kinds of pottery from that time possessed a feature with the motif coloured in blue on a white background. Most of these patterns were imitations of Chinese porcelains. Thus, Luca della Robbia could have had many references for his choice of colour. However, no matter which kind of ceramics he had gained inspiration from, it is clear that in his very first piece of enameled terracotta work, his choice of colour was influenced by Islamic elements to some extent.

When it comes to the colour combination on the cube design on the roof of the Chapel of the Cardinal of Portugal, the combination of yellow, green and black shares more similarities with certain Islamic ornaments, especially Hispano-Moresque wares, which is the most plausible source for explaining the strong colour choice for the ceiling (Fig.30). In this case, the Italian tin-glazed earthenware called Maiolica, which became famous in the last quarter of the fifteenth century, played a crucial role. By the sixteenth century, it had become a typical and specific kind of ceramics which became popular

[55] Hess, *The arts of fire*, 98-99.
[56] Pope-Hennessey, *Luca della Robbia*, 35.
[57] Atasoy*, Iznik*, 264.
[58] Kupiec, *The materiality of Luca della Robbia's terracotta*, 50.

Italy due to its cultural content, delicate glaze and beautiful colour.[59] The great success of Maiolica has owed itself to the Hispano-Moresque wares which had been imported to Italy during the fourteenth century and which were created by the Moors who had conquered and dominated the southern part of Spain. The name 'Maiolica' refers to the Majorca Island, which was the central trading point between Muslim Spain and Italy.[60] Due to its more delicate technique than that of local Italian earthenware, Hispano-Moresque wares tended to be highly appreciated by noble families such as the Medici family.[61]

According to Owen Jones, the featured use of yellow and green on Hispano Moresque wares was greatly influenced by Moorish ornaments, and indeed, yellow, green and black are all the colours which are featured on the wall tiles of Moorish architecture (Fig.31). Considering the great similarity between the colour combination of the Hispano-Moresque wares and the Italian Maiolica, as well as the trading which was occurred at that time, Moresque ornaments have great impact on the development of Italian ceramics and art.

Luca della Robbia, the discoverer of enameled-terracotta technique and normally related to Italian Maiolica, both Solon and Elliott have argued that he must have taken note of the fame of this Islamic claywork.[62] To create the concept of enameled terracotta, it seems not avoidable for Della Robbia to dealing with all kinds of ceramics. Hence, with regards to the unique colour integration which he applied for the ceiling outlook of the Chapel of the Cardinal of Portugal, it is possible that he imitated an Islamic style to a certain extent.

[59] Solon, *History and Description of Italian Majolica*, 26.
[60] Elliott, *Italian Majolica*, 244.
[61] Solon, *History and Description of Italian Majolica,* 26.
[62] Solon, *History and Description of Italian Majolica,* 34-35.
Elliott, *Italian Majolica*, 245.

2. Function of the Pattern during the Renaissance Period

In this chapter, the function of the cube pattern within the chapel will be discussed by the time when this chapel was constructed. The Renaissance period being discussed in this chapter especially refers to the period during Luca della Robbia's life time from 1399 to 1482 which almost equals to the entire fifteenth century. The theories being used in this chapter includes those theories which have been acknowledged by fifteenth century to form the function of this cube pattern might could achieve by that time.

2.1 The expected function of the ceiling design of the chapel

In the thirteenth century, Peter of Limoges wrote a book which was popular through the European Catholic priests, *A Moral Treatise on the Eye*. He delivered the knowledge of the science of eye and vision through this book and linked these knowledges to the spiritual interpretation within Christianity.[63] In the book, he states:

> "…many things are expounded in holy discourse relating to our vision and our physical eye. From this it is clear that a consideration of the eye and of such things as appertain to it is a very useful means of knowing more fully about the divine wisdom."[64]

It indicates that at least during thirteenth century vision had been considered as a very important human sense in experiencing and understanding the Christian spirituality. Not just for the thirteenth century, vision has been always considered as the most crucial sense in the Renaissance era, especially for religious purpose.[65] The places where could have people feel the power of the religion through vision are mainly in the churches and chapels. Hence, both the

[63] Peter of Iimoges, *A moral treatise on eye*, introduction.
[64] Ibid., A VII r.-B VII v. The original text is as follows: "Se diligentemente vorremo col spirit pensare nella lege del signore, facilmente cognosceremo che nelli sacri eloqui spesso si recitano quellw cosec he alla vision & occhio material si apartengano. Donde e manifesto che la considerarione del occhio & di quelle cose che ad esso si apartengano e assai utile ad havere piu piena notitia de la sapientia divina."
[65] Baxandall, *Painting and experience in fifteenth century Italy*, 103-104.

architectural design and the artifacts in these religious buildings are both crucial to what people can see, what can they feel and what the builder wants people to see. Every detail matters. So is the case of the ceiling of the Cardinal's Chapel. There must be some expectations for designing the ceiling in certain way, for the chosen motif and chosen ornament. Then in this section, the expectation for the ceiling design in the Cardinal's Chapel would be discussed by two parts: the ceiling design in the religious building in general during the Renaissance period and the importance of the more engaged spectators.

2.1.1 Ceiling as an important factor in religious architectures

In the twenty-first century, astrology and astronomy are mainly considered two individual, separate subjects. However, during and before the Renaissance period, there was no clear division between astrology and astronomy.[66] Astrology, which is no longer regarded as scientific today, was particularly important to people of the fifteenth century.[67] From the fourteenth century, the philosophy, literature, religion, art, music, etc. of Greek and Roman antiquity were revived as well as new concepts and values were developed based on the classics.[68] The lives and works of ancient scholars such as Plato and Aristotle were again studied. The Roman poet Marcus Manilius (about the first century) who presented scientific topics in poetic form following a Platonic logic, gained appreciation from many Renaissance scholars and art patrons.[69] In his work *Astronomica*, on astrology, he stated:

> "For my part I find no argument so compelling as this to show that the universe moves in obedience to a divine power and its indeed the manifestation of God, and did not come together at the dictation of chance… If chance gave such a world to us, chance itself would govern it…Why are the summer nights and the nights of winter ever made beautiful with the selfsame stars…All of this is not

[66] Quinlan-McGrath, *Influences*, 2.
[67] Ibid.
[68] Hunt, *The Renaissance*, 1.
[69] Quinlan-McGrath, *Influences*, 15.

the result of chance, but the plan of a God most high."[70]

These statements reflect the poet's understanding of the close relationship between the universe and God, which was used by intellectuals as evidence of the existence of a creator, which is crucial to Christianity.

Another vital aspect of astrology is the theory of the soul. Plato, in *Timaeus*, claimed that when people die their souls fly back to God, and then God creates more living beings and brings the souls to birth again.[71] He continued as follows:

> "…And when he had compounded the whole, he portioned off souls equal in number to the stars and distributed a soul to each star, and setting them in the stars as though in a chariot, he shewed them the name of universe and declared to them its fated law."[72]

Plato thereby made the theory of the soul a central part of astrological theory. Horoscopes were used to judge an individual's personality and talent, a city's character, and so on. Although the "God" referenced in Plato's *Timaeus* is not the same as that of the Christian religion, humanists and scholars of the Renaissance still used Plato's theory to explain life and death, which was widely accepted by intellects and scholars at the time. Marsilio Ficino (1433-1499), a Neoplatonist, a catholic priest and the most influential humanist at that time, was greatly influenced by Plato's theory of soul. In the part his *Three Books on Life* on "Obtaining Life from the Heavens", he introduced the souls of the stars, man's nature according to stars, how to absorb the spirit of the world through Sun and Jupiter, man's natural power through stars and so on.[73] He believes that all the aspects of a man depends on certain celestial stars and those stars offer the spirit for mankind.[74] The impact of his astrological and cosmological arguments was very influential at that time.[75]Another example is provided in Vasari's *Lives of Artists*, narrating the birth of Michelangelo:

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[70] Manilius, *Astronomica,* 483-531.
[71] Plato, *Timaeus*, 41A-41D.
[72] Ibid., 42E-42D.
[73] Ficino, *Three books on life*, 243-293.
[74] Ibid.
[75] Allen, *Marsilio Ficino*, 316.

> "… to whom he gave the name of Michelangelo, for without thinking any further about the matter, he was inspired by One from above and wished to make him into something celestial and divine, beyond the usual human scope, as was seen in the horoscope of his birth, which had Mercury ascendant and Venus entering the house of Jupiter in a favourable position, showing that one could expect to see among his accomplishments miraculous and magnificent works created through his hands and his genius.[76]

Astrology was used to predict the fate not only of people, but also of buildings. Leon Battista Alberti (1404-1472) offered directions on how to build a city and sacred building in his On the Art of Building in Ten Books. In his seventh book of this series, he clearly stated that every place inside or near a building should be matched with a distinct guarding spirit or god.[77] Architecture built for different gods should have styles that reflected the position and characteristics of the god.[78] This opinion delivered by Albert shows the concept of 'decorum'. The decorum was first referring to the field of classical rhetoric and poetry, which designates the appropriateness of the role and style to one subject.[79] This kind of rhetoric concept is also applicable and needed in the architectures for their different social or private purpose. When discussing the ceiling design of sacred architecture, Alberti not only emphasized the need for graceful decoration as decorum in sacred buildings, but noted that he appreciated vaults painted to imitate the sky because this offered an eye-catching way to present a heavenly house to spectators.[80] Alberti's treatises are not the only texts in which ceiling design was linked with astrology; there are innumerable examples of plans to decorate ceilings in the form of the sky, the universe, an imaginative heaven, etc. For example, in the Church of the Holy Sepulchre in Jerusalem which was built in the fourth century and renovated in the eleventh century (Fig.32), the vault of it is depicted with Jesus in the middle and with Saints and Angels surrounding him which shows the idea of heaven and their divinity. Also, in Santa Maria Sopra Minerva which was built in the fourteenth century in Rome (Fig.33), the ceiling of the church is depicted as sky in blue with stars

[76] Vasari, *The lives of artists*, 417.
[77] Alberti, *On the art of building in ten books*, 189-195.
[78] Ibid.
[79] Dorsch, *Classical literary criticism*, 85.
[80] Alberti, *On the art of building in ten books*, 220-223.

in gold and in some parts of the ceiling there are angels being depicted. So as in Depicting Heaven on the domes and ceilings of churches and chapels had long been a fundamental artistic expression of Christianity, from early Christianity and the Byzantine era to the medieval and Renaissance periods.[81] Domes that presented Heaven as an afterlife, a place where the soul ends up after a person dies, became a crucial decorative part of chapels and churches. More examples could be found in churches like Hagia Sophia in Istanbul (Fig.34), St. Peter's Church in Vatican (Fig.35), etc. which make the depiction of sky and heaven as a universal rule for Christian religious buildings.

As stated in the introduction, the chapel under study here was built for Cardinal James of Portugal to memorialize his accomplishments during his career as cardinal. The chapel's patrons were all close relatives of the young cardinal.[82] They must have set high standards for the construction and decoration of a chapel for the young cardinal being both important family member and role model, to remind people of the young cardinal's loyalty to God, nobility and great virtue. The ceiling of this chapel, for its crucial position in the construction of religious building in general as well as the nobility of the young cardinal, must be a very important part in the construction of this chapel. Luca della Robbia, who was responsible for decorating the ceiling, depicted the Four Cardinal's virtues which presented the cardinal's position and nobility, and the Holy Spirit Dove which represents one of the forms of God.[83] These motifs were expected to accurately represent the young cardinal's position and virtue to people who visited the chapel.

2.1.2 More Engaged spectators to the ceiling design

The spectator is a crucial factor in the creation and completion of an art work. The invention of an art work depends not only on the artist's own thoughts, but also on the

[81] Lehmann, *The dome of heaven*, 1-24.
[82] Hartt, *The Chapel of the Cardinal of Portugal*, 42-43.
[83] Hall, *Dictionary of subjects and symbols in art*, 19, 109, 309. According to Hall's explanation, God is of one nature yet three persons, Father, Son and Holy Ghost. God the Father was depicted in symbolic form as an eye or a hand emerging from a cloud, while God the Son would be holding a crown. The Holy Ghost/ Spirit was most often symbolized by a dove. This shows the idea of "Trinity".

patron's requirements and the engagement of spectators.[84] If spectators are not well engaged with an art work, it will be easy for them to misunderstand its true purpose and meaning. Not only modern artists but also those of the Renaissance were aware of the importance of the viewer's role and what the viewers are supposed to see and feel. An example is the *Madonna and Angels* by Filippo Lippi (Fig. 36). To form a more vivid scene, Lippi chose to paint a frame inside the painting, as if the Madonna, child and angels were standing on the same side of the frame as the spectators. The smiling angel in the foreground seems to be looking back at the spectators. This makes the scene and characters in this painting appear more welcoming to the viewers. The figures in the painting help with the progress of engagement, as viewers are first encouraged to engage with the little angel, and subsequently to gain a more in-depth sense of the emotions and motifs of the painting.[85]

The idea of engagement is related to classical rhetoric and to understand this concept in a more direct way is from the Greek and Roman eloquence. It was crucial to have the audience engaged in the orators' speeches and thus their speeches need to be more persuasive.[86] In order to be more persuasive, the orators need to establish a common that people could understand, creating an atmosphere to draw the audience's attention and emotion and orators need to be in touch with their audience.[87] This kind of rhetoric in eloquence is also applicable and required in the architecture because rhetoric and architecture share the same character that they are both within the society and in the other way affecting the society.[88] The importance of architecture for society is quite eloquent and architectures are all built with expected purpose. Buildings like churches and chapels are mainly designed with a religious purpose and thus they are needed to design, build and decorate in some ways to enable to attract and move the spectators.[89] To be persuasive enough to achieve the expected purpose, therefore, how to draw spectators' engagement is extremely crucial.

The Chapel of the Cardinal of Portugal itself is commented as an example of engagement with spectators in John Sheaman's book *Only Connect: Art and the*

[84] Shearman, *Only connect*, 27.
[85] Shearman, *Only connect*, 74-75.
[86] Eck, *Classical rhetoric and the visual arts*, 61.
[87] Ibid., 61.
[88] Ibid., 42-43.
[89] Ibid., 31.

Spectator in the Italian Renaissance.[90] Sheaman illustrates how the altarpiece and the design of the tomb together ingeniously engage the spectators. While it is relatively easy for paintings, with certain scenes and backgrounds, to engage spectators, the situation is different for ceilings. As a ceiling is located high above spectators' heads, it is inevitably difficult for them to view, because they need to look up to see it instead of looking directly ahead horizontally, like looking at a painting. What makes things more difficult is that the ceilings of chapels and churches are usually domes or half domes, with a spherical structure. As such, not every part of the ceiling receives enough light, and some parts of the dome do not receive any. In addition, if the spectator looks at the ceiling from different angles, the vision, light, and effect will vary greatly, and they may only see a limited part of the ceiling. The ceiling of the Chapel of the Cardinal of Portugal is exactly like this: it has a spherical construction, and when you enter the chapel without looking up to the ceiling, you can barely see anything on the dome. Another obstacle to spectators' engagement with the ceiling is that they are normally high above (Fig.37). The distance between the spectators and the ceiling may make the figures on the ceiling vague and difficult for the spectators to distinguish.

In addition to the difficult viewing conditions, the question arises as to how the figures on the roof of the Chapel of the Portuguese Cardinal can be correctly identified and understood by the viewer to achieve the expected objective of the ceiling design. It would be analyzed in the next section how Luca della Robbia managed to attract the spectators' attention by his technique and the ornament of cube pattern.

2.2 Light, enamelled terracotta and vision

2.2.1 The importance of light to spherical ceiling designs

The last section detailed the difficulties of producing an ideal ceiling design for the chapel, which could help the spectators to understand the purpose of the design. Due to the chapel's spherical structure and the height of the ceiling, less light could reach the surface of the dome than other parts of the chapel. To solve this problem, Luca della Robbia designed a ceiling that could gain enough light to clearly show the figures on

[90] Shearman, *Only connect*, 77-78.

the ceiling. Light had a vital role to play. Scholars before and during the Renaissance had realized light was a precondition for vision; accordingly, the importance of light to vision and the perception of colour were repeatedly mentioned in scholars' treatises.[91]

One of the most influential ancient Roman mathematicians and astronomers, Claudius Ptolemy (c. 100-170), mentioned in his treatise *The Optics* that colours are contingent on the compactness of bodies and cannot be seen without light. Light is a precondition for seeing colour, and it is impossible to see colour in darkness.[92] Colour is not a stable and unchangeable object; it can vary with changes in light as well as visual flux, and an object can be seen more clearly when there is more light shining on the surface of the object.[93] The Arabic scholar Ibn al-Haytham (c.965-1040), shortened to Alhazen, who also had a great impact on Medieval and Renaissance astrology and the study of optics. He believed that the brighter a surface is, the more light is reflected into our eyes, thereby making the figures of objects much clearer.[94] When colours are exposed to strong light, they appear brighter and clearer, and the more intense the light shines on them, the brighter and clearer they will become. Conversely, if an object is placed in a dark location without enough light, our sight will be unable to discern its real colour.[95] During the medieval time, scholars also had formed theories on optics based on Ptolemy, Alhazen and other former scholars' theories. For example, Thomas Aquinas (1225-1274), in the thirteenth century, also delivers his opinion that: "sight is aware of sensible objects in a more certain and perfect way than the other sense".[96] Furthermore, he states that though objects could be perceived in the dark but there would not be any colour being perceived on the object; light is colour and colour is invisible without light; colour acts upon a certain transparent medium, which is light, and light is necessary for colour to be perceived.[97] Therefore, it is a continuous recognition that light is crucial to how people perceive objects.

During the Renaissance period, both Ptolemy's and Alhazen's theories of optics were studied and used by Renaissance humanists, artists, architects, etc. In addition, many scholars and artists in the fifteenth and sixteenth century wrote theories of art

[91] Ptolemy, *Optics*, 71-72.
[92] Ibid.
[93] Ibid., 74-76.
[94] Alhazen, *Theory of visual perception*, 344-347.
[95] Ibid., 344-347.
[96] Lisska, *Aquinas's theory of perception*, 151.
[97] Ibid., 153-155.

based on the knowledge of optics formed by Ptolemy, Alhazen, Bacon and Aquinas. The influence of these theories in the works of Renaissance artists and scholars is the best proof that people at that time indeed realized that light is crucial to art works. Leon Battista Alberti is another good example. He understood that one side of a spherical and concave surface is somewhat dark, and the other is lighter.[98] Alberti also integrated Alhazen's theory with his own, claiming that when combining colour with shadow, the luminosity and the brightness of the colour will decrease, whereas with an increase in light, the colour will shine and become more radiant.[99] Alberti was said to be close to Niccolò de' Niccoli (1364-1437), the Italian Renaissance humanist, and at that same time Niccolò de' Niccoli was also close friend of Luca della Robbia.[100] Moreover, Alberti gives high comment on Luca della Robbia, Hence, there is great possibility that Luca della Robbia and Alberti were also close friend at that time. If so, Della Robbia might have learnt about Alberti's theory on optics and later adapted the theory into his own work.

2.2.2 Luca's enamelled terracotta and vision

In the Chapel of the Cardinal of Portugal, Luca della Robbia's technique of enamelled terracotta played a crucial role in enhancing the light and brightness of the figures to make the figures depicted on the ceiling clearer. Each enamelled terracotta piece was made by Luca della Robbia in six steps: preparing the clay, modelling, first firing, preparation and application of the glaze, second firing and application of colour. Sometimes there was another firing after colour was applied to the tiles.[101] This whole process is quite a conventional means of producing tin-glazed ceramics, but Luca della Robbia's technique differed in the details of preparing the clay and the glaze.

The clay Luca chose was similar to that used in other Renaissance workshops; it contained a significant amount of calcium, so firing produced a light-coloured body. These clay bodies contained 12-25 percent calcium oxide and were thus very suitable

[98] Alberti, *On Painting*, 30-31
[99] Ibid., 31-32.
[100] Summers, *Vision, reflection and desire in Western painting*, 56.
[101] Cambareri, *Sculpting with Colour in Renaissance Florence,* 129-143.

for glazing and colouring.[102] The secret of the clay used by Luca della Robbia is that during preparation it was mixed with some soft river sand, *liso*, which gave the clay not only a higher endurance for firing, but also more reflectivity to light. The glaze Luca chose for his works had two main components: *marzacotto* and *calcine*. The former consisted of silica from sand and an alkali flux from natron or wine lees, which provided the glassy effect for the glaze, while the latter component was composed of a mixture of tin and lead, which gave the surface opacity and fluidity.[103] The special nature of Luca's glaze was its greater inclusion of *calcine*, which contains lead and tin oxides, giving it a brighter surface and greater opacity. This created the characteristic della Robbia milky-white colour and shiny surface. In an investigation in 1990, a science team leading by Kingery analysed Luca's enamelled terracotta, which turned out to contain microcrystals of tin oxide in its glaze.[104] The tiny crystal particles suspended between the clay and tin-glazed layer made the surface of Luca's terracotta reflect more light which created an even brighter visual effect. The various colours in the glaze were created the same way. Other, metallic minerals were added to the glaze and then the glaze was fired.[105] The chalky and opaque clay body, rich with calcium, enabled the coloured glaze to bind well over the clay body, and due to the good compactness of the clay and glaze, the whole piece of work was much more smooth and glassy on its surface and did not easily crack or be stressed.

With Luca della Robbia's enamelled terracotta, the roof of the Chapel of the Cardinal of Portugal became a glassy surface that could reflect more light than other materials, because the smoother the surface is, the less light it can absorb. The shiny surface of the ceiling gave it a luminous intensity, which meant that with the same amount of light reflecting on other materials, the ceiling in enamelled terracotta will look brighter and the colour seemed more saturated. The cubic pattern applied to decorate the intervals of the five medallions played an important role in making the ceiling more conspicuous. If so, given the other fancy decorations in the chapel, such as the blue and white fresco on the surrounding wall and the exquisitely designed and carved tomb, the spectators would have been more attracted to these eye-catching

[102] Tite, *Lead glazes in Antiquity*, 241-60.
[103] Kupiec, *The materiality of Luca della Robbia's terracotta*, 62-65.
[104] Kingery, *The glaze of Luca della Robbia*, 221-225.
[105] Cambareri, *Sculpting with Colour in Renaissance Florence,* 135-136. According to Cambareri, the colour of blue was created by adding cobalt, green by adding copper, and yellow by adding antimony and lead.

objects and the ceiling would have received less attention. The pattern ensured that this was not the case. The yellow and green used to form the cube were "Naples yellow" and apple green, which are both very bright and fresh colours.[106] The similar yellow was used on the ceiling and on the altarpiece in the chapel, but the one on the ceiling seems much brighter because of the glassy surface. The wood panel of the altarpiece has a rougher surface than the ceiling, so less light is reflected back from the painting than the ceiling. Hence, by applying the technique of enamelled terracotta, the ceiling in the chapel gained a brighter tone than the other elements in the chapel, ensuring that it stood out and caught viewers' attention. However, it is interesting that although the ceiling creates a striking and appealing effect to Vasari, Hartt, Pope-Hennessy and other scholars, there is barely literature focusing on the ceiling design. The most possible explanation for this is again linked to the concept of decorum and rhetoric. According to Gherardo Spini, not just the architecture itself serves some social purpose, but also the ornaments being used within the building have to be arranged in certain order, and normally the most sublime ornament needs to be placed on the highest place of the building.[107] Thus, those striking ceiling designs are like traditions for religious building and people might get used to this fact, which people barely paid attention to how this effect was achieved.

Thanks to Luca della Robbia's inventive technique, the ceiling of the chapel indeed stands out from the other elements in the chapel. However, this was not enough to achieve the final purpose of this ceiling design: to ensure that viewers recognised the people depicted and understood the spiritual and biblical motif of the ceiling – the Four Cardinal's Virtues and the Holy Spirit. To make people focus on the motif of the ceiling, the cubc pattern needs to function as background to attract people's attention towards ceiling and later move their attention on the real motif. Then the theory of contrast plays its role here. In Alhazen's theory of optics, another interesting viewpoint can be found: "we see the stars at night but do not see them in daylight…while the air is dark, we see stars; but when the intervening air between our eyes and the stars is illuminated, the stars will be invisible to us."[108] This seems to focus on the knowledge of optics, but another issue is addressed: the link between vision and contrast. A star looks bright during the night-time, but when it appears in the same kind of light as itself, it can no

[106] Kupiec, *The materiality of Luca della Robbia's terracotta,* 146-151,167.
[107] Eck, *Classical rhetoric and the visual arts*, 47-48.
[108] Alhazen, *Theory of visual perception,* 344.

longer be recognized. An oasis can be very easily recognized in the desert, but it would become imperceptible if transplanted into a tropical setting. Similarly, with Luca's ceiling design, the contrast in colour saturation between the enamelled terracotta ceiling and the other elements in the chapel made the ceiling more conspicuous. As the whole ceiling had the same high level of colour saturation, the motif depicted on the ceiling needed another contrast within the ceiling to make it stand out.

The cubic pattern of the ceiling design consisted of two very bright colours, yellow and green, along with black to create the shadow of each cube to form a spectacular three-dimensional visual effect. In addition, the cubes were arranged densely, filling in all of the space outside the five medallions. The special surface and ingredients enamelled terracotta enables the high saturation of the colour, and the high colour saturation of yellow and green together with the arrangement of the cubic pattern gives the ornamentation a vivid and blazing feeling. In contrast, the medallions are designed in a plain and neat style. The outside roundel of each medallion is plain milky white and the inside blue rings become increasingly light in colour until they reach that of the motif in the middle. The medallions depicting the four cardinal's virtues have a pure blue background inside, and the figure of each virtue is made from pure white enamelled terracotta. The Holy Spirit medallion in the centre of the ceiling has a blue background and the spiritual dove is pure white with more golden rays surrounding it on the blue background. In short, the five medallions depicted with the Four Cardinal's Virtues and the Holy Spirit are in quite simple and pure colours, creating a plain effect. Next comes the contrast. The resplendent cubic ornamentation forms a strong contrast with the plain and neat medallions. The more complicated background design serves as a foil to the five medallions, making the motif of the ceiling design much clearer to the spectators.

The extraordinary technique and the materials adopted by Luca della Robbia successfully gain the ceiling design in the chapel the effect that the ceiling could look brighter than the other decorations in this chapel. Hence, the spectators could gain a clearer visibility for the ceiling. Furthermore, the contrast within the ceiling between the cube pattern and the motif is strong enough that could both attract the spectators' attention to the ceiling and later move their attention to the motif. Combining with these two factors, the possibility for the spectators paying more attention to focus on the ceiling greatly increased, and thus, they are more likely to identify the motifs on the

ceiling and understand the meaning of them. Based on the already known knowledge of the Renaissance Period, it seems that the ceiling design could fulfil the expectation by the builders and patrons that viewers could at least be more engaged in the ceiling and then there will be more chances for them to understand the representational meaning of the motifs on the ceiling.

In this chapter, the visual effect and the function of the cube pattern were discussed only within the theories of rhetoric and optics already known by the Renaissance time. The visual effect provides by the cube pattern is limited. To examine if the function of the cube pattern is still applicable and achievable at present, it is needed to turn to the contemporary psychological theories established in the twentieth and twenty-first century, to see what visual effects the pattern creates and how it affects people's emotion, which would be analysed in the next chapter.

3. Visual Effects Analysed from Contemporary Theories

In the last chapter, it was discussed that the main purpose of the cube design with a resilient colour contrast was firstly to draw spectators' attention, enabling them to understand the ceiling design's principal motif. Although it is impossible to know every comment which was made on the ceiling design during the Renaissance period, it can be presumed, at least according to the comment made by Vasari in the sixteenth century, that the ceiling design more or less achieved its goal to draw the spectators' attention. In the twentieth century, Frederick Hartt finished a book on this specific chapel, and while commenting on the ceiling design, he stated that:

> "A rather harsh yellow, bright green and black provide a sharply dissonant background for the blue and white of the medallions, as if the pure and harmonious essence of the cardinal virtues were really pitted against hostile colouristic forces in a Psychomachia taking place in the 'celo' of the vault."[109]

Such comments made by scholars from the sixteenth century until now have all illustrated their opinions towards the ceiling design. Moreover, their opinions towards the ceiling design like 'striking', 'attracting' and so on commonly revealed that the chapel's ceiling had gained their attention. It is however interesting that although they remarked upon it as being significant, attractive or even disharmonious, none of them, nor any other scholars, have ever tried to figure out the reason why the ceiling design and the pattern applied to it have elicited such responses. The question therefore remains as to why this ceiling design captures people's attention and how its pattern really works. While these questions might still be of concern to art historians, anthropological and historical approaches only are not enough in answering this question. Although scholars may conduct a visual analysis and describe the visual effect given by the object, it is not possible for them to explain the reason through these two approaches alone.[110] Given that the fulfilment of the ceiling's purpose involves people's visual perceptions and feelings, contemporary psychology theories need to be taken into account. This chapter's analysis will therefore be mainly focused on

[109] Hartt, *The Chapel of the Cardinal of Portugal*, 75.
[110] Gombrich, *Arts and Illusion*, 3.

psychological theories on visual perception and art raised by psychologists like Rudolf Arnheim (1904-2007), Richard L.Gregory (1923-2010) and Nicholas Wade (1942-), etc.

3.1 Pattern and illusion

When discussing the visual effect of the cube pattern which is applied to the ceiling design in the Cardinal's Chapel, it is necessary to first make some concepts and terms clear. The concept 'visual effect' of a certain pattern is not only formed by the pattern itself. Instead, it is an effect constructed by our brain after the whole process of visual reception and perception. The retina in our eyes firstly receives lights (signals) from the outside world; it then delivers these signals into a visual cortex in our brain; through the decoding, or interpreting, of these signals, it finally forms the cognition of what we see and the whole process of visual perception is finished.[111] The visual effect of certain patterns is also formed under this process unconsciously. To examine what visual effect of this cube pattern has been constructed, it is necessary to find out how our brain tends to decode such a pattern.

Rudolf Arnheim formed a theory in his book, *Art and Visual Perception,* linking the psychology of visual perception with art works, which formed a theory involving many aspects of the visual perception of art works including balance, shape, form, space, light, etc. According to Arnheim, the perception of a given pattern is, first of all, largely determined by its simplicity. The simpler the pattern is, the easier it is for viewers to recognize and memorize it.[112] Thus, when people encounter more complex patterns, they tend to simplify them into something which is easier to understand. Moreover, according to him, when viewers are looking at a shape or pattern from a distance, the edge of the shape/pattern will turn out to be rounded because distance can weaken the stimulus of a viewers' own perceptual mechanism to a certain degree, leading it to impose the simplest possible shape, a circle, upon the perceived shape/pattern.[113] With respect to this statement, Arnheim has not given further explanation as to why a circle

[111] Gregory, *Seeing through illusions*, 20.
Zeki, *Inner vision*, 59-69.
[112] Arnheim, *Arts and visual perception*, 55.
[113] Ibid., 63.

is the simplest shape and there seems to be no other scholar who has given any such example. It is probably because a circle is formed by one line and there is no extra pointed edge like triangles or rectangles have. Thus, the opinion raised by Arnheim towards perceiving the shape from a distance could be controversial. However, there is no doubt that when people are seeing something from a distance, the edge of the object is weakened and becomes vague and could thus also turn out to be rounded. Hence, in either case, the shape of a pattern could be altered when people see it from a distance. Therefore, for the case of the cube pattern in the Cardinal's Chapel, since it is located on the dome of the chapel approximately ten metres away from the ground, when the viewers watch the ceiling design, there is a great possibility that the cube pattern will be perceived in a different way or, moreover, into a different pattern. Then the question comes as to how the cube pattern ornament is actually perceived by our brain.

On the ceiling of the Chapel of the Cardinal of Portugal, countless three-dimensional cubes have been repeated and neatly ordered, which form the whole cube pattern among the interval of five medallions as ornaments (Figure.38). However, it is interesting to notice that not all the cubes are arranged in the same way. In Figure.39, the cube pattern has been separated into several sections, and from this perspective, there are four pairs of cube combination, section A and C, B and D, E and H, and F and G. Within each pair, the two sections share the same arrangement and direction of the cubes. But for different pairs, their arrangements are not respectively the same. For example, for section A and section B, the cubes are formed as if they were vertical to each other, which is the same case for section C and section D. However, this kind of arrangement makes the cubes seem to be facing to and encircling the middle medallion which depicted the Holy Spirit Dove from different directions.

Here, the similarity of the shape is crucial. Any similarity between the aspect of perception, including shape, colour, brightness, location, movement etc, could, according to Arnheim, create a grouped impression on condition that the objects proceed from a common base.[114] Nicholas Wade has also stated in his book that when our visual system is perceiving shapes, they tend to be grouped by similarity.[115] For example, when looking at this picture, instead of recognizing the letters A, R, and T in the word 'ART', observers will tend to recognize the parallel oblique lines formed by

[114] Arnheim, *Arts and visual perception*,79.
[115] Wade*, Art and illusionists,* 6.

them (Fig.40). This phenomenon becomes more obvious when observing a picture made up of only geometrical patterns (Fig.41). The image is formed with black and white squares of the same size and ordered in a certain arrangement. Instead of identifying it as a whole square shape, observers tend to recognize the waving lines formed by the black squares first. Thus, when we look back at the cube patterns in the Cardinal's Chapel, under the condition that the shape and size of these lozenges is the same, in each cube pattern section (as shown in Fig.39), the cubes with the same colour will be grouped together, forming lines in yellow, black and green. With the vertical direction of the cubes between section A, C and section B, D, the lines formed in different sections tend to be linking with each other. Moreover, because the ceiling of the Chapel of the Cardinal of Portugal is a semi-spherical surface, even though the cubes are ordered in straight directions, the lines formed by the grouping of similar cubes create an illusion as if there were many circular lines surrounding the middle medallion.

Because of the illusionary lines and the spherical surface of the ceiling in the Cardinal's Chapel, there are spatial distortions occurring within the cube pattern: the actual combination of the three-dimensional cubes tends to be perceived as lines, and the straight arrangement of the cubes can be perceived into curvy lines. According to Nicholas Wade, this kind of illusion of the cube pattern in the Cardinal's Chapel can be more specifically identified as 'optical illusion', because the image is formed by geometrical and hard-edged shapes and the illusion is induced by spatial distortions.[116] In addition, the optical illusion of the cube pattern further causes a 'visual jazzing', which refers to the visual phenomenon that although the pattern is depicted without movement, the pattern stimulates the region which is in charge of the visual perception of motion in our brain to produce sensations of movement.[117] Moreover, Gregory commented that the visual jazzing of the optical illusion can cause significant and remarkable visual effect to the viewers.[118] Furthermore, Wade has also commented that

[116] Wade, *Art and Illusionists*, 119-200.
Wade, *The art and science of visual illusion*, 1-2.
[117] Greogry, *Seeing through illusions*, 139-142.
Zeki, *Inner Vision*, 59-73. In Zeki's book, he introduces that the whole visual perception system in our brain contains five regions. V1 is the primary visual cortex, receiving signals from retina; V2 is the visual association cortex; V3, V4 and V5 are in charge of different aspects of visual cognition. V5 is the visual motion centre. He believes that the cause for the visual jazzing of optical illusion is because certain pattern stimulates the cortical area V5 and leads to the after effect of movement.
[118] Greogry, *Seeing through illusions*, 139-142.

"Although not every kind of illusion can give people the feeling of being attractive or striking, optical illusions formed by geometrical patterns can provide observers with these dramatic effects by the arrangement of their lines and shapes".[119]

As mentioned at the beginning of this section, during the whole process of visual perception, because of distance or other factors, what the viewers can really perceive from such a cube pattern can be altered. Indeed, the contours of the cubes within the cube pattern might be rounded because of the vision distance between the ceiling in the chapel and viewers' eyes. Together with the tendency of the grouping of similar shapesduring the process of perceiving patterns and the arrangement of the cubes in different sections, it enables the occurrence of an optical illusion. Thus, the cube pattern being applied to the ceiling design in the Chapel of the Cardinal of Portugal is indeed very strong and intriguing because of the optical illusion that it could induce to the visual perception of the viewers. Compared to the other elements in the chapel, of which most of them are painted in relatively plain colours (Fig.1, 2&3), it seems there are no other elements owning a stronger visual effect than the ceiling design. Hence, the ceiling design with the cube pattern which causes the most intriguing and significant visual effect can attract the spectators' attention more easily.

Although the visual effect by the pattern itself is already strong, the colour combination of the cube pattern is as important as the shape of the pattern in producing an optical illusion. Wade has also stated that the colour of such a kind of cube pattern could be even more vital than its shape considering the visual effect. Therefore, in the next section, the colours of the cube pattern will be discussed, as well as what kind of visual effect they produce and how they function in the chapel.

3.2 Colour and its effect

Every colour that humans can see is based on the visible spectrum. We perceive colour through the medium of light, and colours are determined by illumination.[120] The wavelengths which human eyes can perceive are between approximately 400 and 700nm and every colour has its own wavelength which results in their variety

[119] Wade, *The art and science of visual illusion*, 1-2
[120] Itten, *The elements of color*, 15.

(Fig.42).[121] The colours being used in the cube pattern are yellow, green and black. Yellow's wavelength is around 600nm, while green's is about 500nm, and the two colours are linked together. Black is actually the absence of colour, but in the case of the cube pattern in the Chapel of the Cardinal of Portugal, the black of the tiles is not the blackest black. Moreover, because of the fading of the original colour over time, the colour of the black turns out to be a very deep purple or a very dark blue. Thus, according to the colour wavelength chart (Fig.42), the colour black in the cube pattern could be assumed to have a wavelength close to 400nm.

Since colours can be determined by illumination, depending on the lighting and environmental conditions, the change of colours will more or less be seen. As such, the luminance of colours present in a certain painting or architectural piece could easily affect each other and both the assimilation and contrast among colours affect how people perceive the actual colours.[122] Therefore, to analyse the three colours respective to the cube pattern, it is necessary to first explore how they affect each other and what kind of effects they have formed.

3.2.1 The colour contrast within the cube pattern

Hartt and Pope-Henessey have both mentioned the contrast of the cube pattern's colour combination in their comments.[123] But what is a 'colour contrast'? The simplest answer to this is that it is when colours sharing the same space appear distinguishable from one another. It is however much more complicated than that. Since we perceive colour through illumination, basic colour contrast is between colours of a different luminance – when colours have larger disparities in luminance, contrast becomes even more evident.[124] Johannes Itten has introduced seven kinds of colour contrasts in *The Elements of Color*, namely: a contrast of hue, light-dark contrast, cold-warm contrast, complementary contrast, simultaneous contrast, contrast of saturation and contrast of extension.[125] In the colour combination of the cube pattern in the Cardinal's Chapel,

[121] Itten, *The elements of color*, 15.
[122] Arnheim, *Art and visual perception*, 344.
[123] Hartt, *The Chapel of the Cardinal of Portugal*, 75.
Pope-Hennessey, *Luca della Robbia*, 48-49.
[124] Doesschate, *Perspective*, 5.
[125] Itten, *The elements of color*, 32.

there are mainly two kinds of colour contrast could be discussed based on Itten's theory: the contrast of hue and the light-dark contrast.

To begin with, there is a contrast of hue occurring among the three colours. As the name of this contrast suggests, it is a simple contrast between different colours, regardless of other characteristics which the colours might have.[126] In the colour combination used in the cube pattern, yellow has the most intense hue among the three colours, since it is one of the three primary colours. In addition, the wavelengths of light respective to the colour yellow and green are linked to each other, which means that green is a colour transitioning from yellow and the intensity of their hues are close to each other. Thus, the contrast formed by yellow and green is not that obvious. However, when compared to the black within the cube pattern, as stated at the beginning of the section it is actually close to very deep blue or purple and its wavelength is thus close to 400nm. Therefore, black's hue differs a lot from yellow and green, especially compared to yellow, because the difference of wavelength between these two colours is bigger than from black to green. Hence, the contrast of hue created by the colour of yellow and black is the strongest.

In addition, the light-dark contrast can also be found in the cube pattern's colour combination. The way to define the lightness or darkness of a colour is to determine what proportion of the colour grey is occupied by it.[127] Black and white are extreme expressions of the light-dark contrast since black is considered the darkest colour and white the brightest, which locates the two at opposite extremes of the colour gradation chart (Fig.43).[128] In the chart, we can find colours that are maybe not exactly the same, but at least similar to the colours being used in the cube pattern. It is easily observable that the yellow being used in it is the lightest among its three colours, while green figures in the middle between yellow and black. Thus, once again, the light-dark contrast between yellow and black is the strongest contrast occurring in the colour combination, followed by the green-black and yellow-green contrasts.

All in all, it can therefore be said that the colour contrast within the cube pattern, either created by the contrast of hue or the light-dark contrast, leads to the same conclusion that the strongest contrast according to both the contrast of hue and the light-

[126] Itten, *The elements of color*, 33.
[127] Ibid., 37.
[128] Ibid.

dark contrast is that between yellow and black, followed by green and black. Moreover, since both the hue and lightness of yellow and black differ a lot, the colour contrast formed by the cube pattern on the ceiling of the Cardinal's Chapel is indeed very strong.

The most direct influence of colour on shape is that after colouring a different shape with a different colour, the boundaries between shapes become more obvious.[129] After a single cube has been coloured with yellow, green and black, yellow appears within the cube as the side of the cube which catches the most light while the green side appears as a darker side and the black side as the darkest; hereby, the three-dimensionality of the cube emerges. Though, as discussed in the former section, from a distance the viewers might not finally perceive the three-dimensional cube; instead, the viewers might perceive many hidden lines formed by the lozenges. After colouring, those illusionary lines are distinguished from each other by different colours which results in the illusion that the middle medallion is surrounded by many circles in different colours. Moreover, according to Gregory, the higher the colour contrast within the image, the stronger the optical illusion would be.[130] Therefore, the high colour contrast between yellow and black can result in a stronger optical illusion, and further raise the possibility of drawing more attention from the spectators.

3.2.2 Yellow as the dominant colour

Except for the colour contrast formed by these three colours, there is another interesting effect of colour within the cube pattern. Despite the fact that the three lozenges forming each cube are the same size and they share the same amount luminance in the cube pattern on the ceiling in the Cardinal's Chapel, there will be the effect that yellow appears to be the dominant colour and it takes more account than the other two colours.

First of all, it is mentioned that all colours have their own wavelength, and to different wavelengths of light, or different colours, our brain responds differently. One psychological research mentioned by Gregory when discussing colour shows that the sensitivity of the eye to various wavelengths is different, and under conditions with enough lightness, our eyes are most sensitive to the wavelengths between 550nm and

[129] Arnheim, *Art and visual perception*, 32.
[130] Gregory, *Seeing through illusions*, 139.

600nm which refers to the colour of yellow (Fig.44).[131] It has been mentioned in the second chapter that Della Robbia's enamelled terracotta technique enables more light to be reflected on the ceiling of the Cardinal's Chapel, and thus there is enough lightness. Therefore, among these three colours within the cube pattern, our eyes are more sensitive to yellow than the other two colours, which is to say, yellow is more recognizable to the viewers.

In addition, according to Itten, different colours possess different colour forces when perceived by human eyes, and this force depends on their light value and extent.[132] The proportion of light value for each colour is "yellow : orange : red : violet : blue : green = 9 : 8 : 6 : 3 : 4 : 6".[133] This indicates that when all of these colours share the same illumination, yellow possesses the biggest light value or highest brilliance among all these colours. Thus, yellow also has the biggest extension, which means that when applying these colours to the same-sized patterns, those with yellow will look bigger than the others. In the case of the cube pattern, since the three lozenges used for forming the cube are of the same size, when they are put together to form the cube, an illusion is created whereby the lozenge painted in yellow will look bigger than the other two.

Moreover, colours possess not only physical factors but also their own character and different emotions to the viewers. Colour emotion refers to the feelings evoked in observers such as excitement, calm, peace, etc, depending on the hue, lightness and other physical factors.[134] Based on an experiment by Li-Chen Ou, M. Ronnier Luo and Angela Wright created a ranking of colours in 2004 for the three key factors of colour emotion: colour weight, colour heat and colour activity (Fig.45). They observed that the higher these factors' statistics were, the more the colour would make an impression upon observers.[135] Thus bright yellow ranks as being the most active in triggering human emotions, while its colour weight occupies a middle position and its colour heat a secondary one. Black ranks in first place for its weight, but at an average level for both colour activity and colour heat. Green in turn has an over-average colour activity and colour heat but the least colour weight. Thus, while being the dominant colour of

[131] Gregory, *Eye and brain*, 90.
[132] Itten, *The elements of color*, 59.
[133] Ibid.
[134] Ou, *A study of colour emotion and colour preference*, 232.
[135] Ibid., 237.

the cube pattern, yellow's colour emotion is also the main colour dominating spectators' feelings. Moreover, due to its high colour activity and colour heat, yellow is the most active and impressive colour, with the exception of red, which ranks in first place for colour activity and colour heat and in second place for its colour weight. That is to say, yellow is a colour that could easily impress people and thus attract their attention more easily.

From the colour sensitivity of human eyes, the colour value and extension, and colour emotion, it can be concluded that yellow indeed can be perceived by our brain as the dominant colour of the cube pattern and yellow can evoke strong emotions in the viewers. Therefore, together with the strong optical illusion created by the pattern, the stronger illusion because of the application of colours, the strong colour contrasts amongst the colours, and the dominant quality of the colour yellow, the cube pattern creates a strong visual effect. Furthermore, since it is our nature that people's eye usually takes note and emphasizes with things of brighter colour or with a strong visual effect, the cube pattern being applied to the ceiling design can indeed attract the spectators' attention.[136]

3.3 The cube pattern as an intermediary for the main motif

As was previously discussed in the second chapter, the intended function of the chapel's ceiling design was firstly to attract spectators' attention, which could lead them to spend more time observing the ceiling and bring them to focus on the main motif depicted in the five medallions, finally leading them to hopefully understand its meaning. In the last two sections of this chapter, the visual effects created by the pattern and colour of the cube pattern have been described, as well as the reasons why such a design could indeed arouse people's attention. The question now remains how people's focus shifts to the motif when the cube pattern itself is so attractive.

First of all, there is a kind of colour contrast occurring between the cube pattern and the five medallions. As stated in the last section, the dominant colour for the cube pattern is yellow and, for the medallions, white and blue are their main colours. The yellow of the cube pattern and the blue of the medallions forms the most extreme colour

[136] O'Conner, *Contrast and Gestalt Theories of Perception*, 86.

contrast of hue.[137] The colour contrast between the cube pattern and the medallions makes them into a pair of objects sharing at least the same importance. In addition, when Arnheim introduced the balance of visual perception, he emphasized the forces created by the structural factors and also gave an example of the visual forces existing within a square (Fig.46).[138] The central vertical lines and horizontal and diagonal axes are the structural skeleton of this square, and at the points where the structural skeletons cross one another, they become, as centres of circles, a hidden force.[139] These circles show the space of this square which contains more forces and is thus more powerful, making it such that human eyes would tend to pay more attention to these areas.[140] Although this applies to the example of a square, when we form the structural skeleton of the five medallions in the chapel, it can be found that their structural skeletons are the same as those of the square, which means that the areas where the five medallions are located contain the most forces and power. Thus, although the cube pattern creates a very strong visual effect, it is only filling in the less powerful areas of the ceiling, while the medallions are located at its dominant positions. Thus, the cube pattern does not dominate over the medallions and people do not therefore miss noticing the motif being depicted. But indeed, the ornamental bands around the medallions concern a different principle of drawing attention, namely by framing, which makes the medallions stand out regardless of the cube pattern.[141] Due to this effect of space, the cube pattern is made into the background of the medallions, which could lead spectators to pay more attention to the medallions, and thus, the cube pattern can serve as an intermediary for the main motif.

However, during the analysis above, it becomes controversial that the cube pattern is really needed to draw the spectators' attention, because the five medallions already stand out by themselves by means of their ornamental bands which frame them against the ceiling. Moreover, the floor decoration in the Chapel of the Cardinal of Portugal also owns five roundels and the roundels are arranged to be mirroring the five medallions on the ceiling. Thus, there is the possibility that when the spectators enter the chapel, they noticed the roundels on the floor and then look up to the ceiling to see

[137] Itten, *The elements of color*, 34.
[138] Arnheim, *Art and visual perception*, 13.
[139] Ibid.
[140] Ibid.
[141] Ibid., 220-222.

the medallions out of habit, and because of the mirroring effect of the floor and ceiling, they can also pay more attention to observing the ceiling. Then the function of the cube pattern is just to fill the blank space between the medallions and was used to complete the whole ceiling design. If so, the function of the cube pattern being applied to the ceiling is purely decorative.

Overall, by analysing the visual effect of the cube pattern through psychological approaches, the following conclusion can be made. The cubes consist of three lozenges in yellow, green and black, creating a strong optical illusion as well as a colour contrast. This, together with the fact that yellow being the dominant colour of the cube pattern evokes strong feelings and emotions in spectators, shows that the cube pattern applied on the ceiling of the Chapel of the Cardinal of Portugal indeed has a very strong visual effect and can further attract the spectators' attention. However, its function for being an intermediary for the main motif is controversial. Although it can also be regarded as the intermediary for the five medallions, since the visual effect of the five medallions is already strong, the cube pattern could only serve as a purely decorative function.

Conclusion

Studies with regards to the Chapel of the Portuguese Cardinal by historians as well as art historians together focused on the tomb, the altarpiece as well as the individual design. Minimal focus has been accorded to the designs of the floor and roof of the chapel. A significant number of researches merely offer a brief outline of the roof, taking note that its pattern appears to reflect that of the mosaic floor. However, the overwhelming and extraordinary roofing pattern by the renowned artist Luca della Robbia calls for further studies. This essay emphasizes the cube design with colour distinction applied by Luca della Robbia to beautify the ceiling of the chapel.

In the first section of the first chapter, it is argued that the cube design Luca della Robbia used was most probably acquired from the mosaic floor patterns of Greece's Archaic period. With the remaining ancient mosaic pavements from the Archaic to the Hellenistic periods of Greek history as examples, the cube pattern can be understood as having been a popular ornament during ancient Greek times. The reason why this pattern was widely used in pavement and floor decoration is probably because of Pythagoras's and Plato's theories that the cube is the most stable and unyielding of geometrical shapes and that it represents the element 'Earth'. The cube pattern appears to have subsequently spread to Italy, where it appears in the decoration of buildings in later centuries. The nature of this design in the Church of San Michele and the Cathedral of Florence convincingly imply that the cube pattern had spread to Tuscany by the fifteenth century and it is very probable that Luca della Robbia would have been familiar with the ornamental pattern and later adopted it for his ceiling outline for the Chapel of the Cardinal of Portugal. With the cube format appearing in ornamentations in a number of places, Hartt's contention for the rarity of the design is not tenable. Moreover, Hartt's statement that the cube pattern was first used in Piero della Francesca's paintings is also not convincing since what Hartt describes as a "similar pattern" in *The Flagellation of Christ* is too vague to identify. The actual shape within *The Annunciation* are not made of three-dimensional cubes but rather a perspectival column pattern.

In the second section of the first chapter, two possible inspirations for Luca della Robbia's application of colour for the cube design were discussed. The first possibility is that he simply referred to the existing colours used to decorate the Basilica of San

Miniato al Monte, in which the Chapel of the Cardinal of Portugal is located. Della Robbia had already been launched by Piero de Medici to decorate the roof and ceiling of the Cappella del Crocifisso, which is also in the Basilica. The colour combination of yellow, green and black can be found elsewhere in the decoration of the interior of the building. These three colours are also typical of, and widely found in, byzantine architecture and art works. The second possible reference for Della Robbia's use of these colours is the influence of Islamic art. Luca Della Robbia was a pioneer of the enamelled-terracotta concept and it can be argued that he must have had frequent exposure to Islamic ceramics. There is a reasonable probability that the colouring of his first enamelled terracotta piece was influenced by elements of Islamic ceramic work and by the popularity and impact of Moresque ceramics in Italian potteries. As the incorporation of green and yellow was significantly applied in the Moresque decorations famous in the 15th century across Florence, such decorations are also a potential spring of motivation for his application of such rare colour integration on the ceiling of the chapel.

The second chapter identified the function of the cube outline on the roof of the Cardinal of Portugal's Chapel, firstly emphasising the general importance of ceiling design for all Italian sacred buildings such as churches and chapels. Now, in the twenty-first century, the practice of astrology is regarded as pseudo-science or superstition. However, from pre-Christian times until at least the fifteenth century, when Luca Della Robbia lived, it was regarded as a legitimate means of foretelling the future and the fortunes of individuals and even cities and states. Astrology therefore played an important role in city planning, designs for architecture and the symbolism of Christianity. The sky and heaven are essential elements in Christian beliefs and ceilings in sacred buildings tended to depict the sky, the heavens and the beings that inhabit those realms. Ceiling designs were, although perhaps not the most important part, at least a very significant aspect in the design of sacred buildings. The importance of these works of art to spectators is also emphasised in this study. Artists in the fifteenth century had already realised that, to be successful, a piece of work must take into account the engagement of the spectator, or the true meaning of the piece can be easily missed or misunderstood. This is the case for the ceiling design of the Chapel of the Cardinal of Portugal. Luca Della Robbia and the patrons of the chapel will have projected that the spectators would understand the motif being depicted on the ceiling, which represents

the high virtue and nobility of the young Cardinal of Portugal. Hence, it is concluded that the intention and expectation of the design of the ceiling was to engage and enthral the spectators so that they would appreciate the nobility of the young cardinal and demonstrate appropriate respect. In the second section of the chapter, the optical theories of Ptolemy and Alhazen, which were known when the chapel was built, were applied to examine how the cube pattern was intended to help achieve the expected impact and effect of the ceiling. Emphasis was given to the importance and challenge of providing sufficient light within a hemispherical dome such as that of the chapel so that objects depicted on the ceiling can be clearly seen. The effect created by the enamelled-terracotta technique used by Della Robbia was also explained. Analysis of the materials used and the substances they contain demonstrates that the enamelled terracotta would indeed reflect more light than other materials, which would create a better visual precondition for spectators to view the hemispherical ceiling. Moreover, because of the brightness of the enamelled terracotta, the colours used, such as blue, yellow, green and black, would appear more saturated and dazzling than the relatively plain colours used on the stone walls and on the oil-painted panels. Furthermore, the plain-complex contrasts within the ceiling design make the five medallions appear more prominent. In the optical theories already known and understood in the fifteenth century such as those by Ptolemy, Alhazen and Thomas Aquinas, it was recognised that the cube pattern would indeed help to attract the attention of spectators to the ceiling and fulfil the expectation on them to understand the motif depicted there. However, optical theories during that time were still limited and questions remain as to what visual effects the cube pattern actually creates.

In the third chapter, the cube pattern was analysed in terms of modern psychological theories to try to understand how people could have perceived it, what visual effects the pattern would have elicited in the spectators and how this would have helped to fulfil the expected function for the ceiling design, making the spectators more engaged in the ceiling design and allowing them to further understand the main motif of the ceiling. The analysis is divided into three parts: pattern and illusion; visual effects created by the colour; and an examination of the intermediary function of the cube pattern. Due to the principle of similarity during the process of visual perception and the limit of human vision, from a distance, the cube pattern can no longer be clearly perceived as its original pattern. Instead, there are illusionary hidden lines formed by

the lozenges of the cubes, which further form an optical illusion. Moreover, the colour combination of yellow, green and black forms a very strong colour contrast because of the difference of wavelength of different colours, which makes the optical illusion even stronger and obvious to the viewers. Furthermore, the colour of yellow turned out to be the most dominant colour which appears to take more account of the cube pattern because human eyes are more sensitive to yellow light and it owns a bigger colour extension and value than the other two colours. The dominant role of yellow can furthermore easily evoke the viewers' feelings and emotions. With all these facts, it is quite certain that the cube pattern with strong colour contrast on the ceiling of the Chapel of the Cardinal of Portugal can indeed draw more attention from the viewers. Whereas, the truly expected function of the cube pattern which was hypothesized in the second chapter is that the cube pattern could at least draw people's attention to the main motif of the ceiling design. However, by the contrast formed by the dominant colour of yellow in the cube pattern and the blue in the main motif medallions, although the cube pattern can serve as an intermediary for the main motif, on the other hand, it turns out that the cube pattern can also be purely decorative.

This thesis has analysed the cube design with strong distinction on the ceiling of the Chapel of the Cardinal of Portugal in detail, from its origins to the psychological effects that spectators experience when looking at it. However, some questions still remain. For example, there may be other possible origins of the cube pattern, since the cube pattern is quite a universal ornamental theme which is found all around the world. Also, there is no documentation to give insight into the ardinal's intentions and the specification of the commission given to Luca della Robbia. The assumed expectation for the ceiling is therefore a probable hypothesis based on deduction from the position of the young cardinal and the general expectations for ceiling designs during that time. If related documents were found, the expectation for the ceiling of the chapel might be subject to change, perhaps even revealing that the cube pattern was used by Della Robbia according to his patron's requirements or specification. As regards the psychological theories propounded in the third chapter, if the cube pattern functions as an intermediary for the main motif or if it is purely decorative also requires further research to set a firm conclusion.

For now, after the whole analysis from the origin of the pattern and colour in the first chapter, to the expected function of the ceiling design discussed in the second

chapter, and the visual effects of the cube pattern based on contemporary psychological theories, the answer to the research question which was raised in the introduction regarding the function of the cube pattern on the ceiling of the Chapel of the Cardinal of Portugal is that it creates a very strong visual effect for the spectators and can draw their attention, but its function as an intermediary for the main motif or as pure decoration still remains controversial.

After the whole analysis from the origin of the pattern and colour in the first chapter, to the expected function of the ceiling design discussed in the second chapter, and the visual effects of the cube pattern based on contemporary psychological theories, the following conclusion can be drawn. The function of the cube pattern on the ceiling of the Chapel of the Cardinal of Portugal is that it creates a very strong visual effect for the spectators and can draw their attention, but its function as an intermediary for the main motif or as pure decoration still remains controversial.

Images

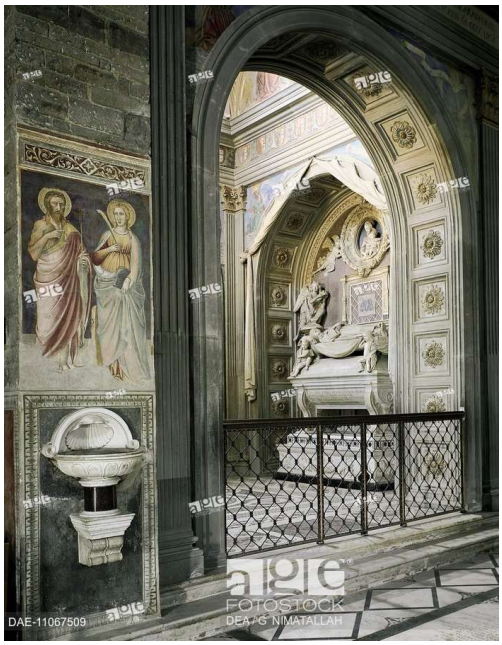

Figure.1: Entrance of the Chapel of the Cardinal of Portugal in San miniato al Monte

Figure.2: The North side in the chapel

Figure.3: The West side in the chapel

Figure.4: floor in the chapel

Front page image and figure.5: Luca della Robbia, Ceiling Decoration, enamelled terracotta and tiles, 1461-1462, San Miniato al Monte, Florence.

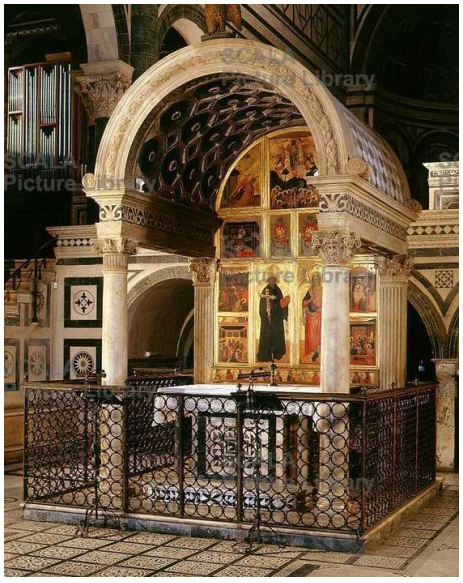

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Figure.13: Mosaic pavemnet in Delos

Figure.14: Mosaic pavement in Pompeii

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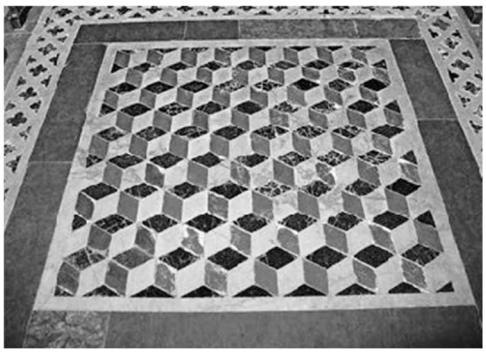

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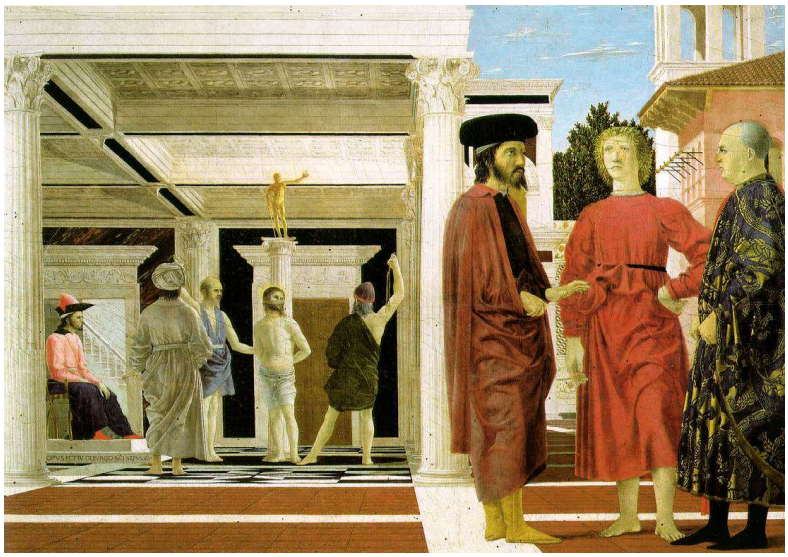

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Figure.20: detail from Figure.19

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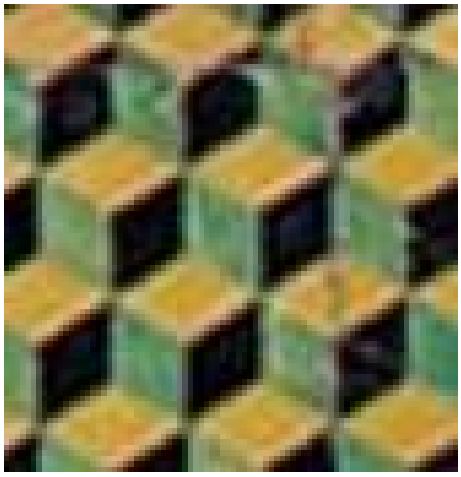

Figure.23

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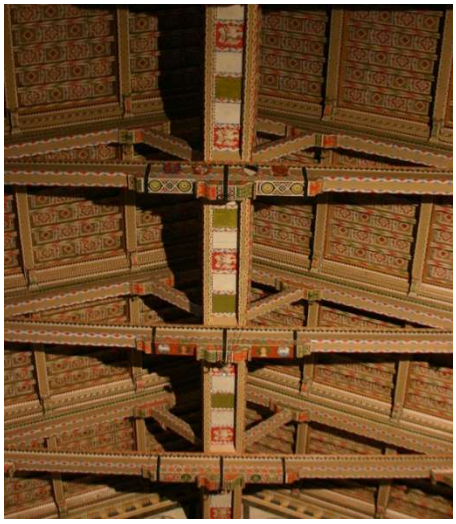

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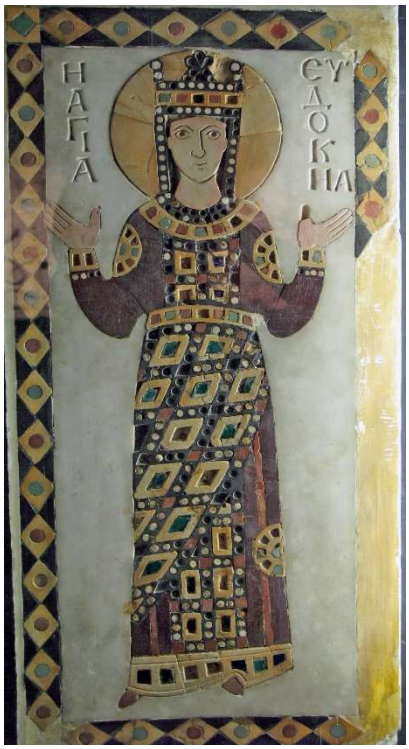

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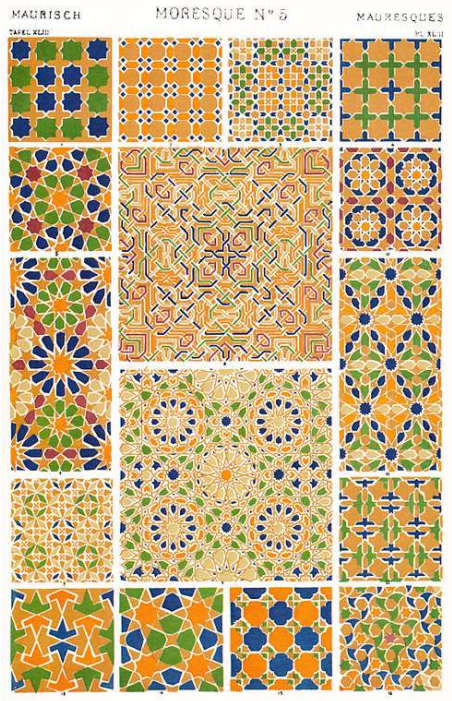

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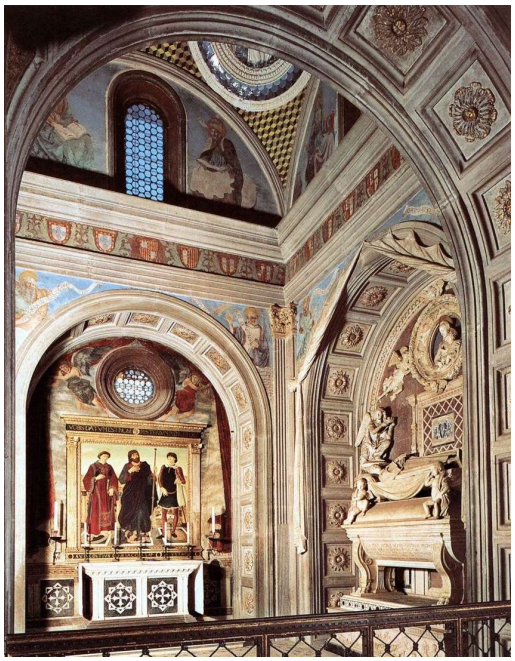

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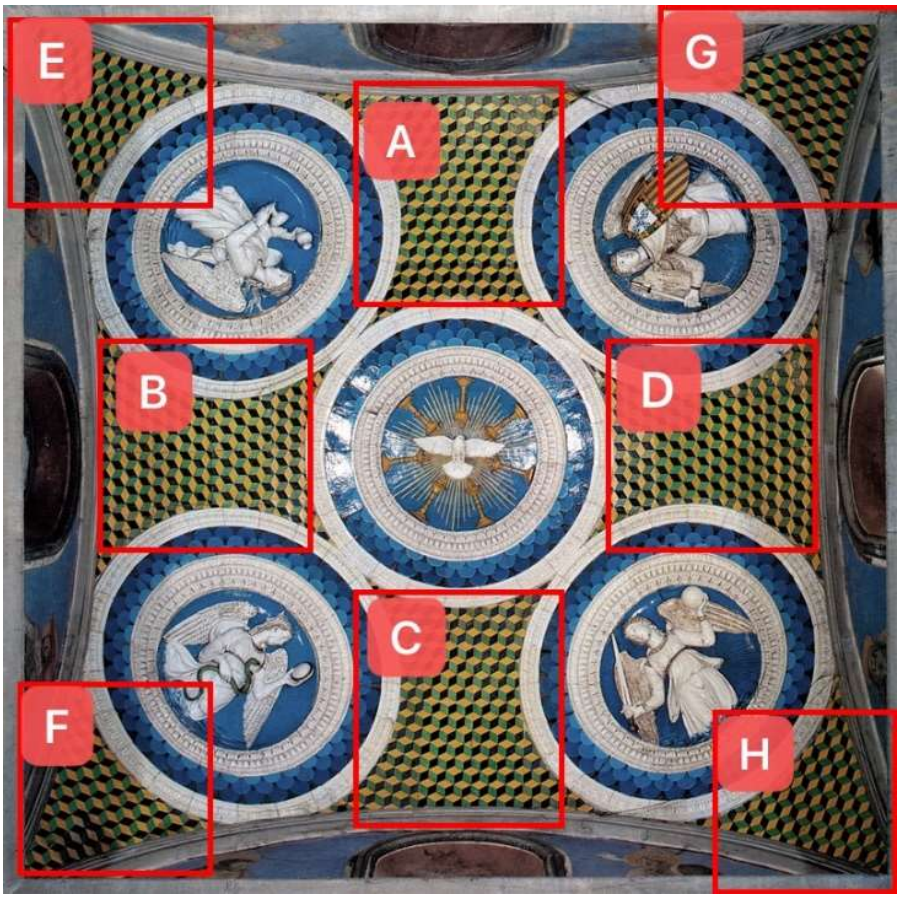

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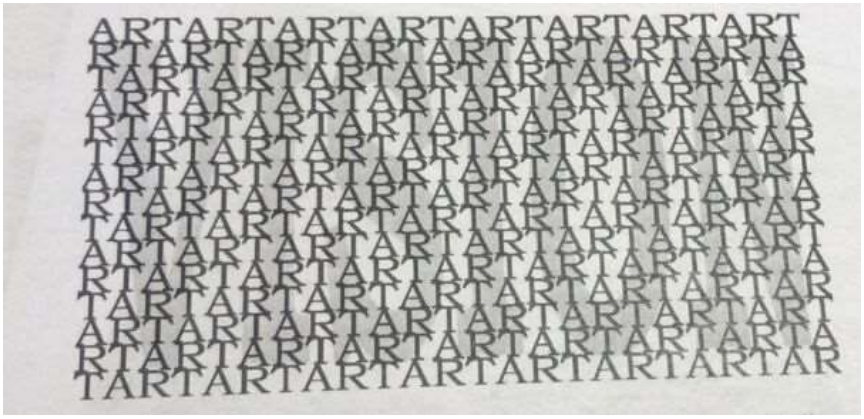

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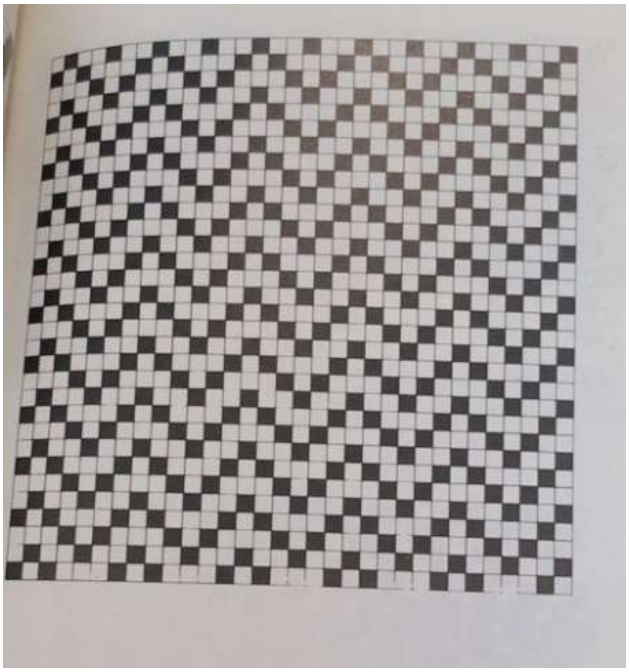
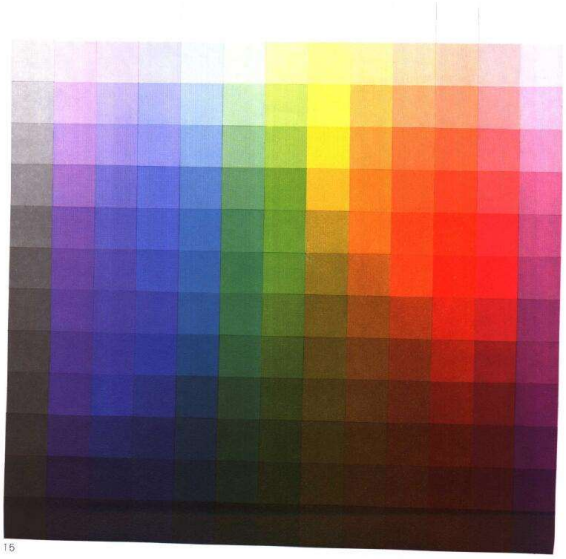


Figure.41: optical illusion caused by similarity

Color	Wave length, mμ
Red	800–650
Orange	640–590
Yellow	580–550
Green	530–490
Blue	480–460
Indigo	450–440
Violet	430–390

Figure.42

Colour wavelength



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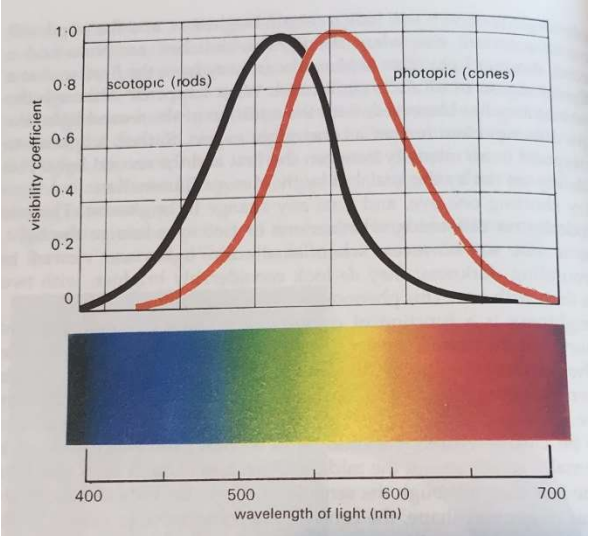
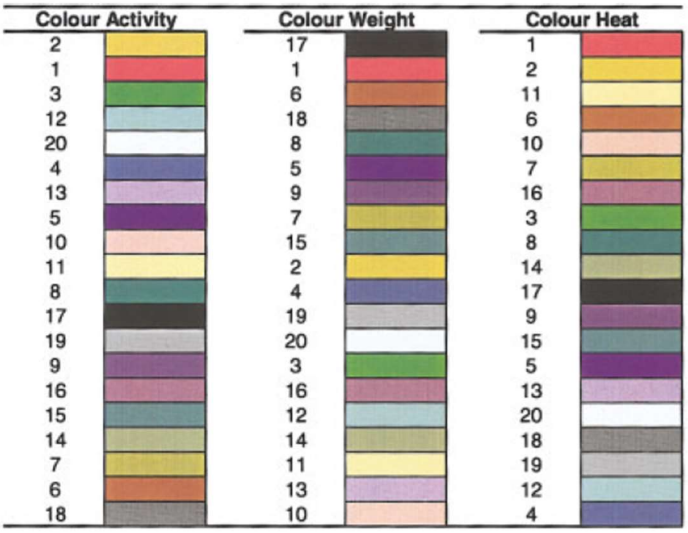


Figure.44

The spectral luminosity curve. The black curve shows the sensitivity shifts along the spectrum when the eye is dark adapted, while the red curve shows the sensitivity of the eye when light is adapted.



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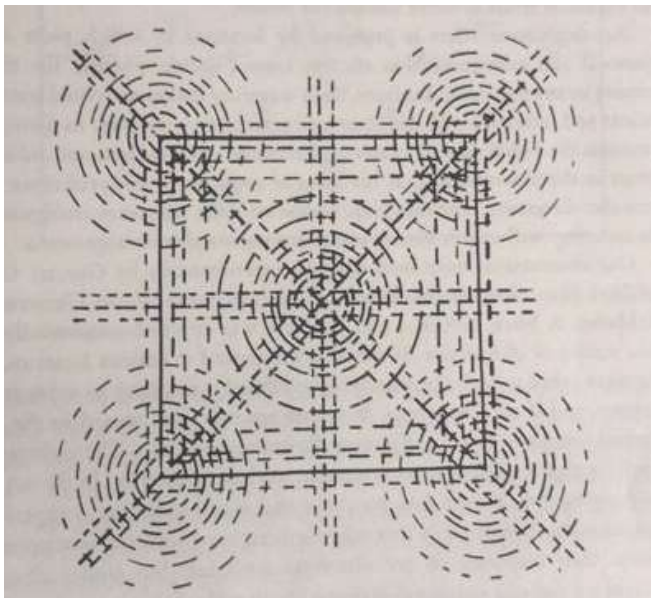

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