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Using Concept Maps to Develop a Didactic Explanation of a Dress with Ambiguous Colours

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JUNTA DE EXTREMADURA

Introduction

- In the present work we will use concept maps to facilitate the process of conceptual change in students from the analysis of their preconceptions on a particular topic, namely the perception of colour of the famous dress with ambiguous colours.

#theDress

#theDress

- This phenomenon began on late February 2015, when a user of the social networking service Tumblr published a photo of a dress and asked people about what colour was the dress.

#theDress

- Surprisingly, the answers to this simple question were divided into two very different categories:

Blue & black / White & gold

Objectives

- Develop an educational and informative explanation using concept maps to promote conceptual change on colour perception.
- Find an answer to the question: *Why is the dress perceived in different colours by different people?*

Why is the dress perceived in different colours by different people?

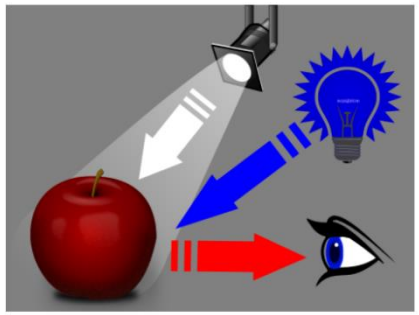
- To answer this question, we must first answer another preliminary question:

On what depends the colour we perceive in a certain object?

First Elaboration Level

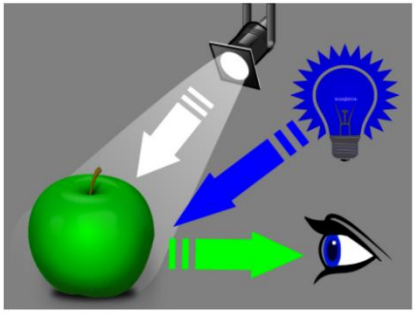
- It is advisable to take first the online test available at http://grupoorion.unex.es/test to detect colour misconceptions.

2. What colour will the apple look once the white light lamp is turned off?



- White
- Blue
- Red
- Green
- Magenta
- The apple is no longer seen

3. What colour will the apple look



- Green
- Cyan
- The apple is no longer seen

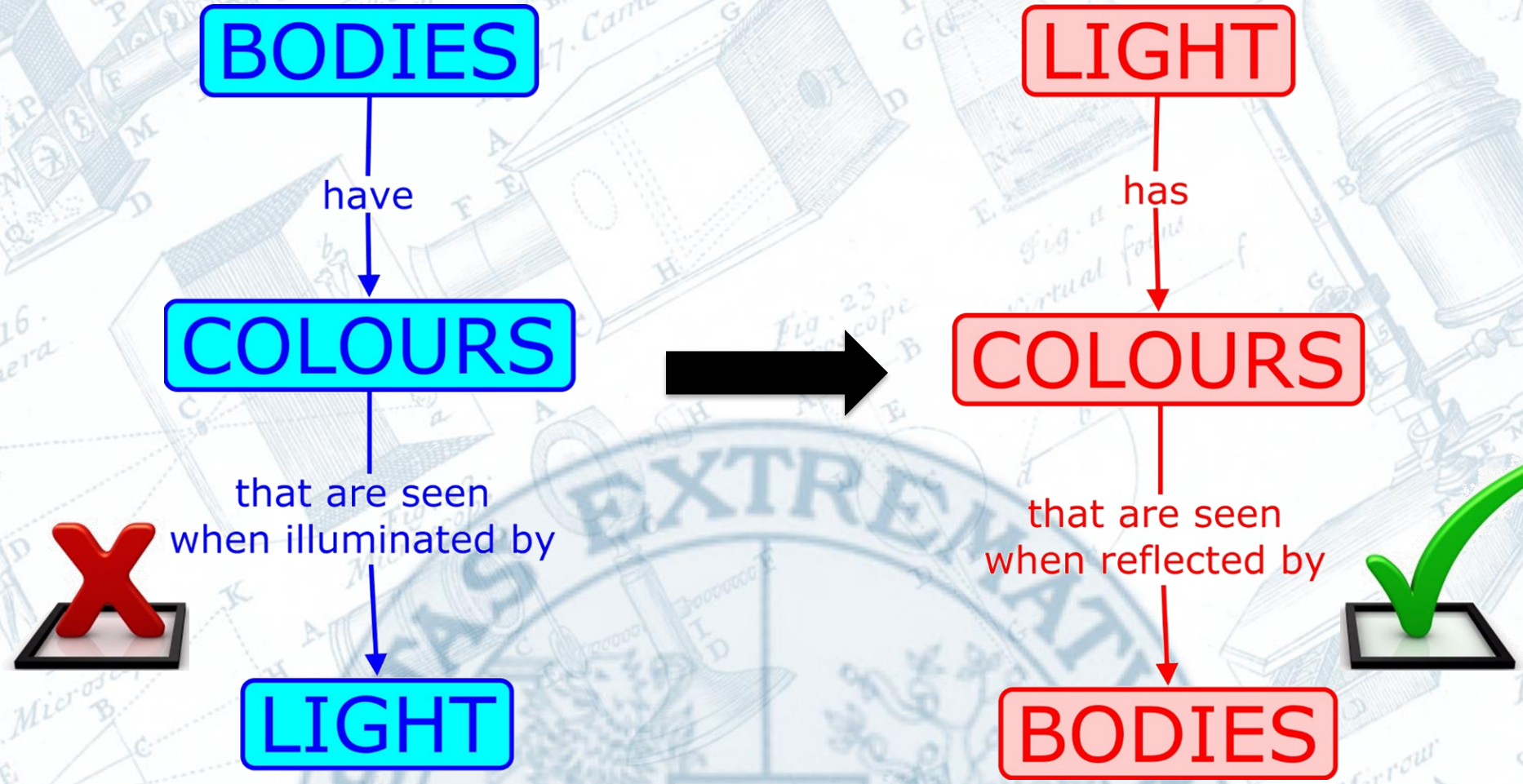
About the *Apple Test*

- Over 20,000 respondents
- Only 15.7% answered correctly
- The vast majority (78.2%) of incorrect response patterns matched just four sequences, corresponding to four types of misconceptions.
- This high percentage of wrong answers revealed the need to develop educational tools to achieve progressive conceptual changes, allowing us to combat the misconceptions found around the perception of colour.

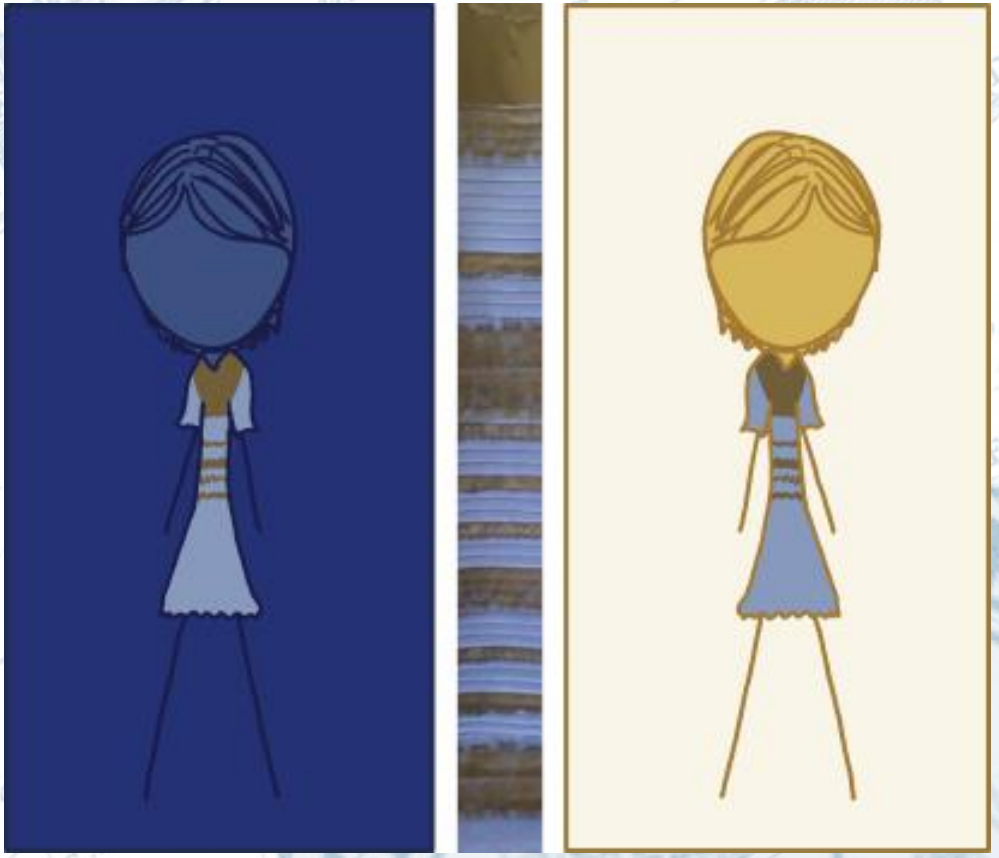
Colour is not a property of the object

- One of the most widespread misconceptions is to consider colour as a property of the object.
- To combat this misconception it is useful to use concept maps allowing us to refine the meaning of the propositions within.
- Thus, the first conceptual change needed to explain the perceived colour of a given object is to clarify that it depends not only on its characteristics, but also on the incoming light, which is reflected by the object.

First Conceptual Change

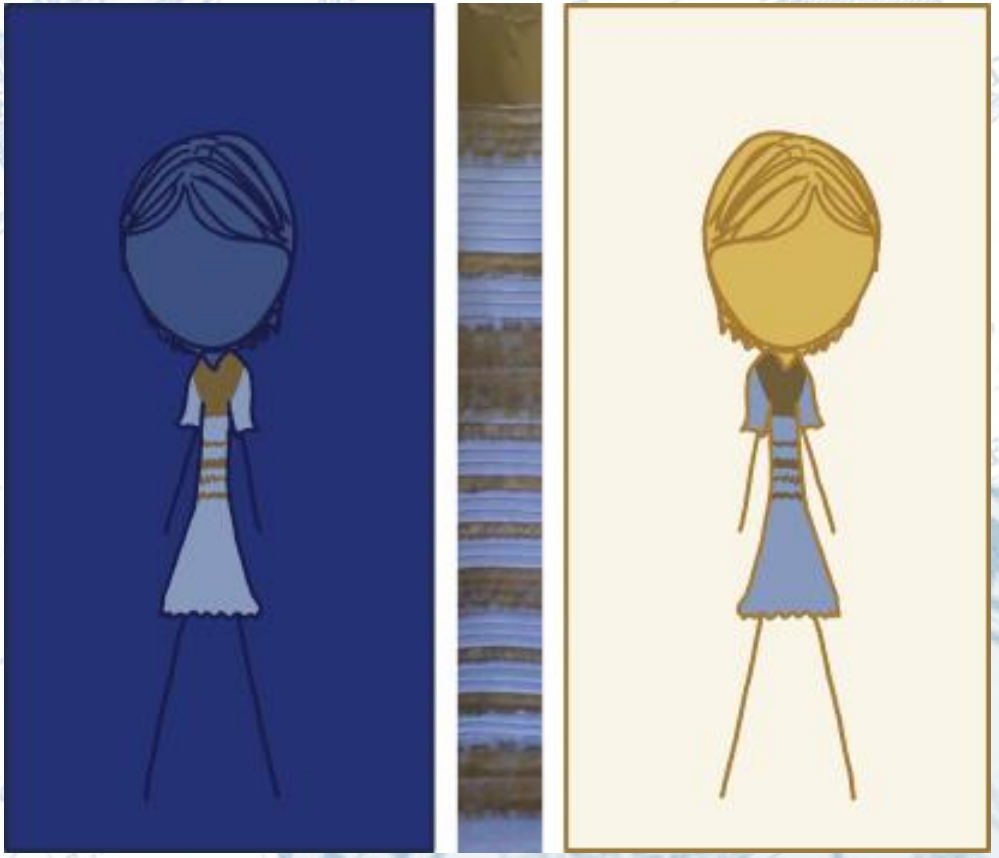


Second Elaboration Level



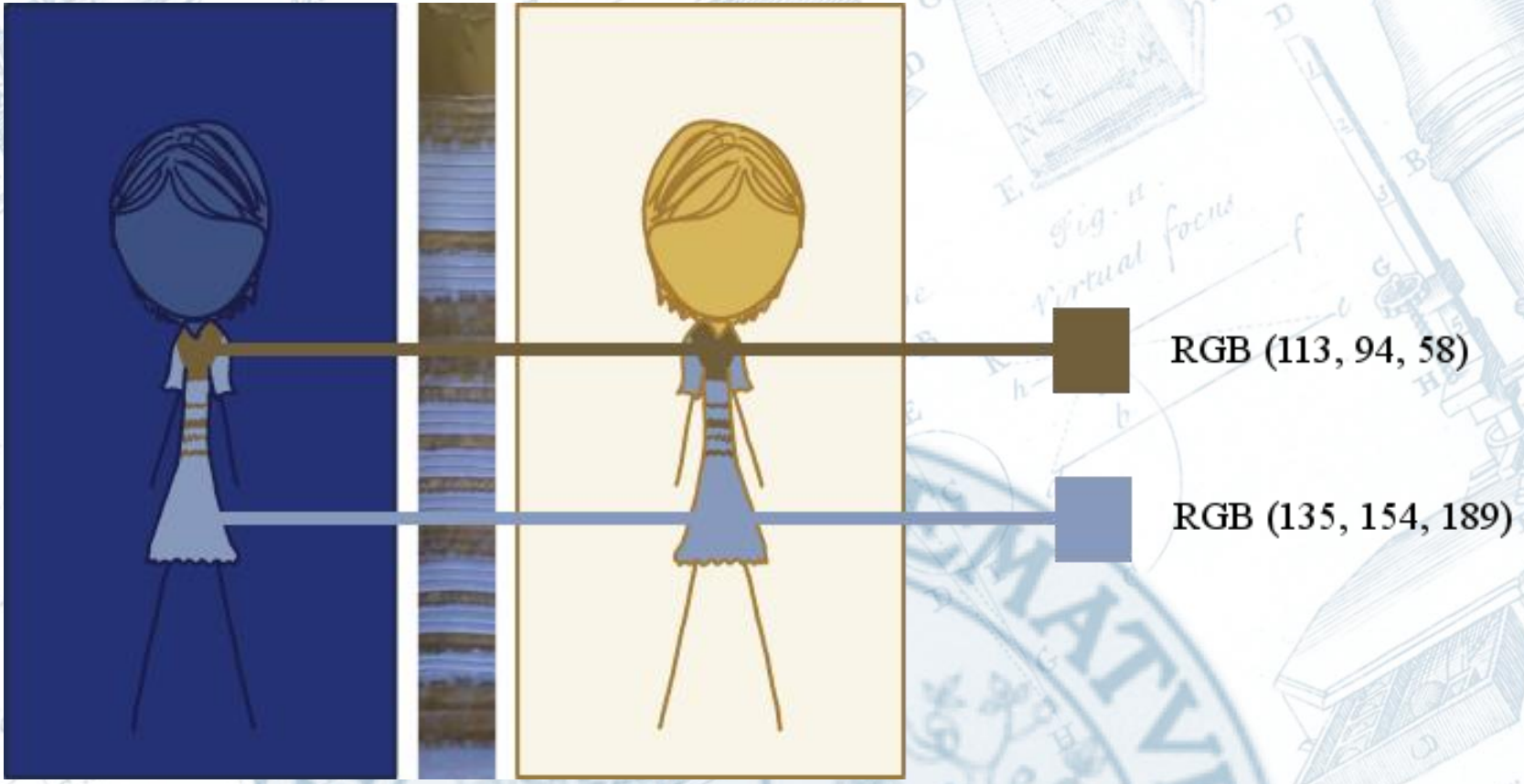
- Both stick figures are wearing the same dress.
- Commonly, we will perceive the blue faced stick figure on the left dressed in *"white and gold"* and the yellow faced stick figure on the right dressed in *"blue and black"*.

Second Elaboration Level



- However, despite perceived differently, if we check the RGB colour coordinates we can note that both dresses have the same colour coordinates (you can use a colour picker tool to check).

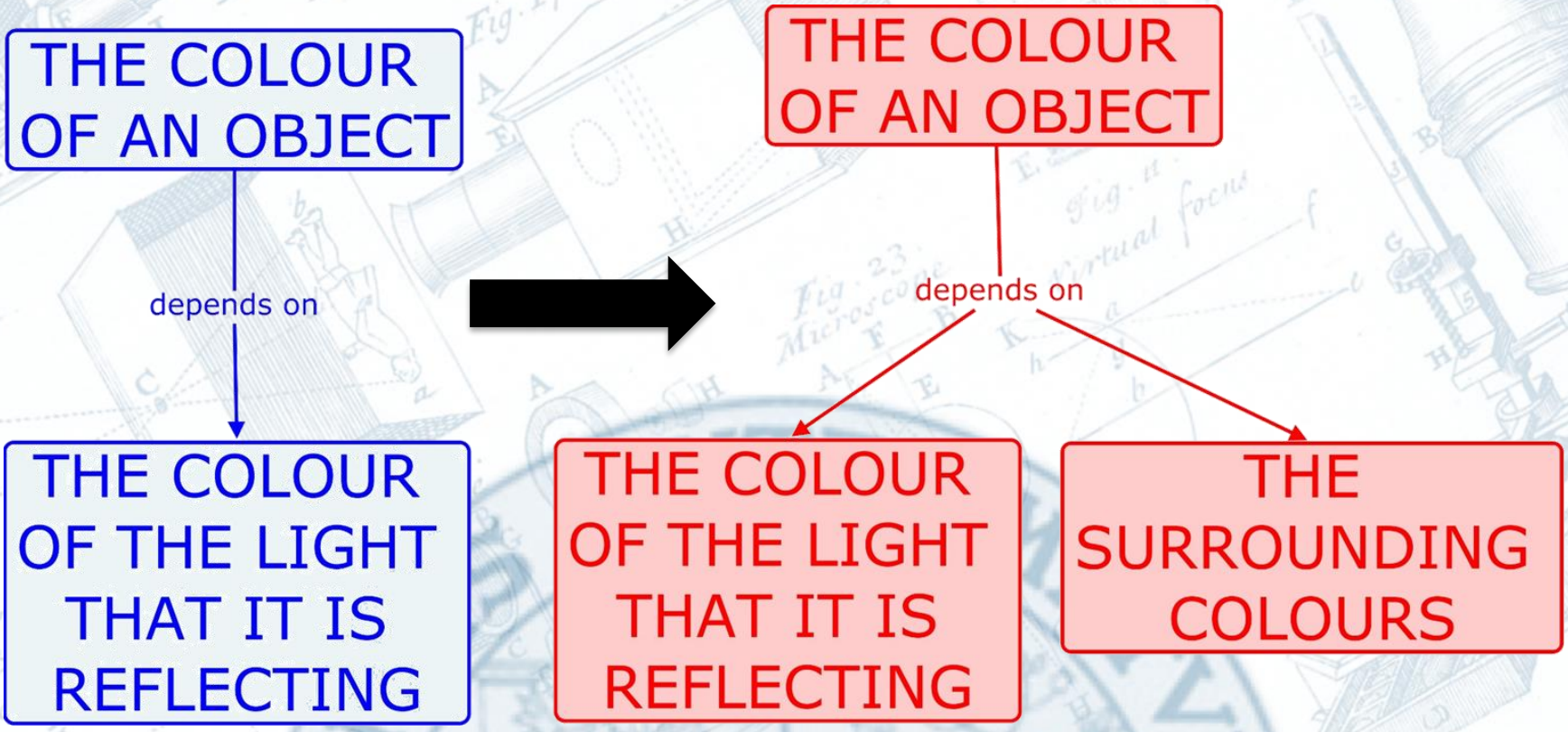
Second Elaboration Level



The colour of the environment influences the colour perceived

- The experience shows that the colour of the environment (background and surround) strongly influences the colour we perceive in an object.
- If we want to incorporate this content in a concept map, we must expand the proposition developed, which implies a second conceptual change.
- The colour an object is perceived depends on both the colour of the light traveling from the object to our eyes and also the colours of the environment (background and surround).

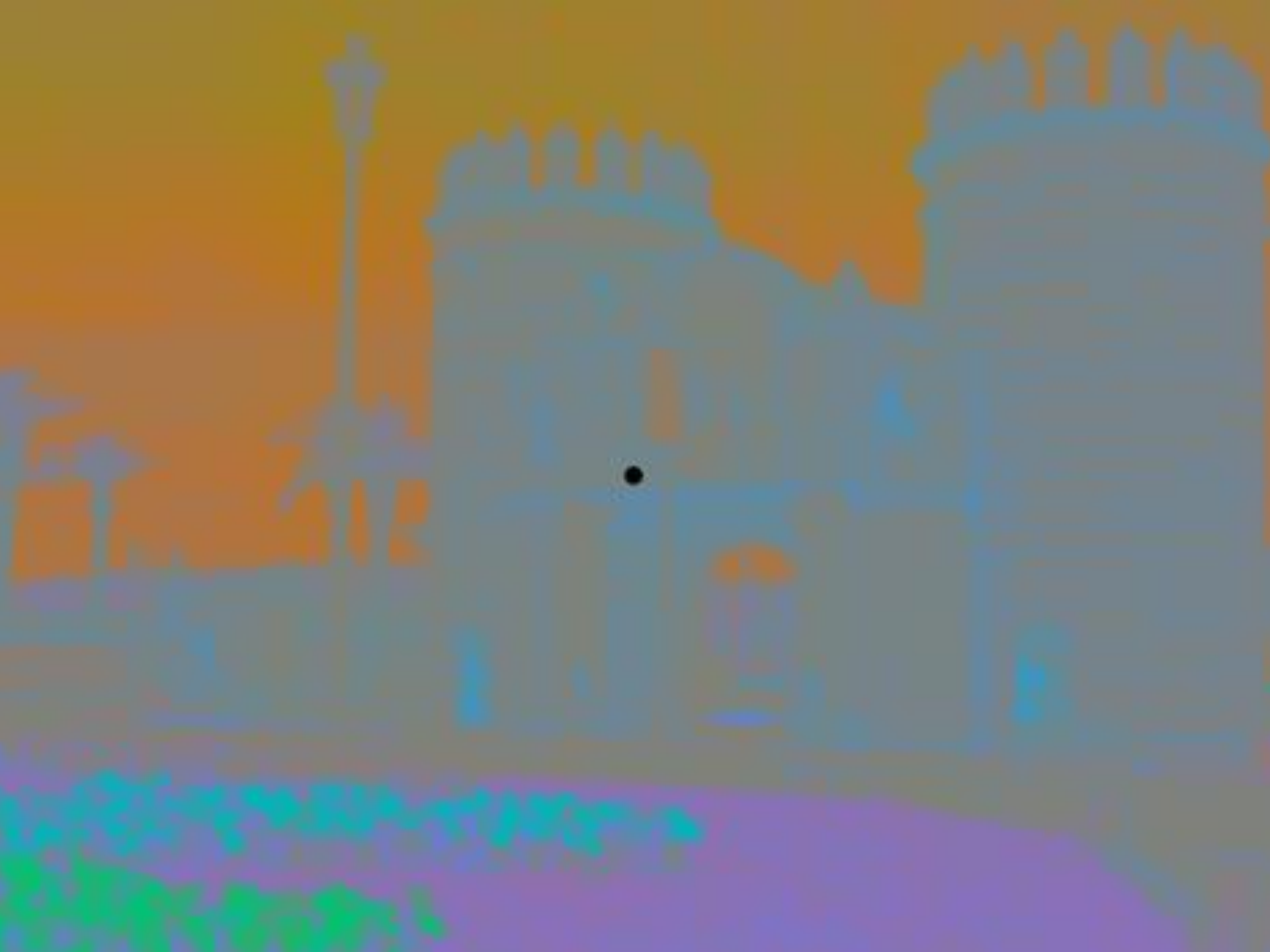
Second Conceptual Change



Third Elaboration Level

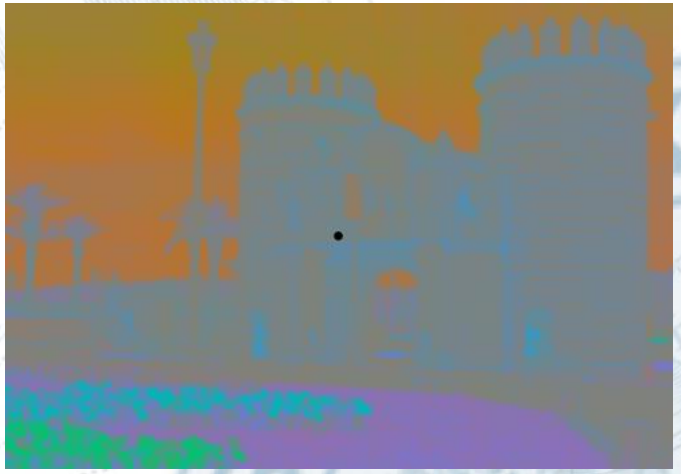
- On the following slide, please stare at the black dot in the centre of the left image for 30 seconds.

- Then, without moving your eyes from the black dot, go to the next slide.



Chromatic Adaptation

- If you did it right, the second image would have looked in full colour for a few seconds.
- However, as you can see, the image is in fact a black & white photograph.

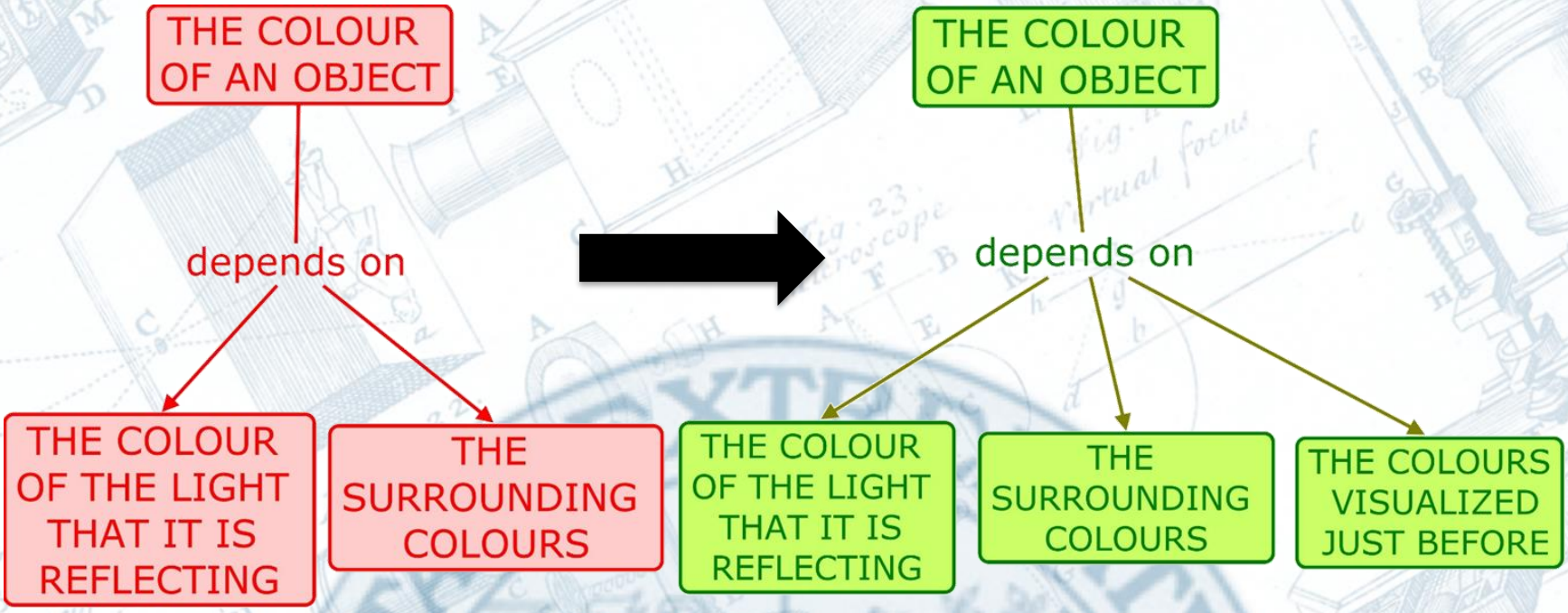


Puerta de Palmas (Badajoz, Spain).

Chromatic Adaptation

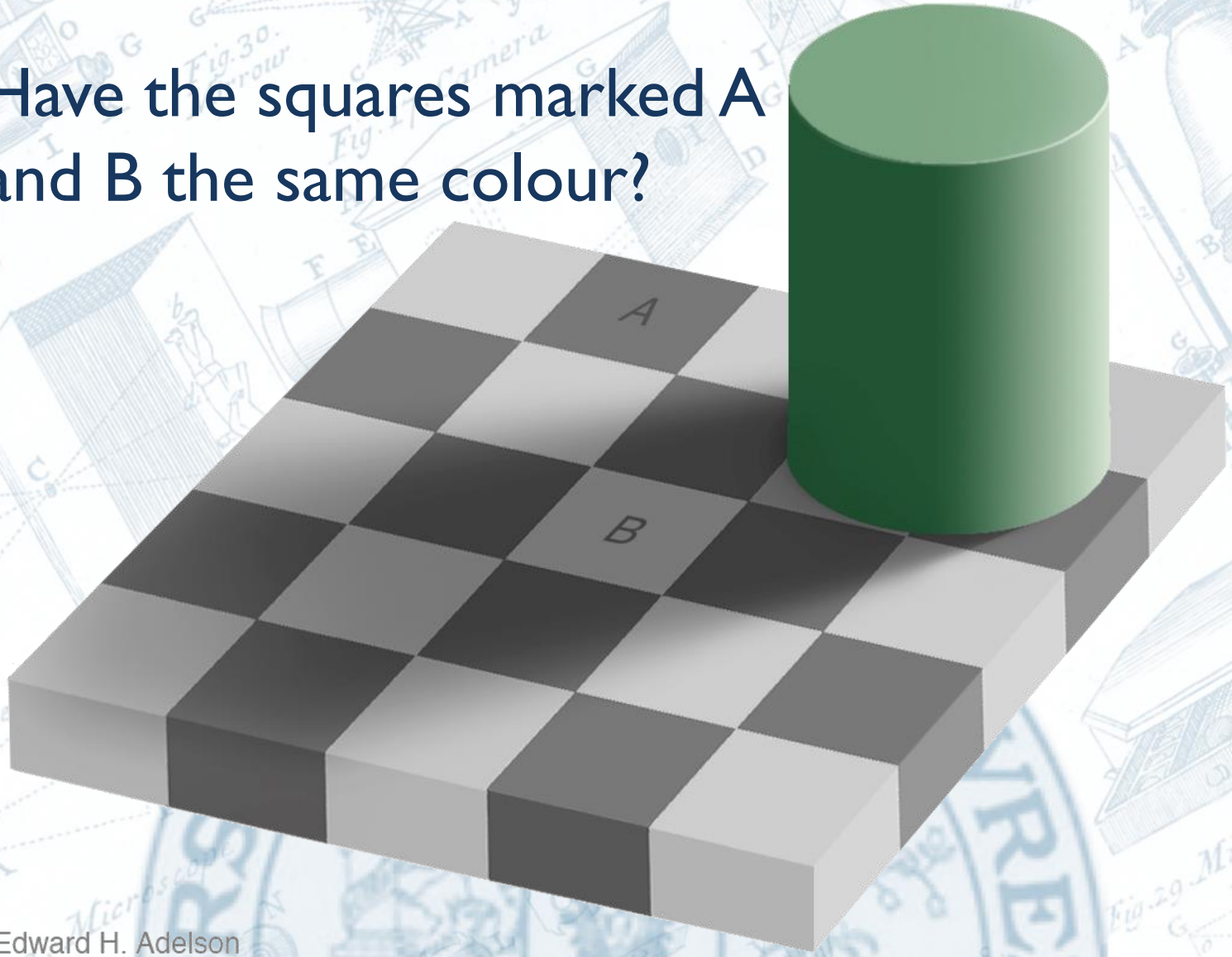
- This is due to the phenomenon known as “chromatic adaptation”, which leads us to add another progressive differentiation in our concept map.
- The perceived colour for a given object depends on the colour of the light traveling from the object to our eyes, the colours of the surrounding environment and also the colours visualized immediately before.

Third Conceptual Change



Fourth Elaboration Level

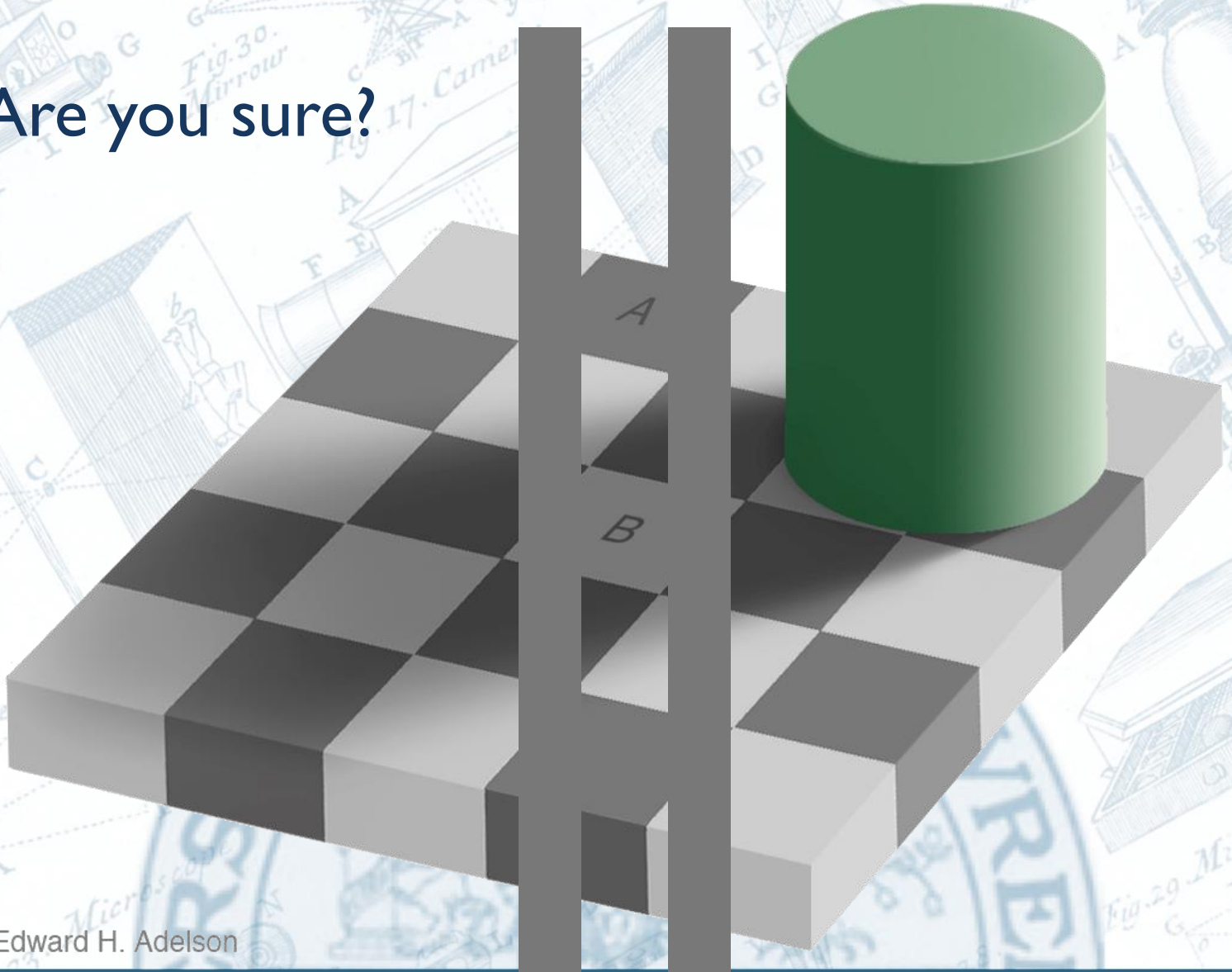
- Have the squares marked A and B the same colour?



Edward H. Adelson

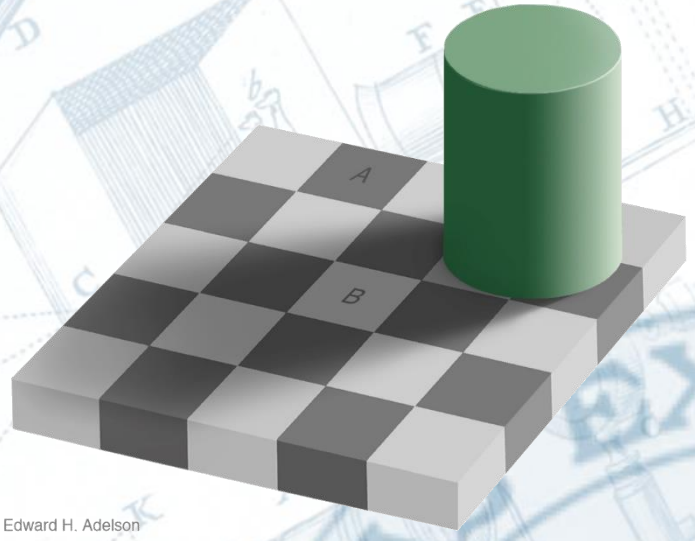
Fourth Elaboration Level

- Are you sure?



Edward H. Adelson

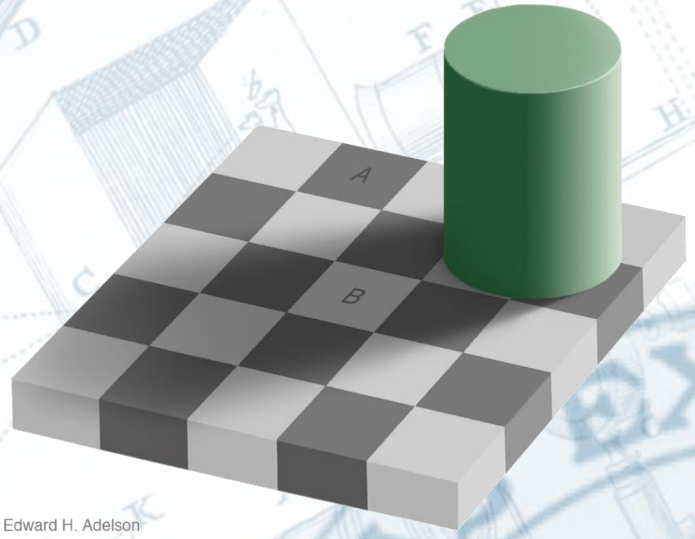
Colour depends on subjective mechanisms



Edward H. Adelson

- The perceived colour of the squares depends on the context.
- Our visual system needs to determine the colour of objects, and it uses several mechanisms to determine where the shadows are and how to compensate for them, in order to determine the "true colour" that belongs to the surface.

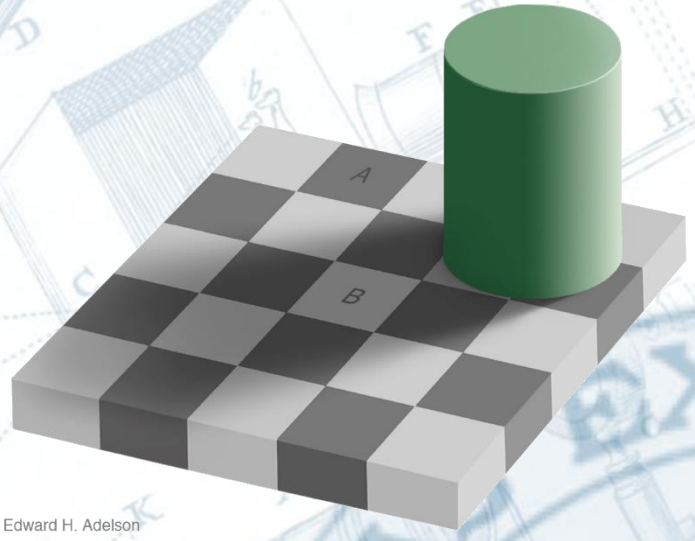
Colour depends on subjective mechanisms



Edward H. Adelson

- Thus, our visual system takes into account first local contrast: a square that is lighter than its neighbouring squares is probably lighter than average, and vice versa.
- The light square B in the shadow is surrounded by darker squares. Thus, even though the square is physically dark, it is light when compared to its neighbours.
- The dark checks outside the shadow, conversely, are surrounded by lighter checks, so they look dark by comparison.

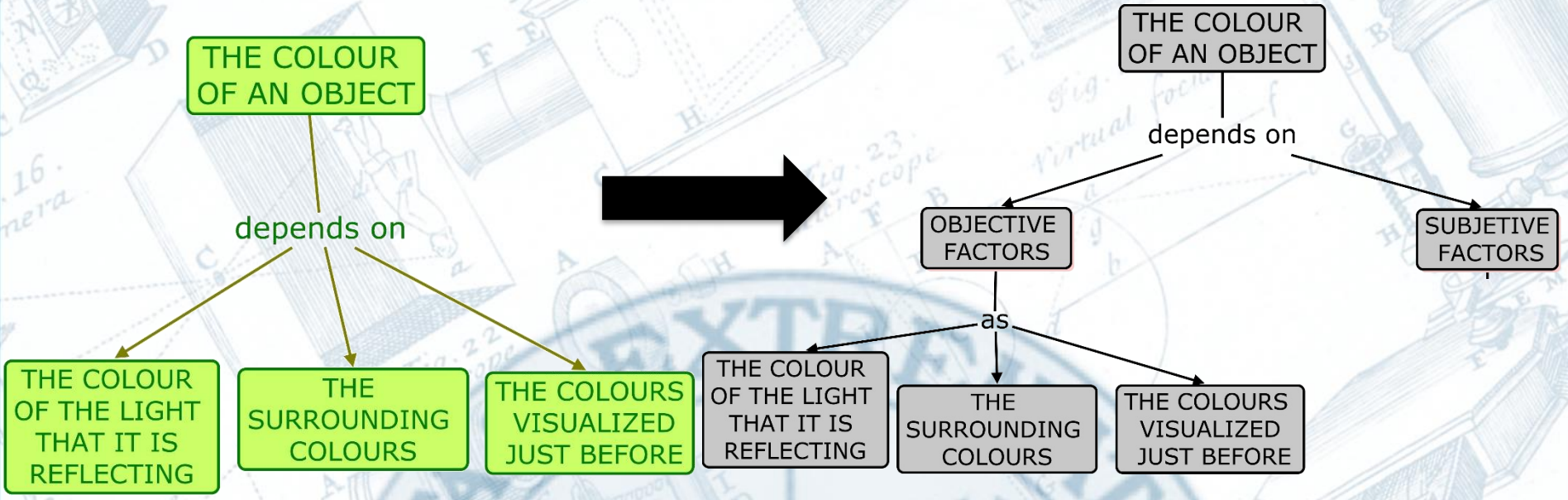
Colour depends on subjective mechanisms



Edward H. Adelson

- The visual system also tends to ignore gradual changes in light level, so that it can determine the colour of the surfaces without being misled by shadows.
- Last, the appearance of the square is aided by the form of the cross-junctions formed by 4 neighbouring squares. This type of intersection is usually a signal that all the edges should be interpreted as changes in surface colour rather than in terms of shadows or lighting.

Fourth Conceptual Change



What kind of mechanisms?

- Within certain limits, we have a tendency to perceive an object always with the same colour, regardless of the type of illumination.
- To avoid confusions, our visual system has evolved by developing what is known as **colour constancy**.

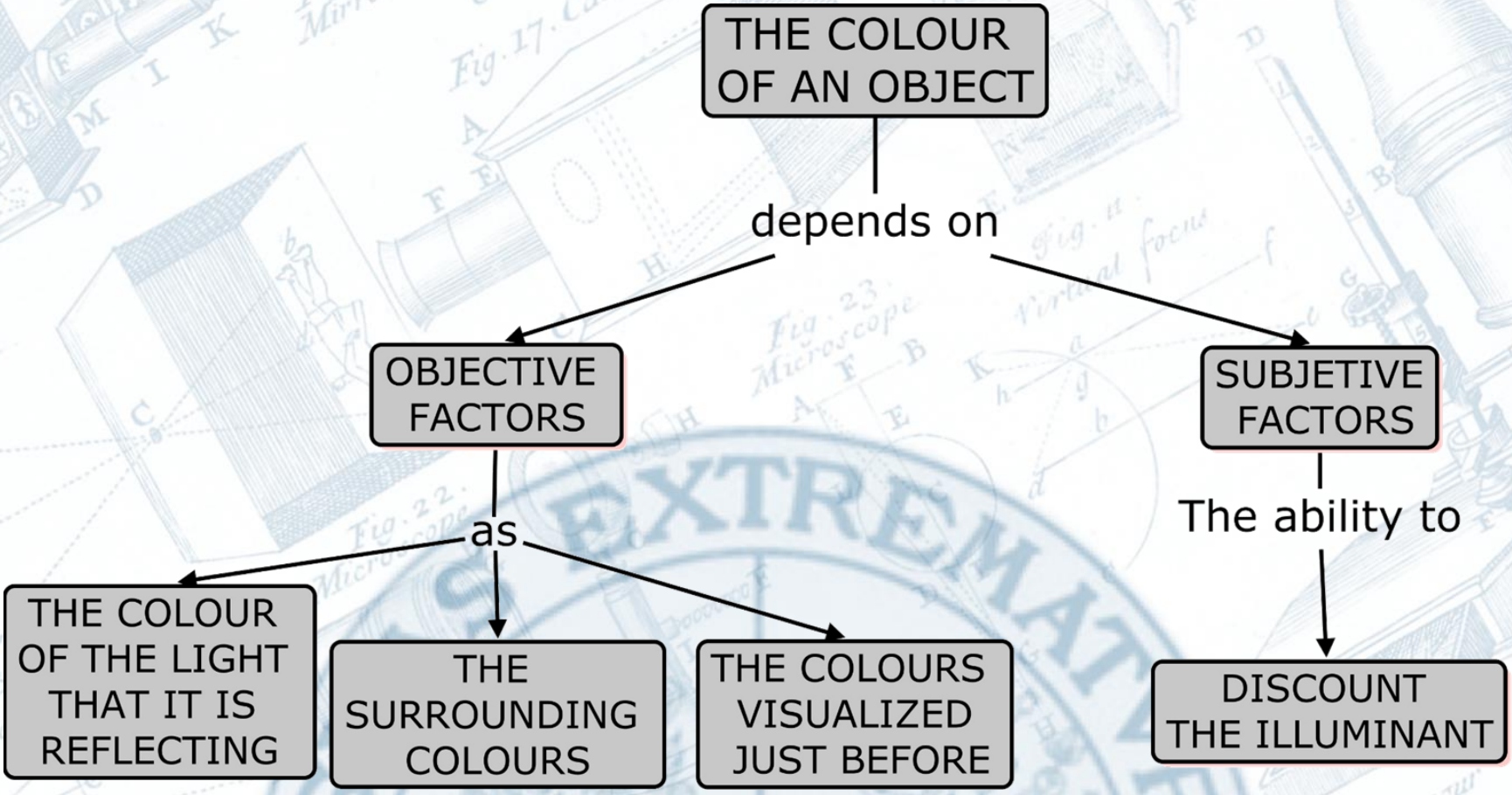
Colour constancy

- Colour constancy is a mechanism by which our visual system evaluates all colour information coming from the whole scene we are viewing.
- From this information, it can be assumed that our brain attempts to determine the approximate composition of the illuminating light, which is then discounted.

Discounting the illuminant

- Thus, the perceived colour of a given object depends on the colour of the light traveling from the object to our eyes, the colours of the environment, the colours visualized immediately before, and the perceptual mechanism called discounting the illuminant.

Final Map


THE COLOUR OF AN OBJECT
depends on
OBJECTIVE FACTORS
SUBJETIVE FACTORS
as
The ability to
THE COLOUR OF THE LIGHT THAT IT IS REFLECTING
THE SURROUNDING COLOURS
THE COLOURS VISUALIZED JUST BEFORE
DISCOUNT THE ILLUMINANT

Back to #theDress

- We acquired a model of the dress from the original manufacturer.

Viral photograph

Photograph from the manufacturer webpage

Photograph from our dress

Results

- The results obtained in our colour laboratory have revealed that **the problem of disparities in colour perceptions is not attributable to the dress itself**, because all the respondents have expressed that they saw such dress as blue and black.

Results

- Specifically, we used a sample of more than 300 people of different ages and educational backgrounds.
- They had to complete a questionnaire with independent variables related to gender, age, education, etc.
- They also identified the perceived colours of the dress under different light sources.

The *problem* is in the photograph

- However, we obtained different answers if they were shown the viral photograph, so:
  - In what conditions was that picture taken?
  - What kind of illumination was used?
  - Which camera model and settings were used?

- The most interesting question to us is:

How can we explain that most people perceive the dress in the photograph with so different colours?

- The answer to this question, from an educational and informative point of view, is related to the different levels of elaboration shown in the previous concept maps.

- The fundamental objective of our visual system is to identify and recognize objects, and colour is one of the most useful tools for this goal.
- In the case of non-luminous objects, if we change the illuminant, the light reflected by the objects will also change.
- Thus, we should perceive them with different colours, which might make us think them as different objects.

- As we have seen, our visual system is probably able to discount the illuminant in a different amount, or as a consequence of different unknown factors.
- That is, the colours that people perceive in the photograph of the dress depend not only on the colours of the light traveling from every area of this photo to their eyes, but also on the specific backgrounds and surrounds behind this dress, the subjects' specific ability to discount the illuminant, etc.
- Nevertheless, this mechanism of colour constancy is not triggered equally in all individuals, and some are abler than others to discount the illuminant.

- The background colour (indicated by the arrow) suggests that, when the picture was taken, a yellowish hue was added (due to the illuminant or the camera settings).

Discounting the illuminant

- If the brain of the person who perceives the photo is able to to realize this and discount the yellowish illuminant, they will see the picture with the colours of the original dress, blue & black.

Not discounting the illuminant

- If they are unable to discount the yellowish illuminant, the brain will perceive the picture white & gold.

- We can assume that the discount of the illuminant is the most relevant factor to explain the differences between colours reported by different observers of the photography (not of the real dress).
- While currently this seems a reasonable hypothesis, it cannot be discarded that other factors (like observers' pupil size) may have also played an important role in the problem we have considered here.

- The figure in the next slide shows the global concept map developed to give an educational and informative answer to the colour perception of the dress with ambiguous colours.

FOCUS QUESTION:
ON WHAT FACTORS DOES THE COLOUR PERCEIVED OF AN OBJECT DEPEND?

THE PERCEIVED COLOUR OF AN OBJECT

depends on

OBJECTIVE FACTORS

as

THE COLOUR OF THE LIGHT THAT IT IS REFLECTING OR EMITTING

THE SURROUNDING COLOURS

THE COLOURS VISUALIZED JUST BEFORE

as shown in this

PRESENTATION

suggests

CONCEPTUAL CHANGES

can origin

SUBJETIVE FACTORS

PAPER

as those shown in this

MISCONCEPTIONS

which can be tested in our

ONLINE TEST

are the origin of

as

COLOUR CONSTANCY

allows

THE ABILITY TO DISCOUNT THE ILLUMINANT

helps

IDENTIFYING THE OBJECT REGARDLESS OF THE ILLUMINANT

FINDING THE MEANING OF THE VISUAL INFORMATION RECEIVED

is the main objective of

THE VISUAL SYSTEM

is important for

THE SELECTION OF THE SPECIES

wich makes use of

THE BRAIN

works

is

PHYSIOLOGICALLY CONSTRUCTIVIST

plays a role in

THE FAMOUS VIRAL DRESS

was taken a

PHOTOGRAPH

is

BLUE AND BLACK

wich added an overall

YELLOWISH COLOUR

wich can be seen in

is seen on the right botton corner

confirmed by

LABORATORY MEASUREMENTS

give

BLUE + YELLOW AND BLACK + YELLOW

these colours are received by

THE OBSERVERS

can be divided into

caused by

THE LIGTH SOURCE AND WRONG SETTINGS

wich addition is a

SIMPLIFIED HYPOTHESIS

based on

LABORATORY MEASUREMENTS

THOSE WHO DETECT THE YELLOWISH COLOUR AS PART OF THE DRESS

perceive

BLUE + YELLOW = WHITE AND BLACK + YELLOW = GOLD

are unable to

DISCOUNT THE ILLUMINAT

THOSE WHO DETECT THE YELLOWISH COLOUR AS AN ADDITION TO THE WHOLE SCENE

are able to

perceive

BLUE AND BLACK

have

do not have

Acknowledgements

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