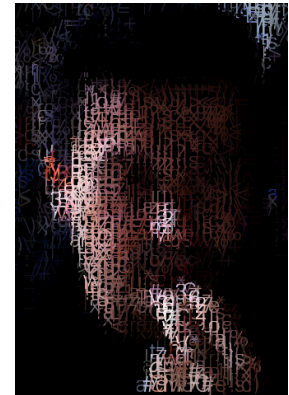


CNAM - dept. Informatique - DUT1 – USAL24

# IHM(4) – Facteurs humains

Pierre Cubaud, CNAM  
cubaud @ cnam.fr



le **cnam**

# Plan de la séance

- vision pré-attentive
- perception des couleurs
- production des couleurs
- lisibilité
- psycho-motricité

et rien sur l'audition 😞

## 1. Vision pré-attentive

01654387629764

93875278964369

06321987449075

33564472688956

combien de 2 ?

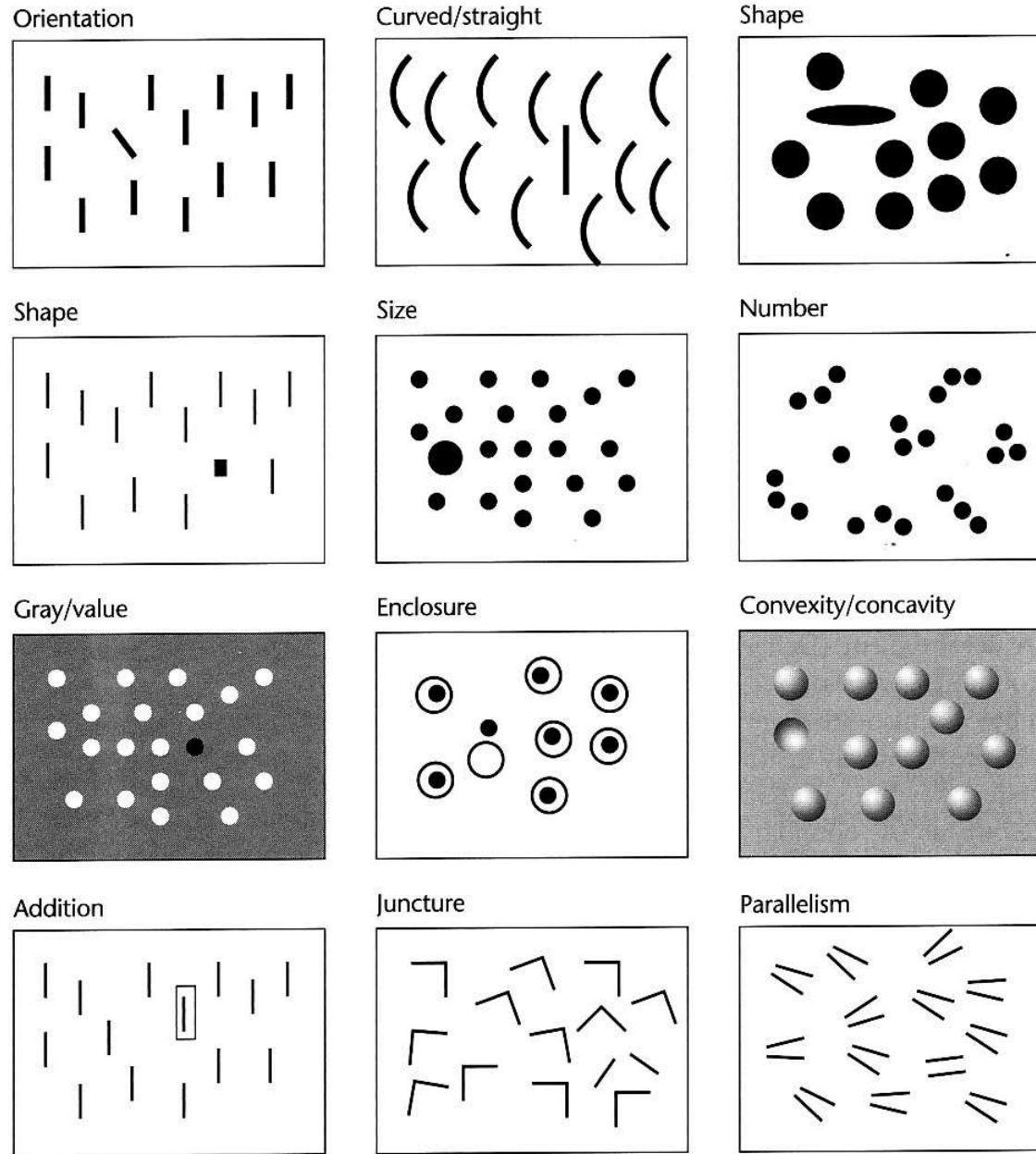
016543876**2**9764

93875**2**78964369

063**2**1987449075

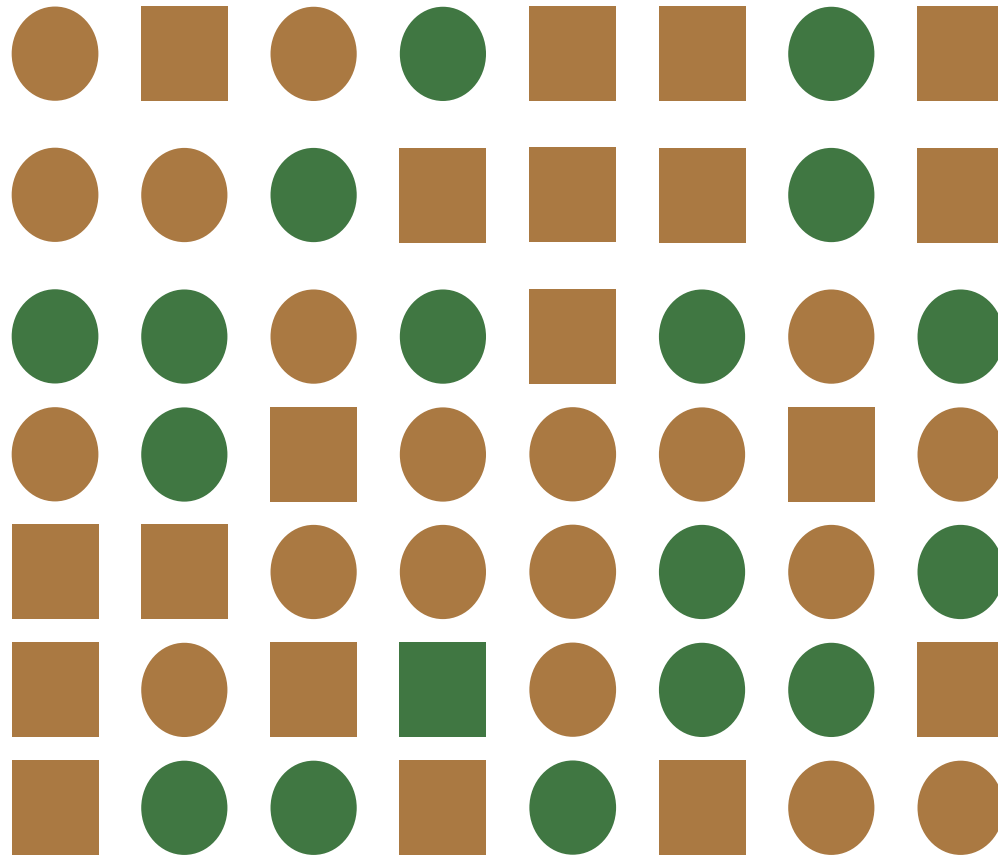
3356447**2**688956

combien de 2 ?

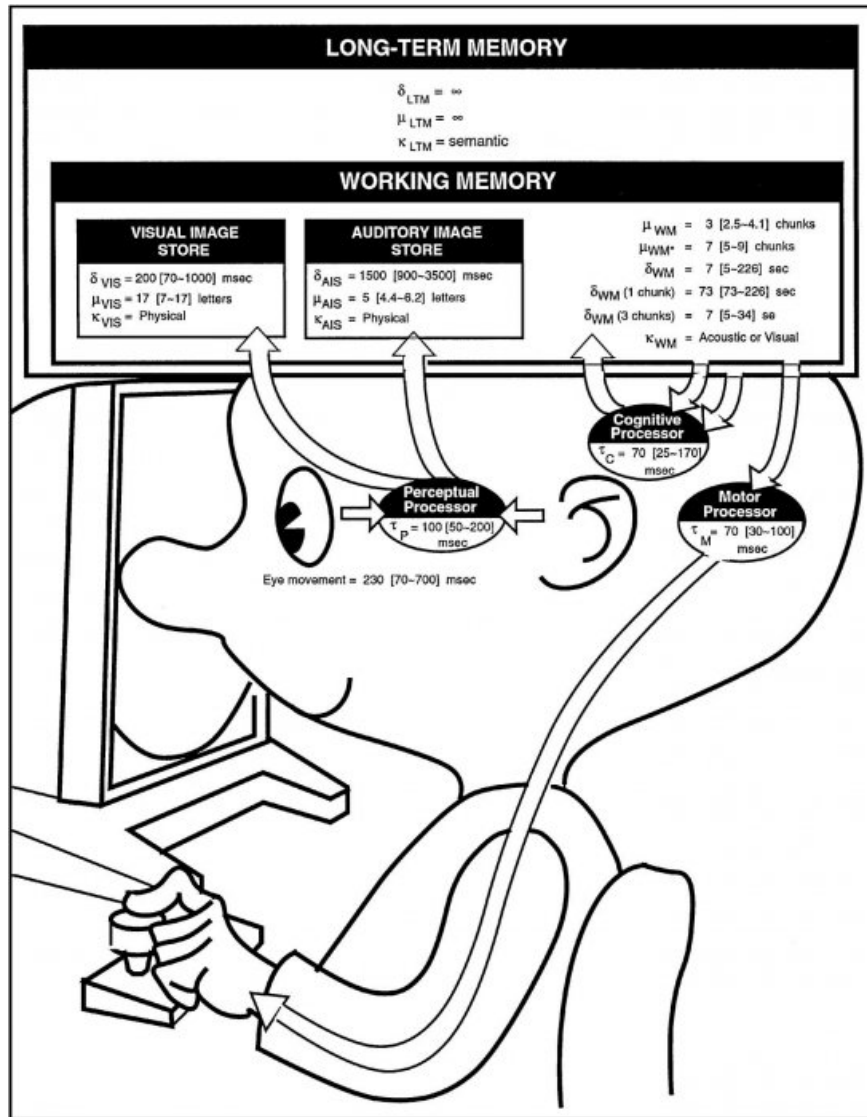


**Figure 5.5** Most of the differences shown are preattentively distinguished. Only juncture and parallelism are not.

[Ware]  
p.153



limite du procédé : la conjonction de codes



Card, Moran, Newell  
 "The psychology of  
 Human-Computer interaction"  
 1983

- 3 processeurs
- Perceptif
- Cognitif
- Moteur

- Hiérarchie de mémoire
- Mémoire de travail (RAM)
- Mémoire sensorielle
- Mémoire court terme
- Mémoire long terme

# Mémoire court terme

- Un« bloc notes » pour retrouver rapidement les informations
- Temps de réponse rapide : 70ms mais décroît rapidement
- Capacité limitée : entre 5 et 9 items (chiffres, nombres, ...)

Psychological Review  
Vol. 101, No. 2, 343-352

© by the American Psychological Association  
For personal use only--not for distribution.

## **The Magical Number Seven, Plus or Minus Two Some Limits on Our Capacity for Processing Information**

**George A. Miller**  
Harvard University

---

This paper was first read as an Invited Address before the Eastern Psychological Association in Philadelphia on April 15, 1955. Preparation of the paper was supported by the Harvard Psycho-Acoustic Laboratory under Contract N5ori-76 between Harvard University and the Office of Naval Research, U.S. Navy (Project NR 142-201, Report PNR-174). Reproduction for any purpose of the U.S. Government is permitted.

Received: May 4, 1955

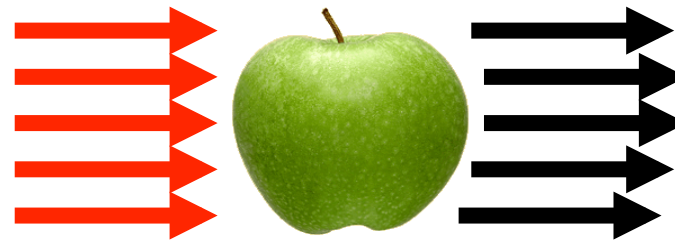
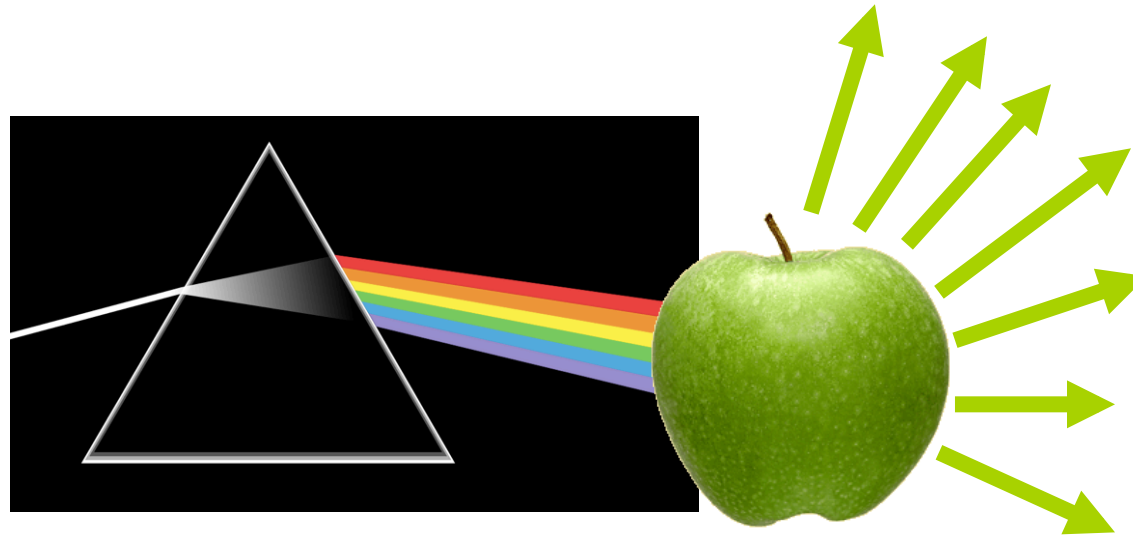
---

My problem is that I have been persecuted by an integer. For seven years this number has followed me around, has intruded in my most private data, and has assaulted me from the pages of our most public journals. This number assumes a variety of disguises, being sometimes a little larger and sometimes a little smaller than usual, but never changing so much as to be unrecognizable. The persistence with which

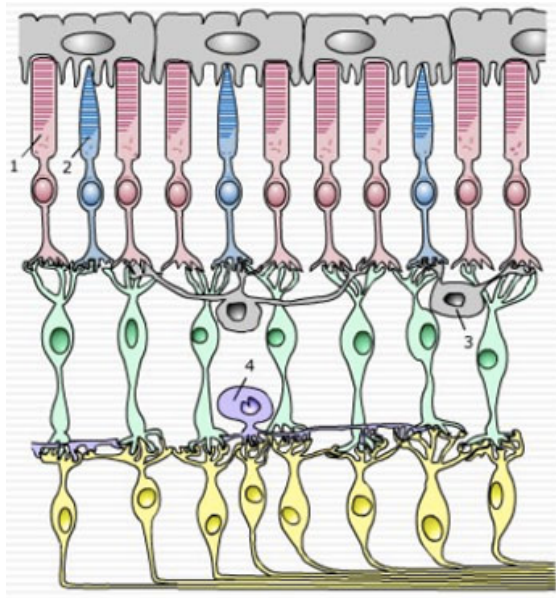


## 2. Perception des couleur

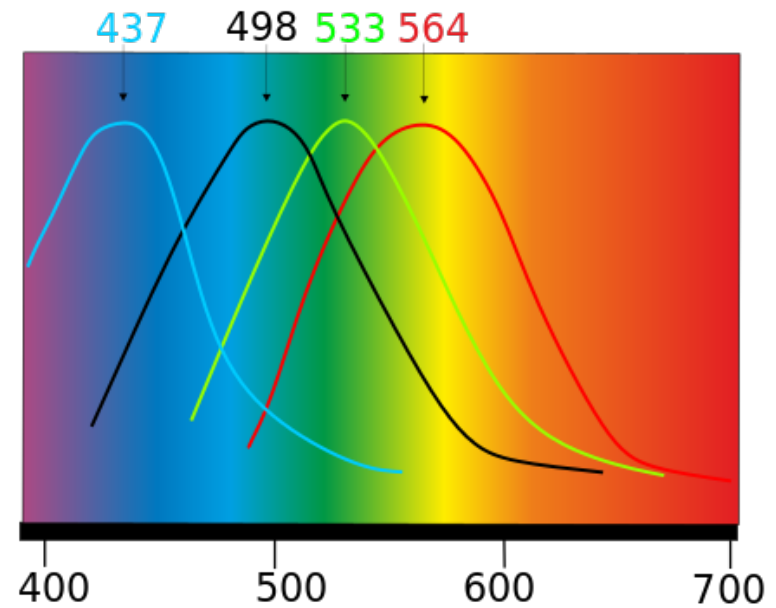
rappels de physique : l'interaction matière-lumière



# l'oeil



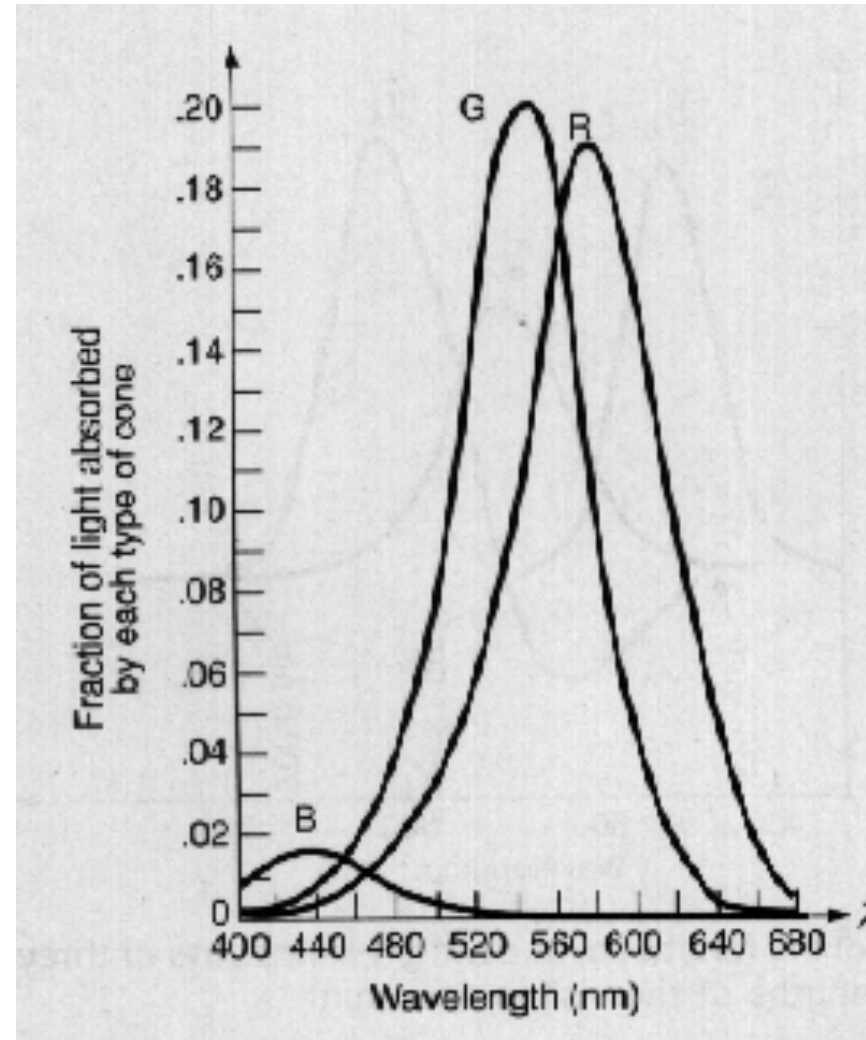
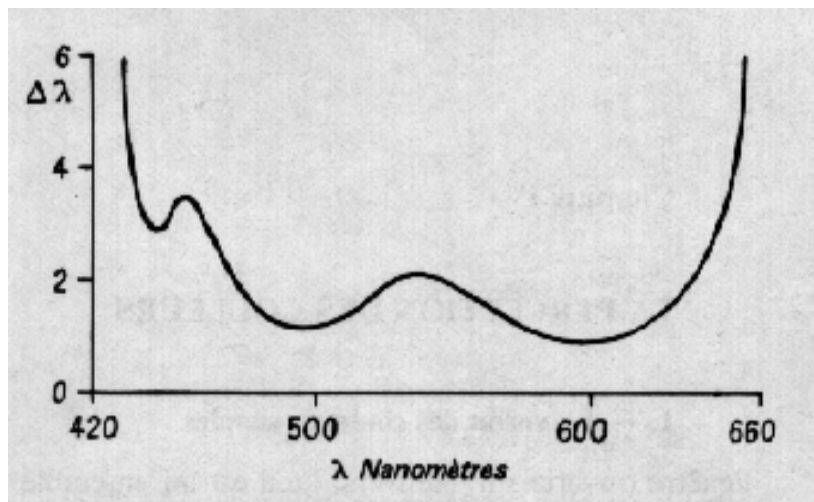
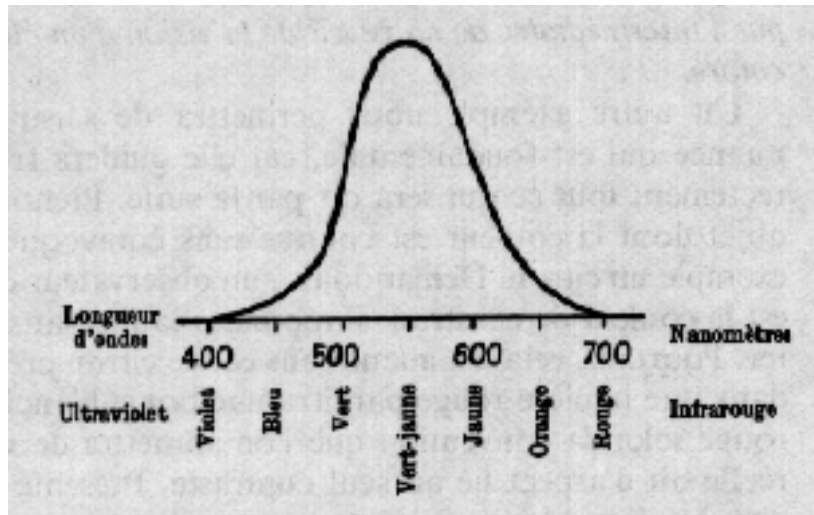
<http://accs.ens-lyon.fr>



wikipedia (en noir : bâtonnets)

7M cônes, 120M bâtonnets

# Inégale sensibilité des cônes



8% des hommes et 1% des femmes ont une forme de daltonisme



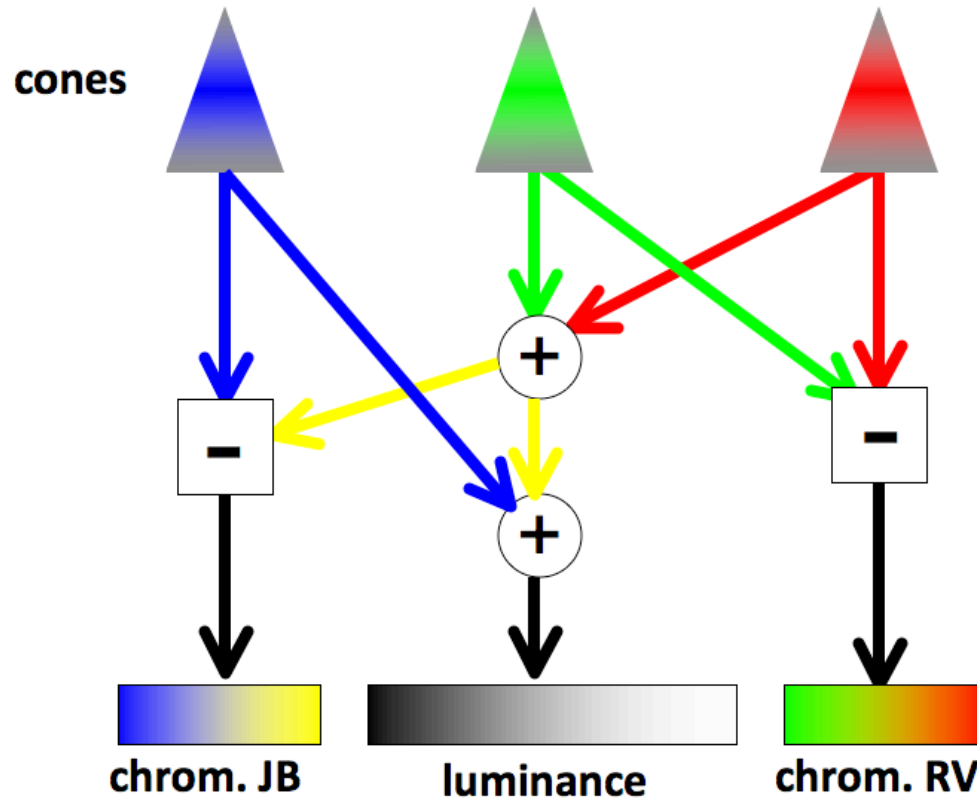
*Normal vision*

*Deuteran*

*Protan*

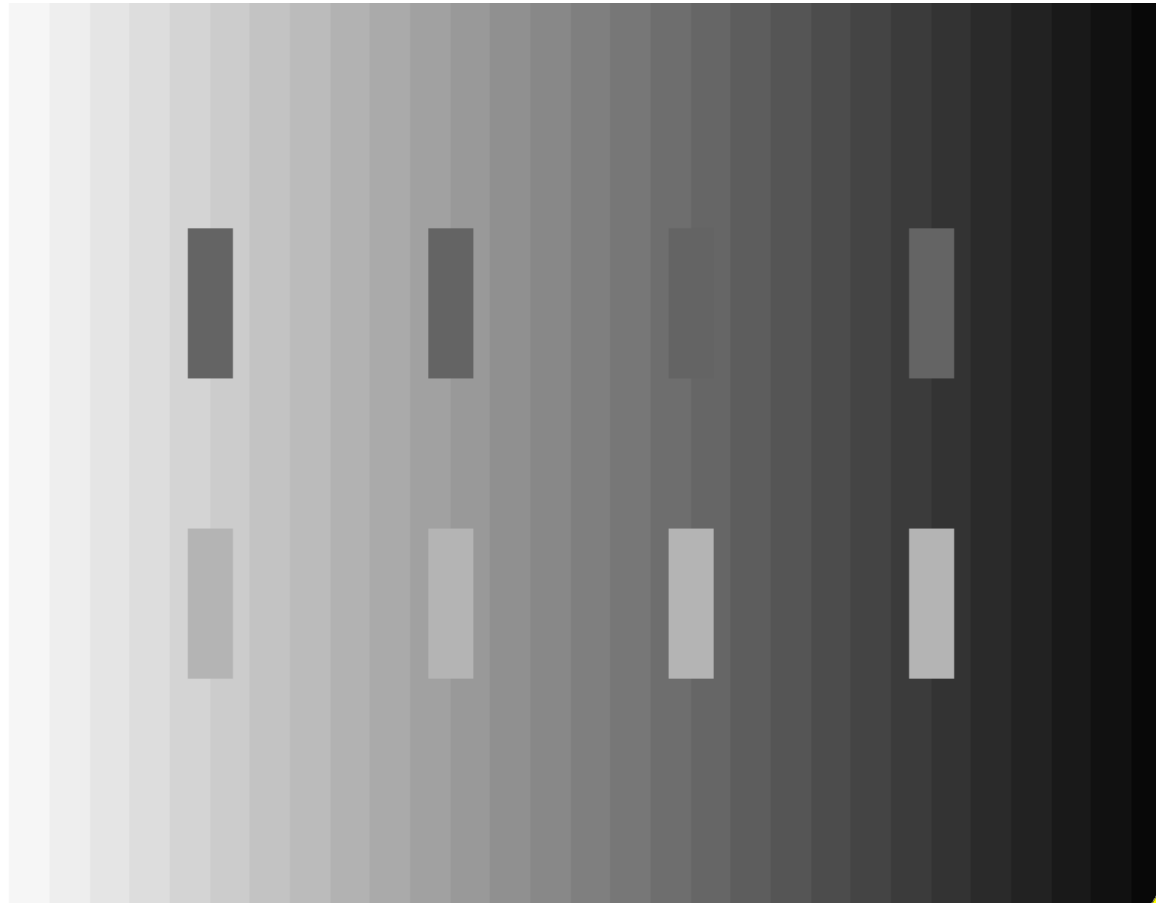
<http://wearecolorblind.com>

# le modèle des couleurs opposées



(CIE LAB, YUV ...)

# Perception des contrastes



d'après [Ware]



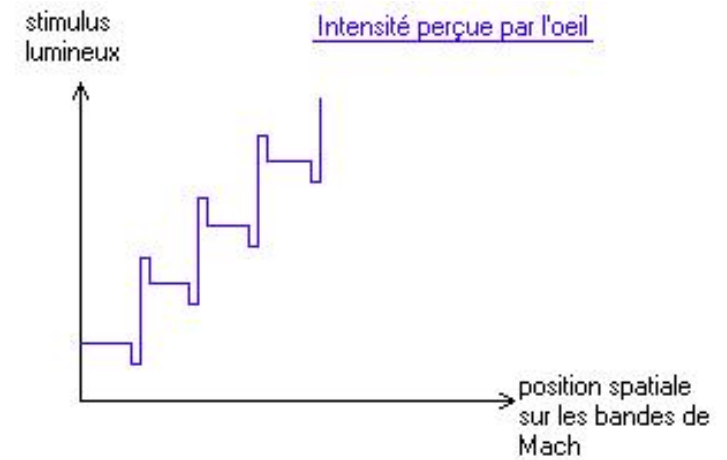
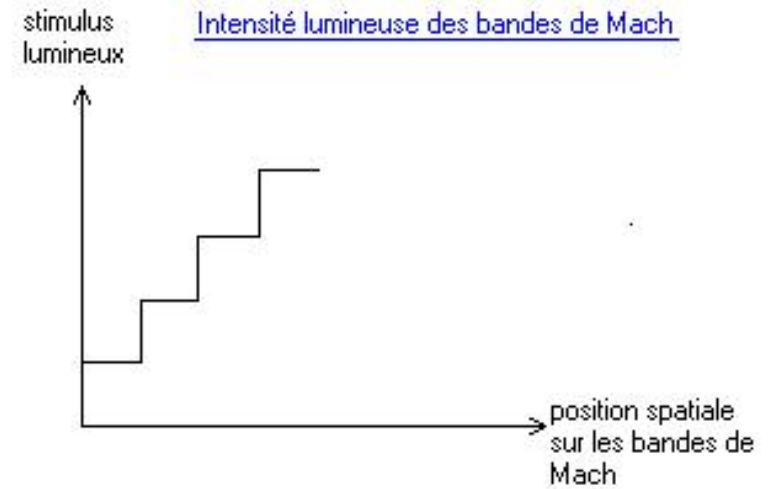
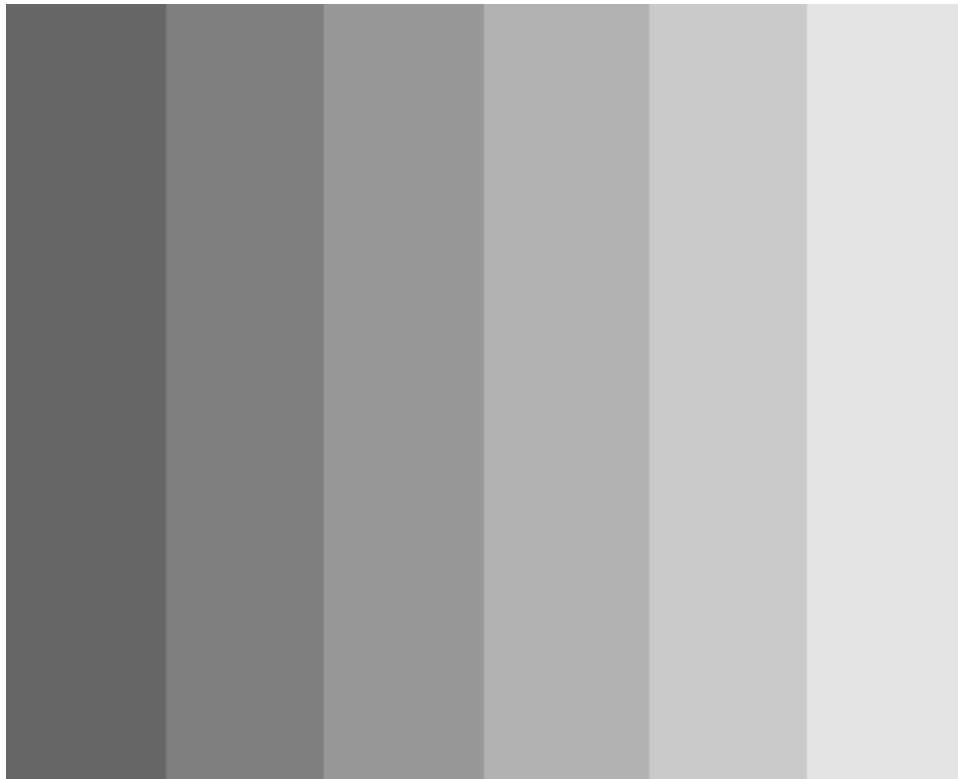
## code Processing pour produire l'image

---

```
int N=40;
size(800,600);
noStroke();
for (int i=0; i<N;i++){
  fill(map(i,0,N,255,0));
  rect(i*width/float(N),0,width/N,height);
}
rectMode(CENTER);
fill(100);
rect(160,200,30,100);
rect(320,200,30,100);
rect(480,200,30,100);
rect(640,200,30,100);
fill(180);
rect(160,400,30,100);
rect(320,400,30,100);
rect(480,400,30,100);
rect(640,400,30,100);
save("contrastGRIS.png");
```

c'est bien quatre  
fois le même gris

# Bandes de Mach





# Ecrans illisibles



<http://asprise.com>

## Un autre

The image shows a screenshot of a real estate website. On the left is a navigation menu with several buttons: 'ACCUEIL', 'NOS OFFRES de VENTES', 'Maisons, Fermettes', 'Appartements', 'Fonds de Commerces, locaux commerciaux', 'Terrains', and 'NOS OFFRES de LOCATIONS'. The 'Maisons, Fermettes' button is highlighted in red. The main content area displays a property listing for 'IVOY LE PRE 18380'. The description is in green text and details a farmstead with a 120m² barn, a veranda, a kitchen, a living area with a fireplace, three bedrooms, a bathroom, a boiler room, and two rooms to be furnished. It also mentions a stable, a barn, various outbuildings, and a well, all on a 4800m² plot. The construction year is listed as 0. Below the description, there is a section titled 'Détail.. de l'offre' with 'Surface en M² : Surface habitable : 120'.

**ACCUEIL**

**NOS OFFRES de VENTES**

**Maisons, Fermettes**

Appartements

Fonds de Commerces, locaux commerciaux

Terrains

**NOS OFFRES de LOCATIONS**

**IVOY LE PRE 18380**

Corps de ferme comprenant: Fermette de 120m<sup>2</sup>: véranda, cuisine aménagée, séjour avec insert, sdb ,wc, 3 chambres, chaufferie, 2 pieces à aménager. Belle possibilités d'agrandissements. Etable, grange, hangar, diverses dépendances, puits. L'ensemble sur 4800m<sup>2</sup> de terrain. A voir absolument!

Année de construction : 0

**Détail.. de l'offre**

**Surface en M<sup>2</sup> :**  
Surface habitable : 120

<http://www.village-immobilier.com/>

un excellent site

## LUMINANCE CONTRAST COLOR GUIDELINES

In terms of color usage, luminance contrast is the most important determinant of legibility of symbols and text, so it's no surprise that luminance contrast frequently appears in color guidelines. Most of the guidelines are directed at assuring sufficient contrast, and this is certainly a first-order concern. However, care must be taken to avoid *unnecessarily* limiting the designers' freedom to intentionally reduce luminance contrast in the interests of labeling and attention management.

More about [Luminance Contrast](#).

**The minimum luminance ratio between symbols and background shall be 3:1.** Various forms of this guideline are nearly universal in guidance documents, differing mainly in the quantity required and in which statistical measure of luminance contrast is used. This is one of the most important usability issues related to color choices.



The problem it addresses is easily demonstrated. In spite of the large chromatic contrasts between the lines of text and the green background none is very legible at the point where the text and background luminances are equal. The black line has higher luminance contrast with the background and can be read (it would be even easier to read with a brighter green).

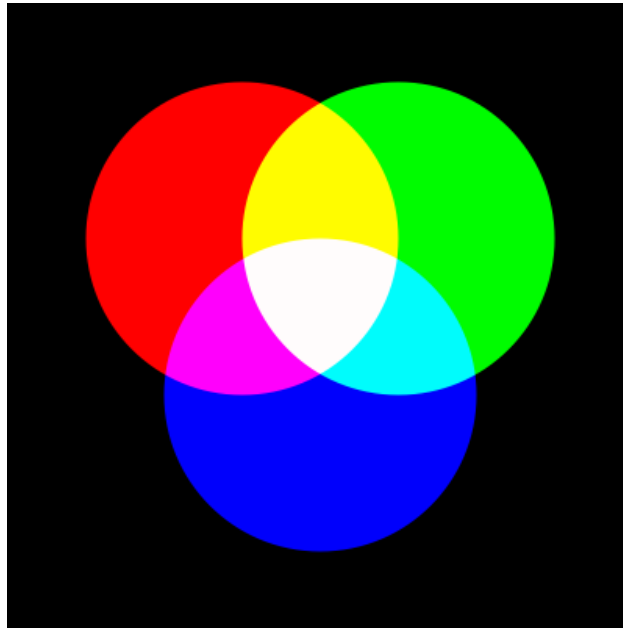
There is no question that this is an important problem, but there are a number of design issues involved that require further elaboration. When producing guidelines, caution is required to avoid such narrow wording as to interfere with good information management.



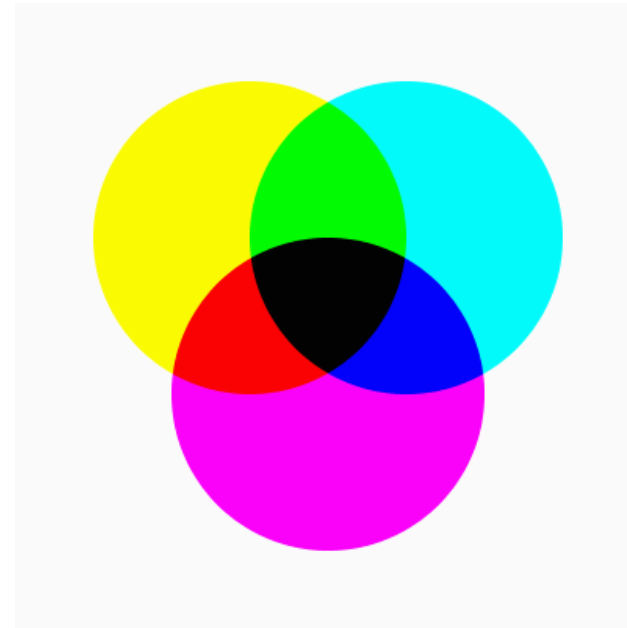
<http://colorusage.arc.nasa.gov/>

### 3. Production des couleurs

synthèse trichromatique

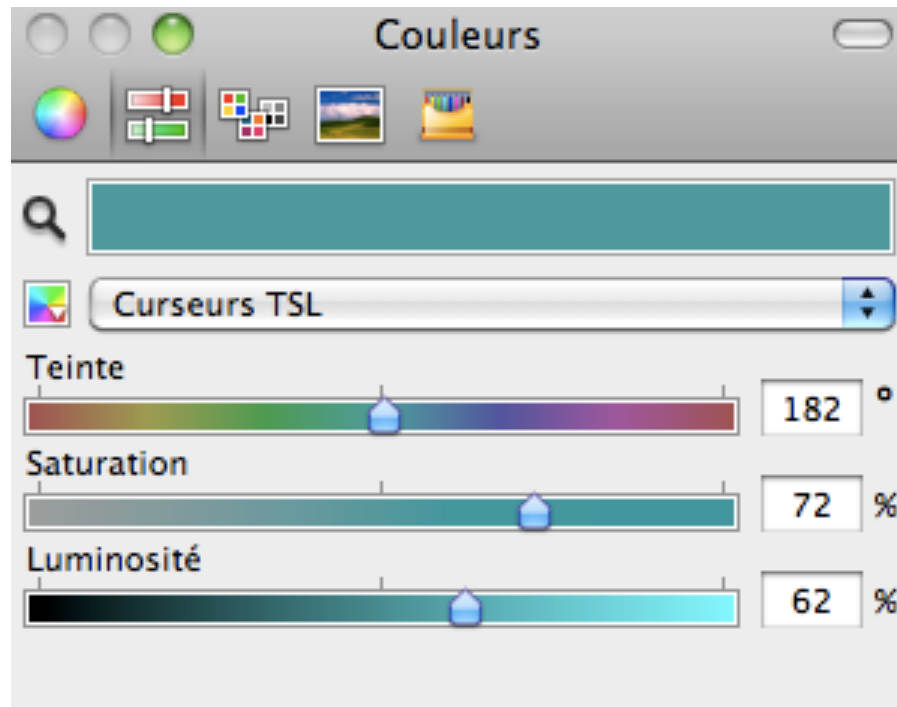


dosage additif  
(projection)



dosage soustractif  
(pigments)

# représentation TSL



Hue  
Saturation  
Value

A.R. Smith, conf. Siggraph'1978

# conversion RGB-HSV

```

procedure RGB_TO_HSV(r, g, b: real; var h, s, v: real)
  {Given: r, g, b, each in [0, 1]}
  {Desired: h in [0, 360), s and v in [0, 1], except if s = 0,
   then h = undefined which is a defined constant whose value is outside the
   interval [0, 360]}
begin
  max := MAXIMUM(r, g, b);
  min := MINIMUM(r, g, b);
  v := max;                                {value}
  if max <> 0
    then s := (max - min)/max           {saturation}
    else s := 0;
  if s = 0
    then h := undefined
    else                                     {saturation not zero, so determine hue}
      begin
        rc := (max - r)/(max - min);      {rc measures "distance" of color
                                                from red}

        gc := (max - g)/(max - min);
        bc := (max - b)/(max - min);
        if r = max then h := bc - gc    {resulting color between
                                                yellow and magenta}

        else if g = max then h := 2 + rc - bc {resulting color between cyan
                                                and yellow}

        else if b = max then h := 4 + gc - rc; {resulting color between
                                                magenta and cyan}

        h := h*60;                          {convert to degrees}
        if h < 0 then h := h + 360        {make nonnegative}
      end      {chromatic case}
    end      {RGB_TO_HSV}
end

```

```

procedure HSV_TO_RGB(var r, g, b: real; h, s, v: real);
  {Given: h in [0, 360] or undefined, s and v in [0, 1]}
  {Desired: r, g, b, each in [0, 1]}
begin
  if s = 0
    then                                     {achromatic color: there is no hue}
      if h = undefined
        then
          begin                               {this is the achromatic case}
            r := v;
            g := v;
            b := v
          end
        else ERROR                          {error if s = 0 and h has a value}
      else                                     {chromatic color: there is a hue}
        begin
          if h = 360 then h = 0;
          h := h/60;                          {h is now in [0, 6)}
          i := FLOOR(h);                     {largest integer <= h}
          f := h - i;                         {fractional part of h}
          p := v*(1 - s);
          q := v*(1 - (s*f));
          t := v*(1 - (s*(1 - f)));
          case i of
            0: (r, g, b) := (v, t, p);      {triplet assignment}
            1: (r, g, b) := (q, v, p);
            2: (r, g, b) := (p, v, t);
            3: (r, g, b) := (p, q, v);
            4: (r, g, b) := (t, p, v);
            5: (r, g, b) := (v, p, q);
          end      {case}
        end      {hue}
      end      {HSV_TO_RGB}
end

```

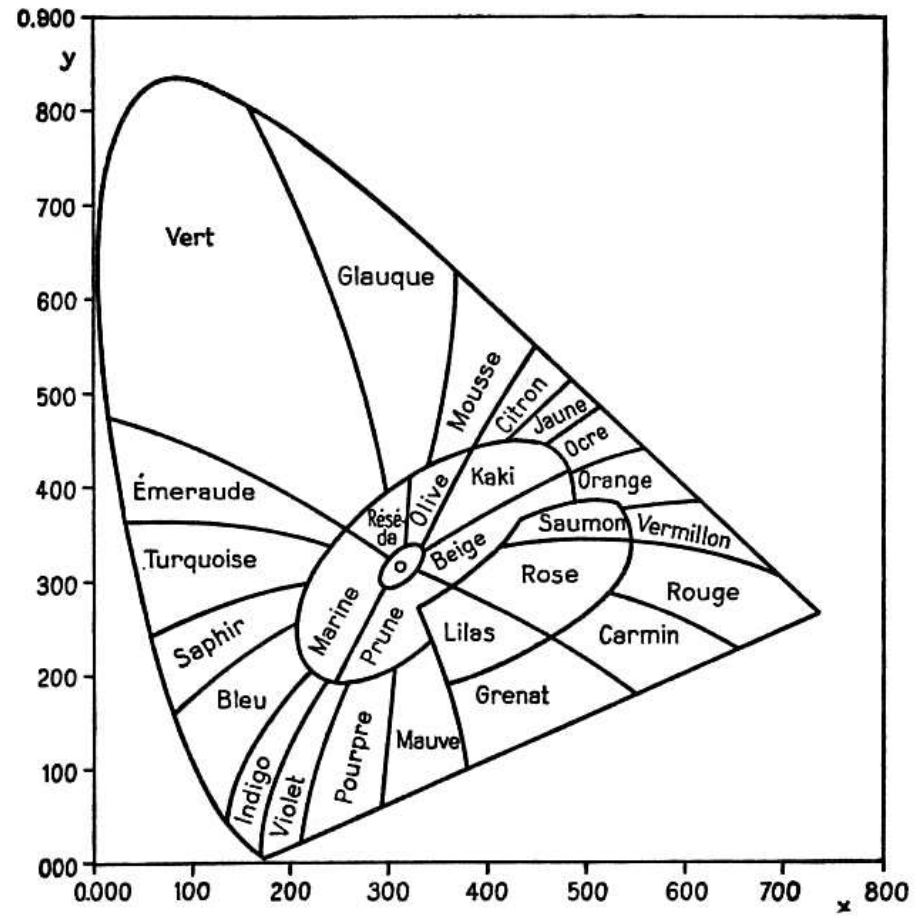
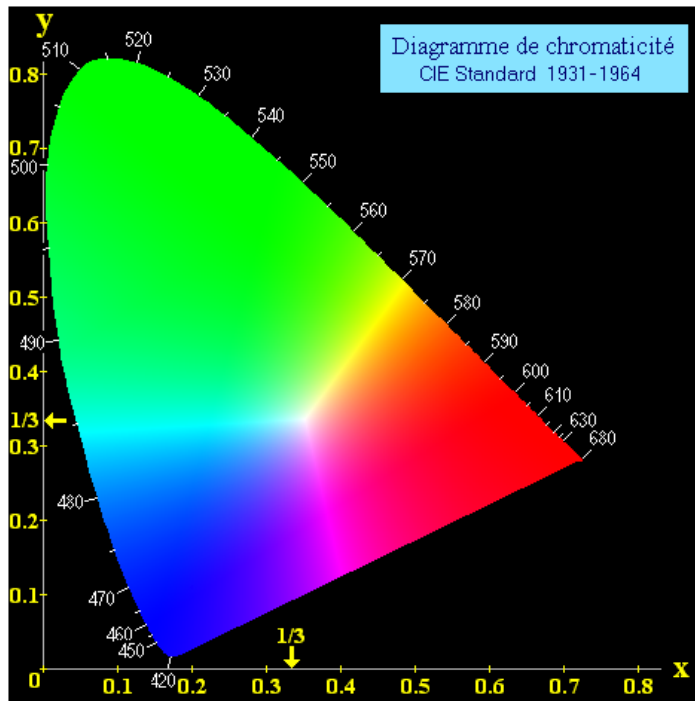
Foley, van Dam. Fundamentals  
of interactive computer graphics, 1983, p.615

TO DO : un sélecteur de couleur





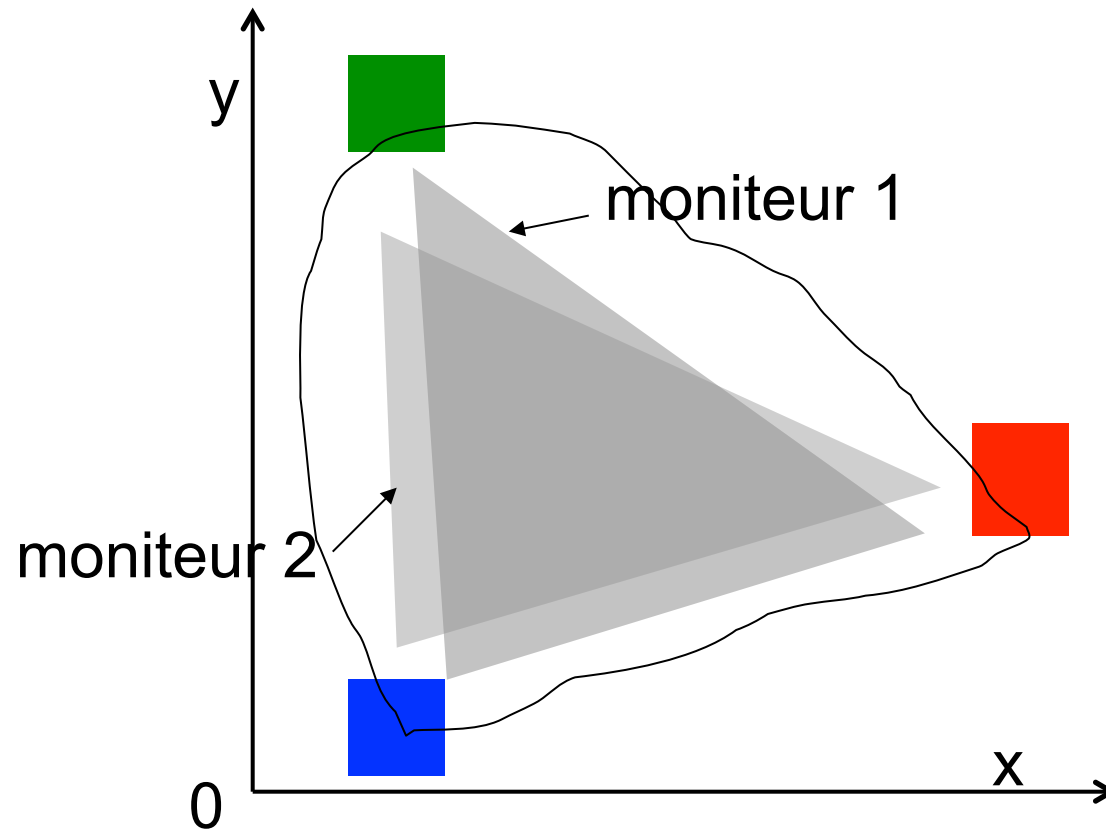
# diagramme CIE-xyz



à voir : <http://www.cie.co.at/>



# gamut d'un moniteur



+ le blanc, défini par la température corps théorique  
5000K blanc rougeâtre "chaud"  
6500K blanc standard CIE D65  
9300K blanc bleuté "froid"

Bonne appli en ligne <http://colorbrewer2.org/>

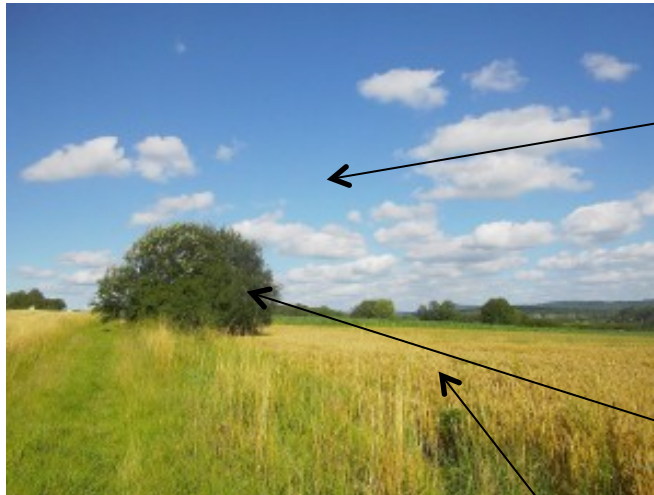
The screenshot displays the ColorBrewer 2.0 web application interface. At the top right, the logo reads "COLORBREWER 2.0" with the tagline "color advice for cartography". Below the logo are navigation links: "how to use", "updates", "downloads", and "credits".

The main interface is divided into several sections:

- Number of data classes:** A dropdown menu is set to "3".
- Nature of your data:** Three radio buttons are present: "sequential" (selected), "diverging", and "qualitative".
- Pick a color scheme:** Two columns of color swatches are shown. The left column is labeled "Multi-hue" and the right "Single hue". A "3-class OrRd" scheme is highlighted in the multi-hue column.
- Only show:** Three checkboxes are checked: "colorblind safe", "print friendly", and "photocopy safe".
- Context:** Three checkboxes are present: "roads", "cities", and "borders" (checked).
- Background:** Two radio buttons are present: "solid color" (selected) and "terrain".
- Color transparency:** A horizontal slider is located below the background options.
- 3-class OrRd legend:** A legend on the left side of the map shows three color swatches with their corresponding values: a light orange swatch for "254,232,200", a medium orange swatch for "253,187,132", and a dark red swatch for "227,74,51".
- EXPORT:** A vertical button is located to the left of the map.
- Map:** The central map shows a geographical area (Pennsylvania) with a 3-class sequential color scheme applied to its data. The colors range from light orange to dark red.

At the bottom left, the copyright notice reads: "© Cynthia Brewer, Mark Harrower and The Pennsylvania State University Support". At the bottom right, the "axismaps" logo is visible.

# Bon conseil de Tufte : choisir des couleurs de la nature



Colorimètre numérique

RVB comme valeur réelle, 16 bits

R	31268.33
V	44375.33
B	55940.33

LCD couleur

Taille du diaphragme

Colorimètre numérique

RVB comme valeur réelle, 16 bits

R	16933.44
V	18989.44
B	8966.444

LCD couleur

Taille du diaphragme

Colorimètre numérique

RVB comme valeur réelle, 16 bits

R	53770.11
V	47649.70
B	23843.88

LCD couleur

Taille du diaphragme

## 4. La lisibilité



saccades :  $\pm 25$  ms

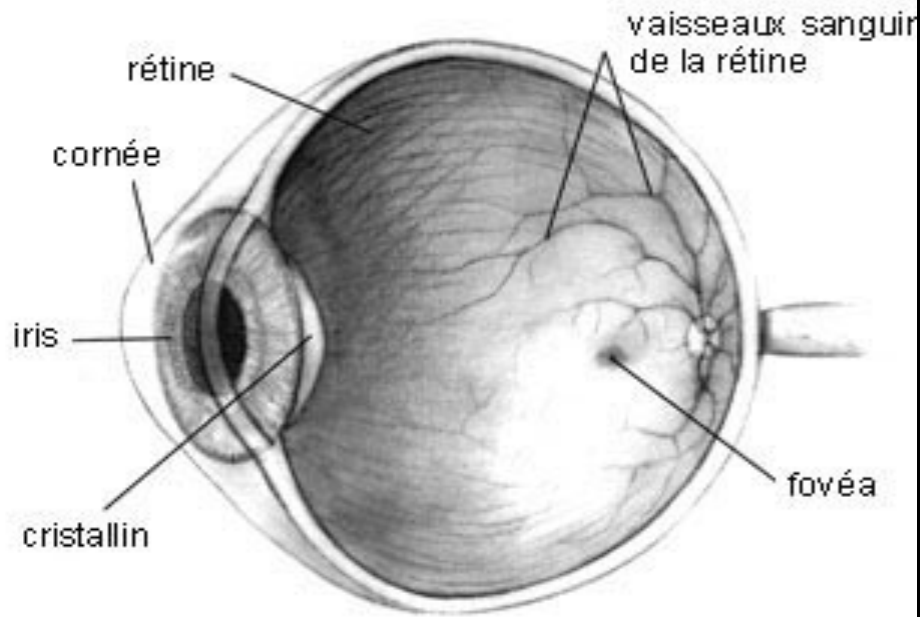
fixations :  $\pm 250$  ms

When a person is reading a sentence silently, the eye movements show that not every word is fixated. Every once in a while a regression (an eye movement that goes back in the text) is made to re-examine a word that may have not been fully understood the first time. This only happens with about 10% of the fixations, depending on how difficult the text is. The more difficult the higher the likelihood that regressions are made.

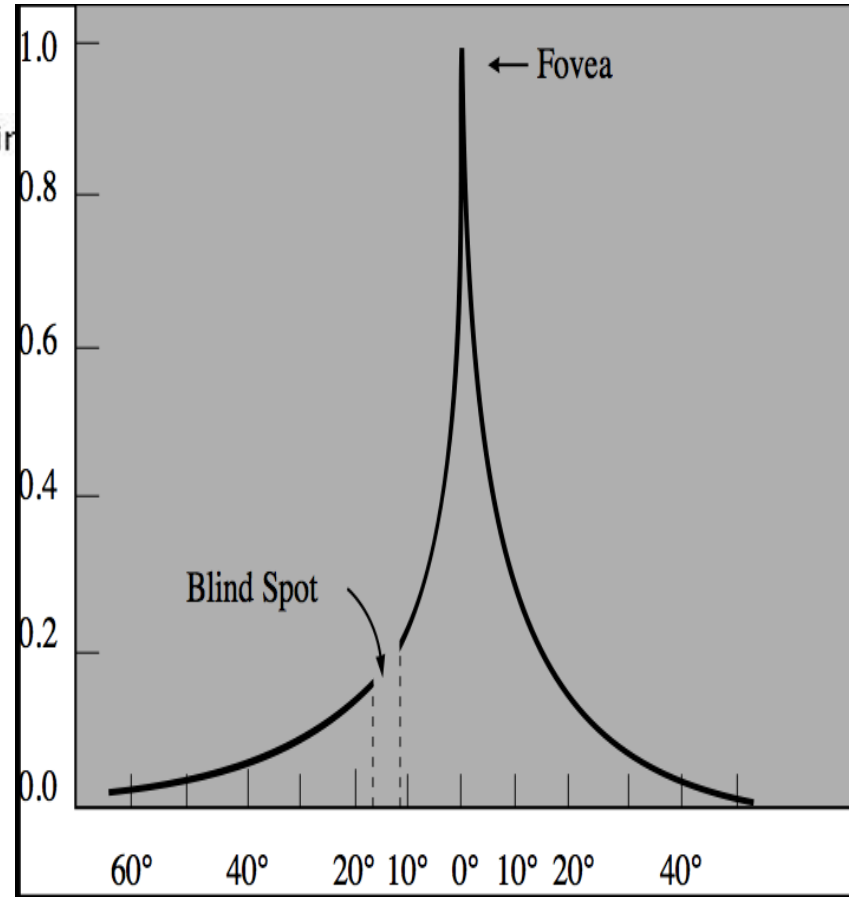


[http://www.scholarpedia.org/article/Eye\\_movements](http://www.scholarpedia.org/article/Eye_movements)

# L'oeil humain (bis)

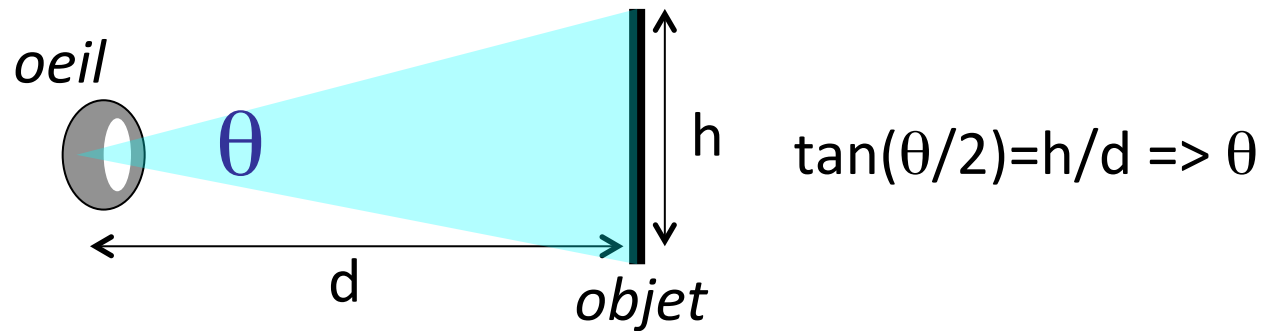


(wikipedia)



acuité / angle de vue

# Acuité



points ● ●

1 min. arc = 1' = 1/60°

traits ||||

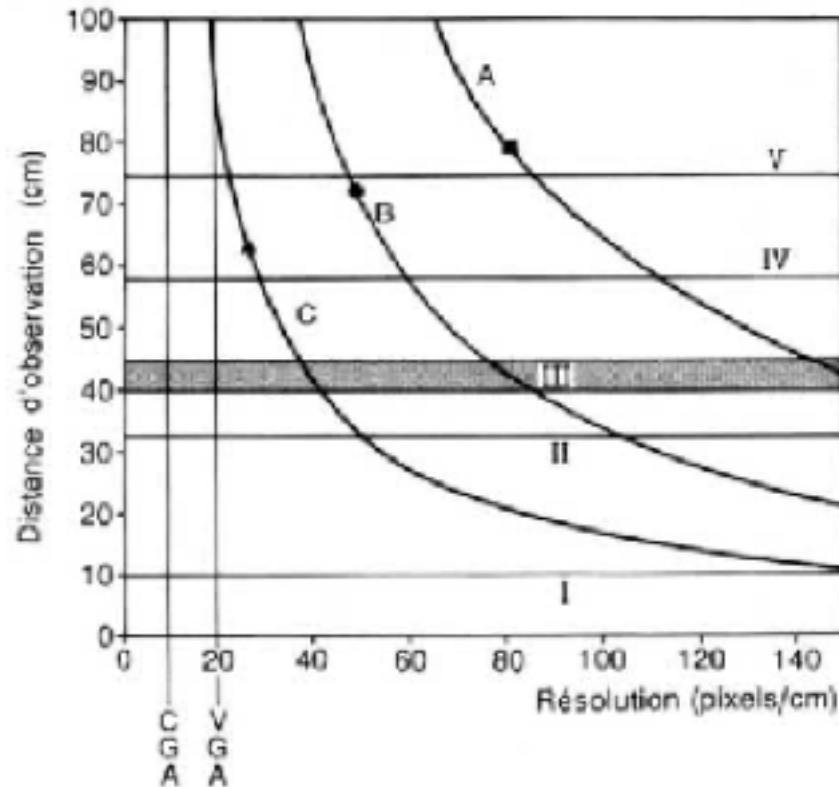
1' à 2'

lettres **LCXY**

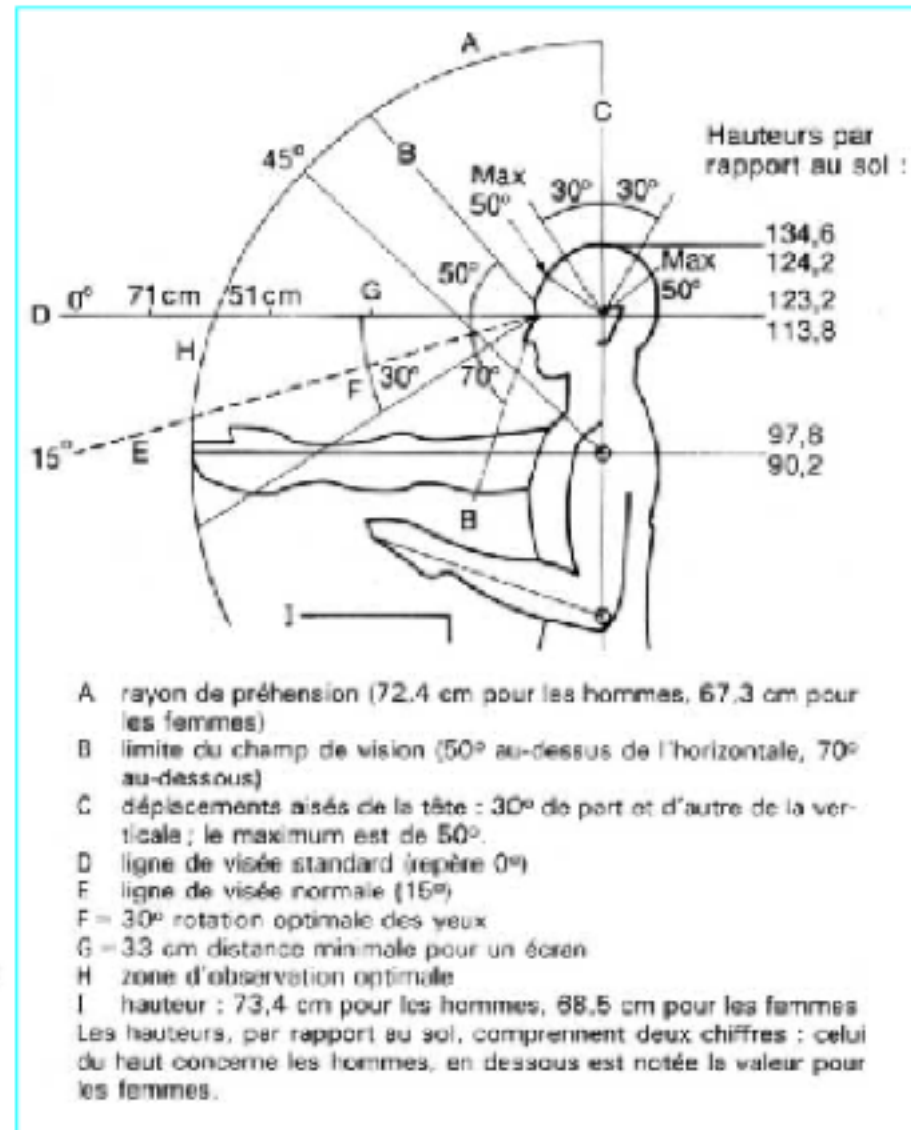
5' (20/20 si reconnu à 90%)



# Lire sur écran



- A optimum d'acuité visuelle de 1'
- B acuité visuelle de 2'
- C acuité visuelle de 4'
- I distance minimale d'accommodation pour un enfant de 10 ans
- II distance de lecture minimale pour un adulte
- III (en grisé) distance d'observation recommandée
- IV longueur moyenne des bras
- V longueur maximale des bras
- CGA color graphic adapter
- VGA video graphic adapter





# Loi de Fitt

Le temps d'acquisition T d'une cible est prop. au log2 du ratio distance D sur taille W de la cible

$$T = a + b \cdot \log_2(1 + D/W)$$

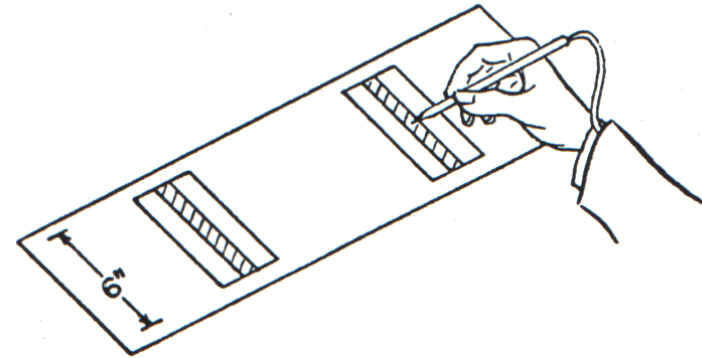
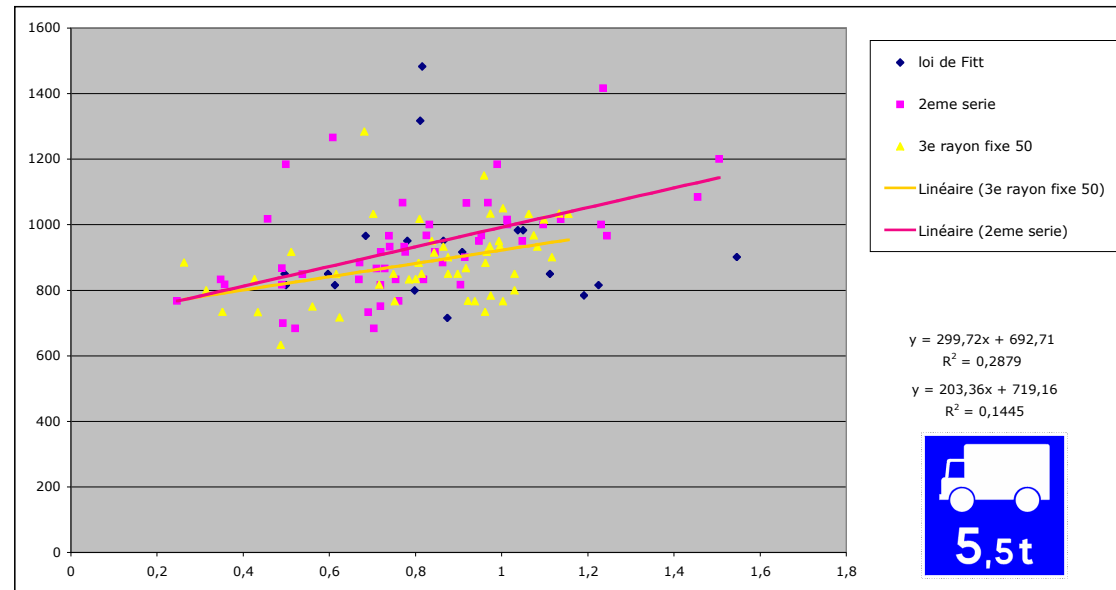
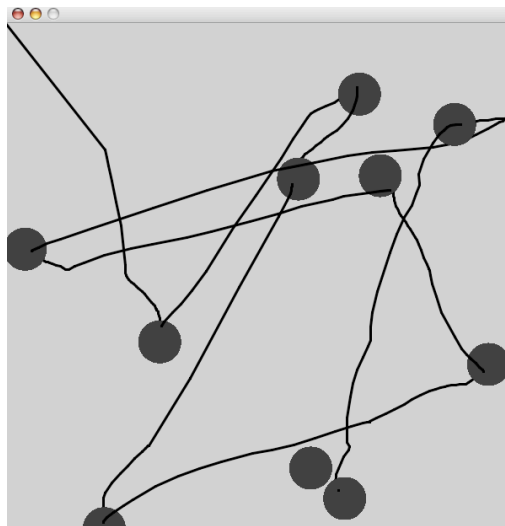


FIG. 1. Reciprocal tapping apparatus. The task was to hit the center plate in each group alternately without touching either side (error) plate.



```
int NBEXPE = 10;
PrintWriter output;
float expe,expx,expy,expr,expdate,oexpx,oexpy,dist2,duree,distance;
```

```
void setup() {
  size(600, 600);
  smooth();
  output = createWriter("resultats"+int(random(0,999))+".txt");
  output.println("num ; duree ; distance ; taille");
  expe = 0; oexpx = 0; oexpy = 0;
  nouvelleExperience();
  background(200);
  strokeWeight(3);
}
```

```
void draw() {
  stroke(255);fill(100);ellipse(expx,expy,expr,expr);
  stroke(0);line(pmouseX,pmouseY,mouseX,mouseY);
}
```

```
void mouseReleased() {
  float dist2 = (mouseX-expx)*(mouseX-expx)+(mouseY-expy)*(mouseY-expy);
  if (dist2 > expr*expr) return;
  // sinon la cible est atteinte
  duree = millis() - expdate;
  distance = sqrt((mouseX-oexpx)*(mouseX-oexpx)+(mouseY-oexpy)*(mouseY-oexpy));
```

```
  output.println(expe+" ; "+duree+" ; "+distance+" ; "+expr);
  println(expe+" ; "+duree+" ; "+distance+" ; "+expr);
```

```
  oexpx = expx; oexpy = expy;
  if (expe < NBEXPE) nouvelleExperience();
  else {
    output.flush();
    output.close();
    exit();
  }
}
```

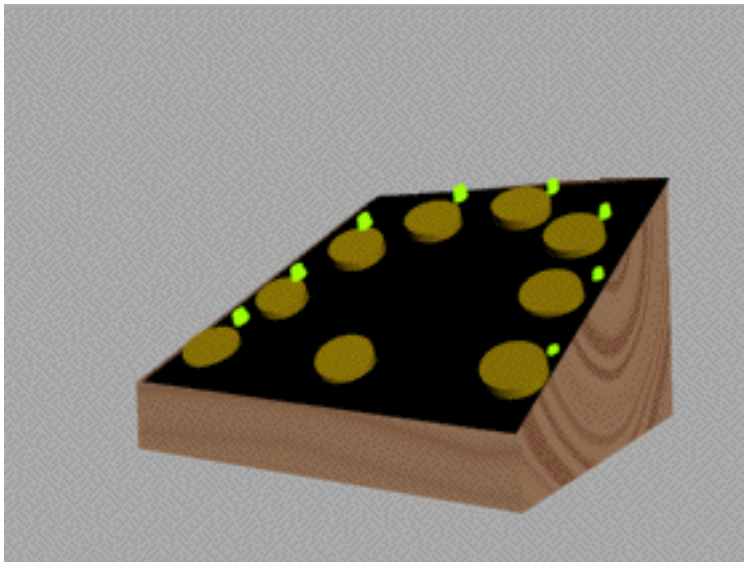
```
void nouvelleExperience(){
  expe++;
  expx = random(0,width);
  expy = random(0,height);
  expr = int(random(10,100)); //50
  expdate = millis();
}
```

# Loi de Hick (et Hyman) 1952-3

Étant donné n choix équiprobables, le temps moyen de réaction T est proportionnel au log du nombre de choix

$$T = b * \log_2(n+1)$$

## Boite de Jensen



[https://upload.wikimedia.org/wikipedia/commons/d/d6/Jensen\\_box.gif](https://upload.wikimedia.org/wikipedia/commons/d/d6/Jensen_box.gif)

## Ex : choix dans un menu

Fichier	Édition	Présentation	Histori
Nouvelle fenêtre			⌘N
Nouvelle fenêtre privée			⇧⌘N
Nouvel onglet			⌘T
Ouvrir un fichier...			⌘O
Ouvrir une adresse...			⌘L
<hr/>			
Fermer			⇧⌘W
Fermer toutes les fenêtres			⇧⇧⌘W
Fermer l'onglet			
Enregistrer sous...			⇧⌘S
<hr/>			
Partager			▶
Exporter au format PDF...			
Ouvrir dans Dashboard...			
<hr/>			
Importer depuis			▶
Exporter les signets...			
<hr/>			
Imprimer...			⌘P