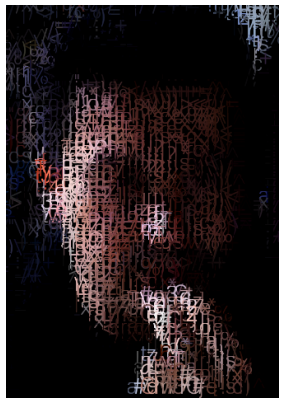
CNAM - dept. Informatique - DUT1 – USAL24

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

016543876297649387527896436906321987449075335644726889 56

combien de 2 ?

0165438762 9764

9387527 8964369

0632 1987449075

3356447 2688956

combien de 2 ?

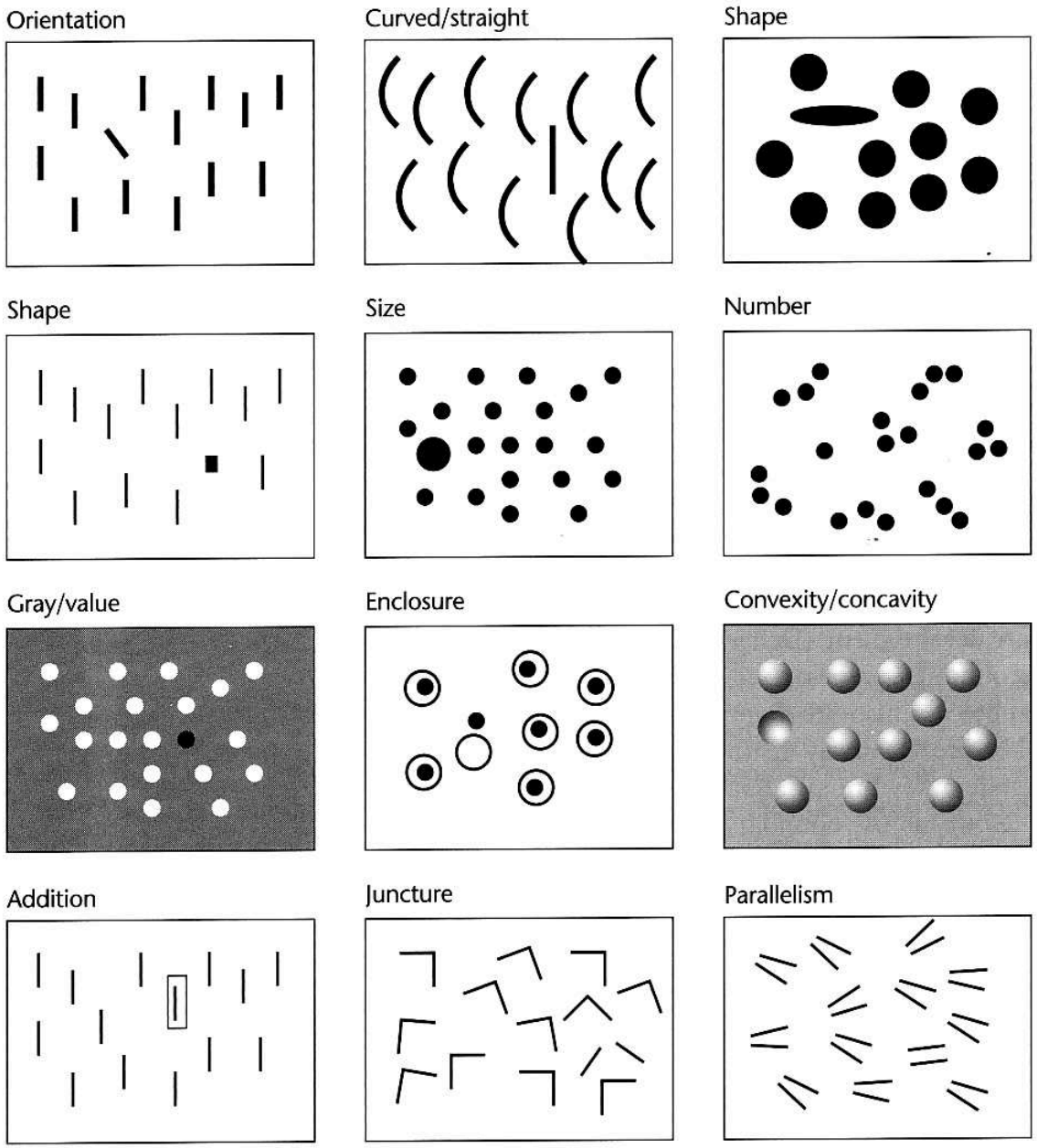
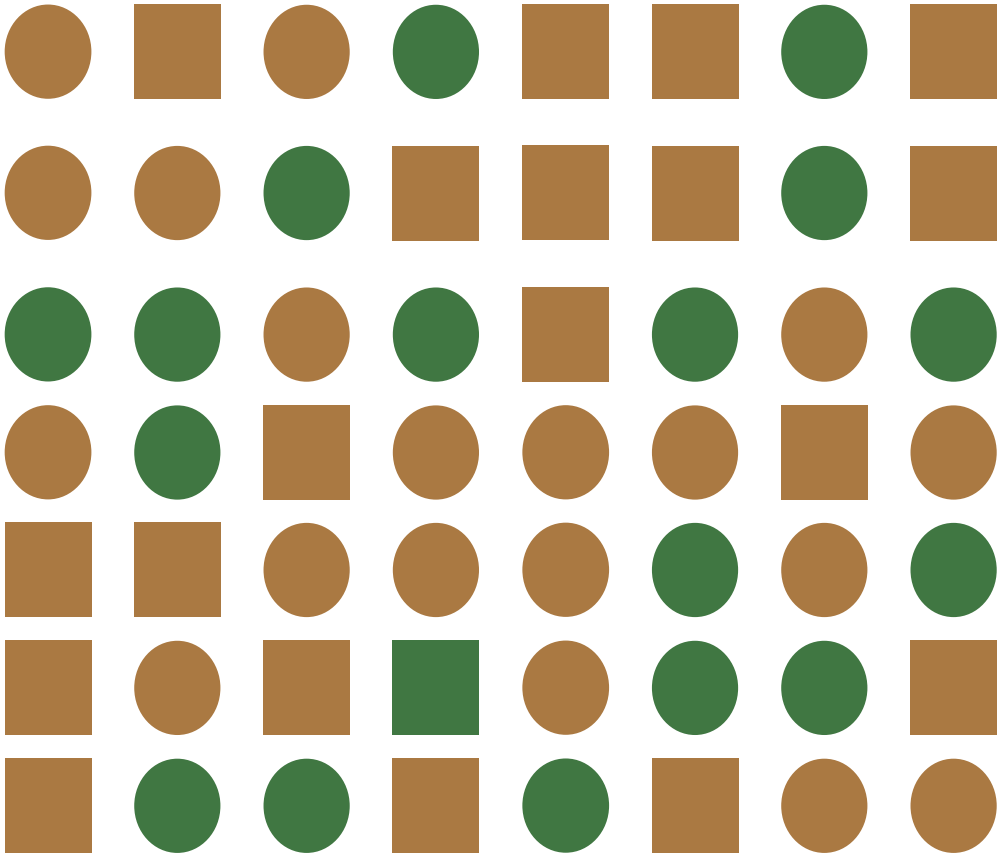
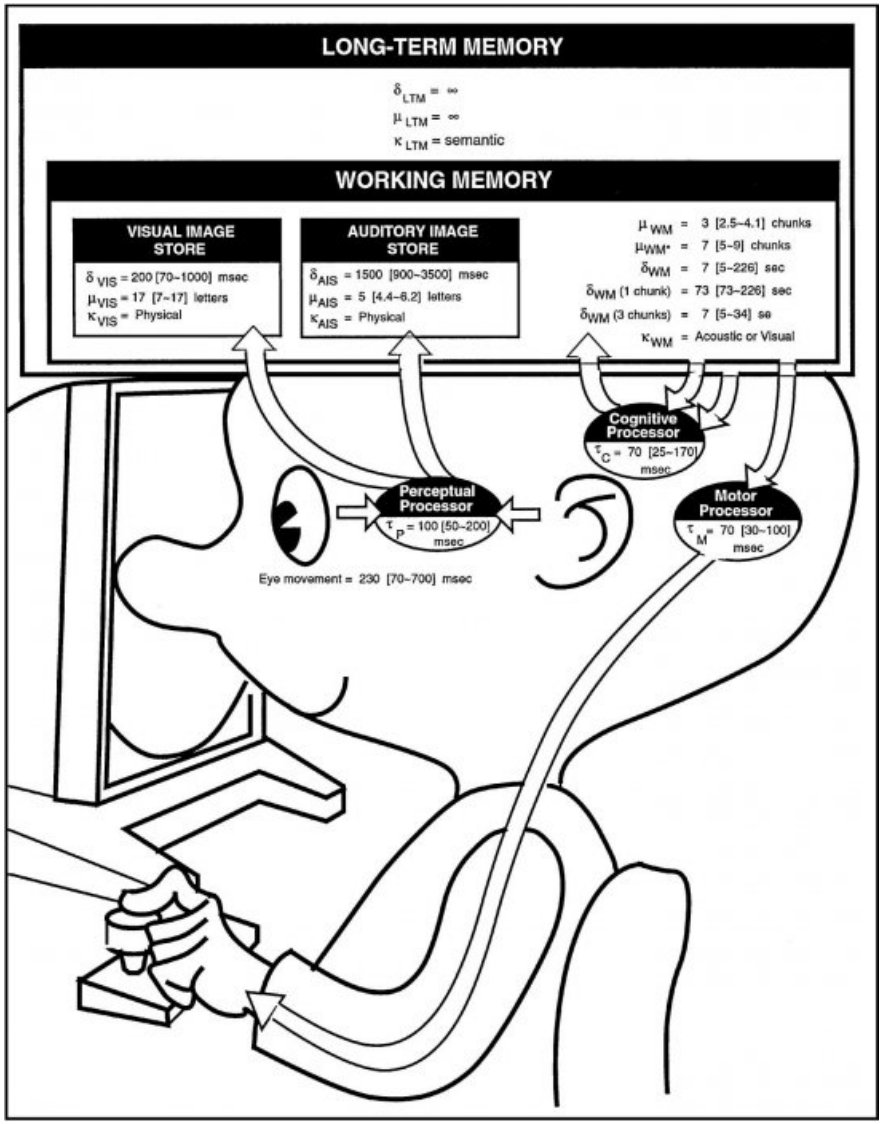


Figure 5.5 Most of the differences shown are preattentively distinguished. Only juncture and parallelism are not.

[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

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

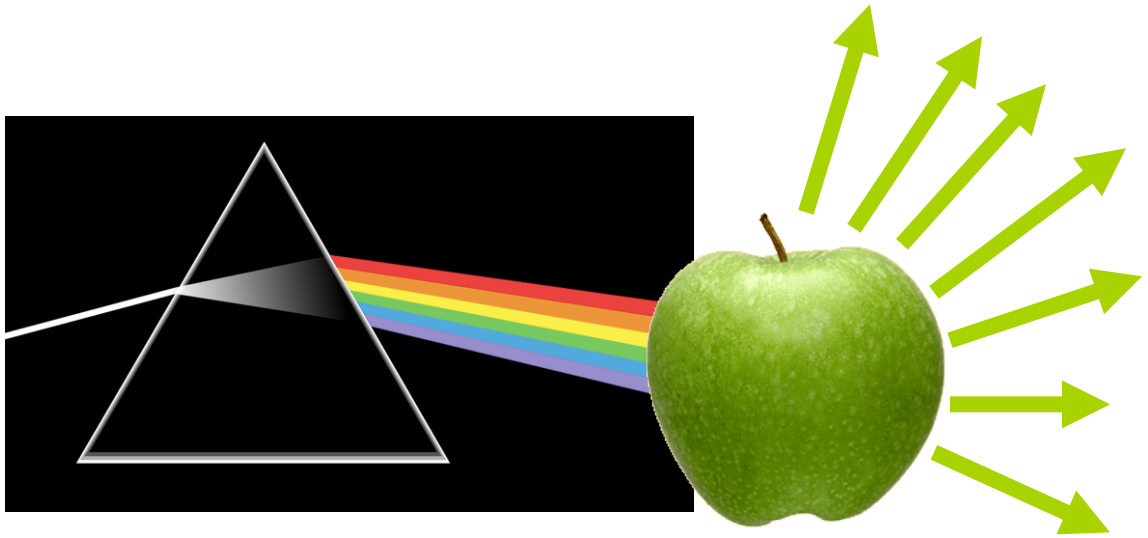
George A. Miller
Harvard University

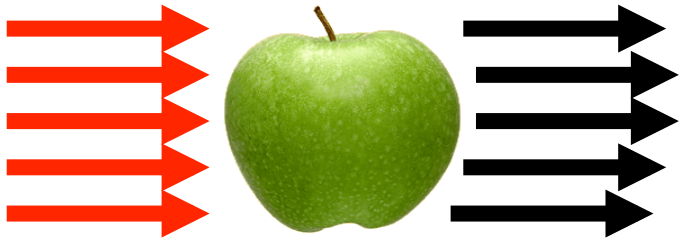
This paper was first read as an Invited Address before the Eastern Psychological Association in Philadelphia on April 15, 1955. Preparation of the paper was supported by the Harvard Psycho-Acoustic Laboratory under Contract N5ori-76 between Harvard University and the Office of Naval Research, U.S. Navy (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

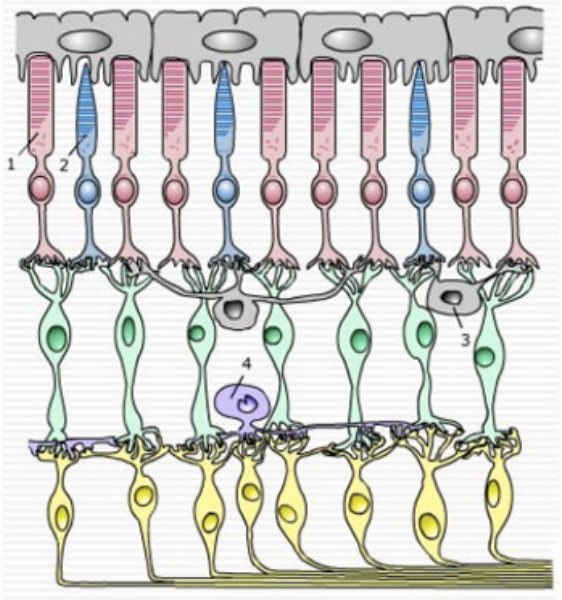
2. Perception des couleur

rappels de physique : l’interaction matière-lumière

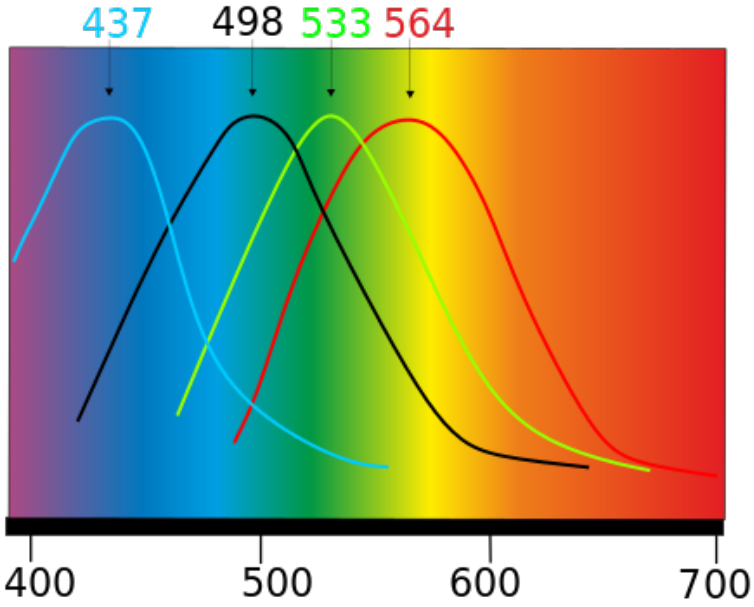




l'oeil



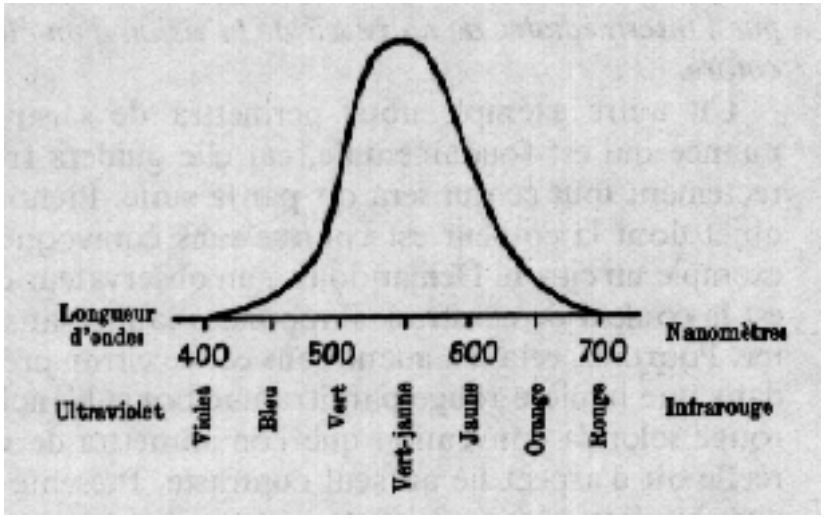
http://acces.ens-lyon.fr

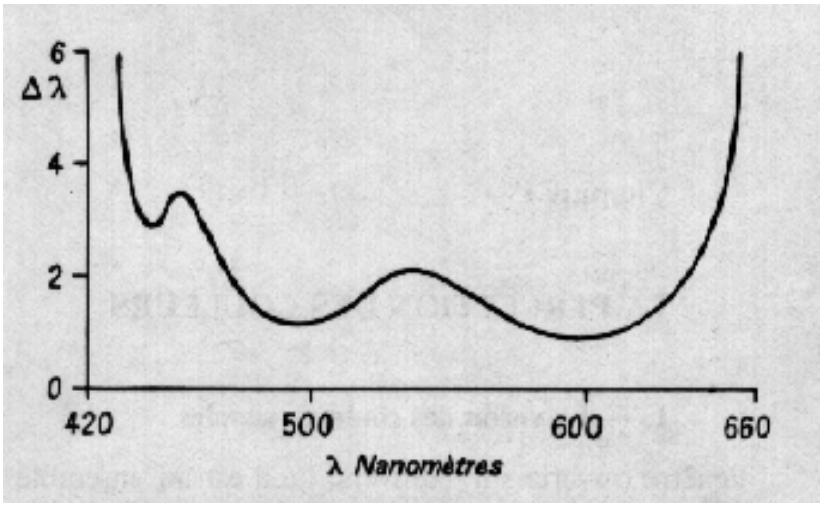


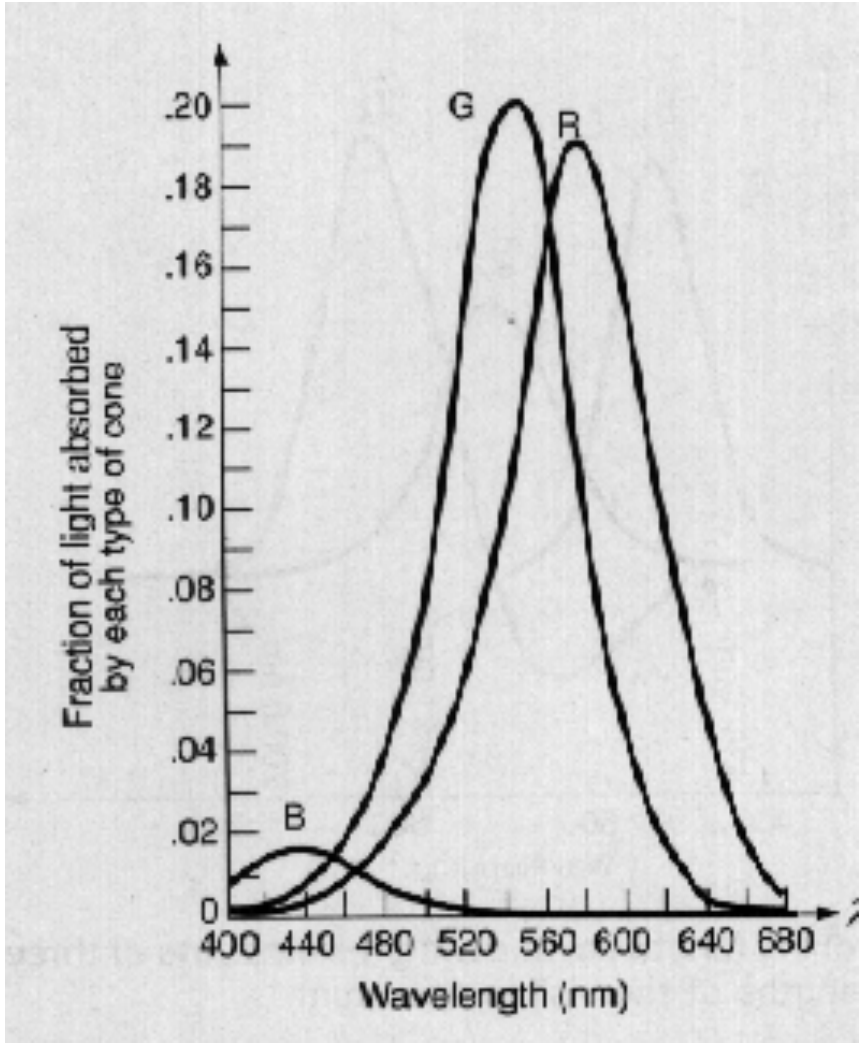
wikipedia (en noir : bâtonnets)

7M cônes, 120M bâtonnets

Inégale sensibilité des cônes





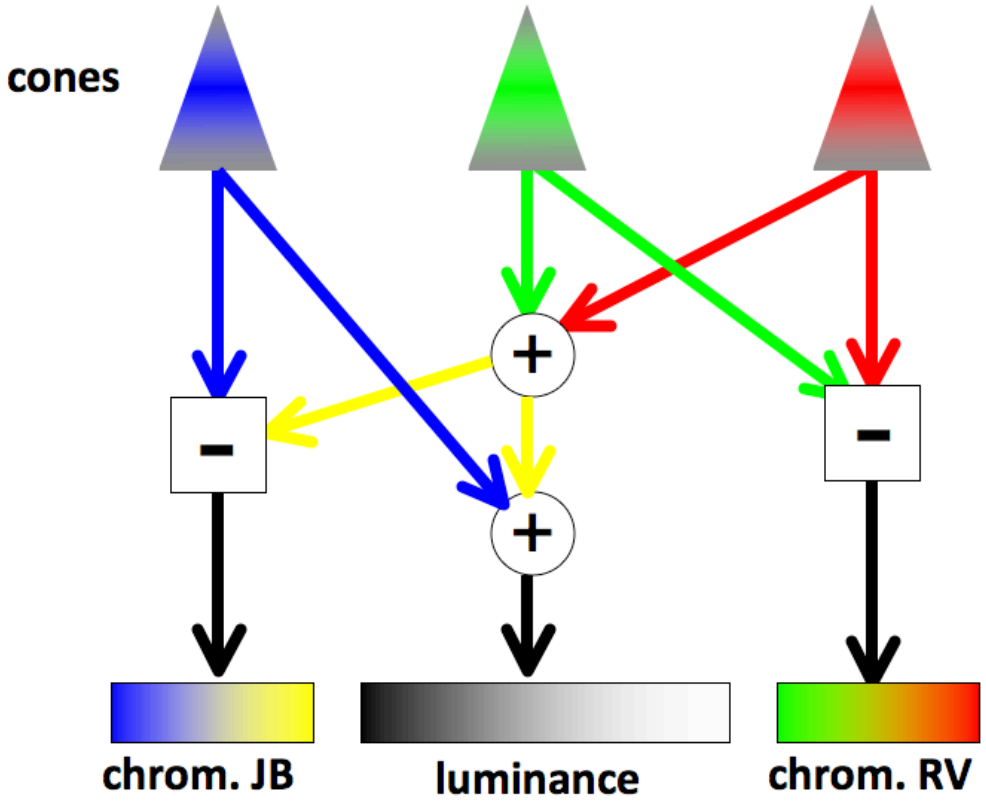


8% des hommes et 1% des femmes ont une forme de daltonisme

Normal vision *Deuteran* *Protan*

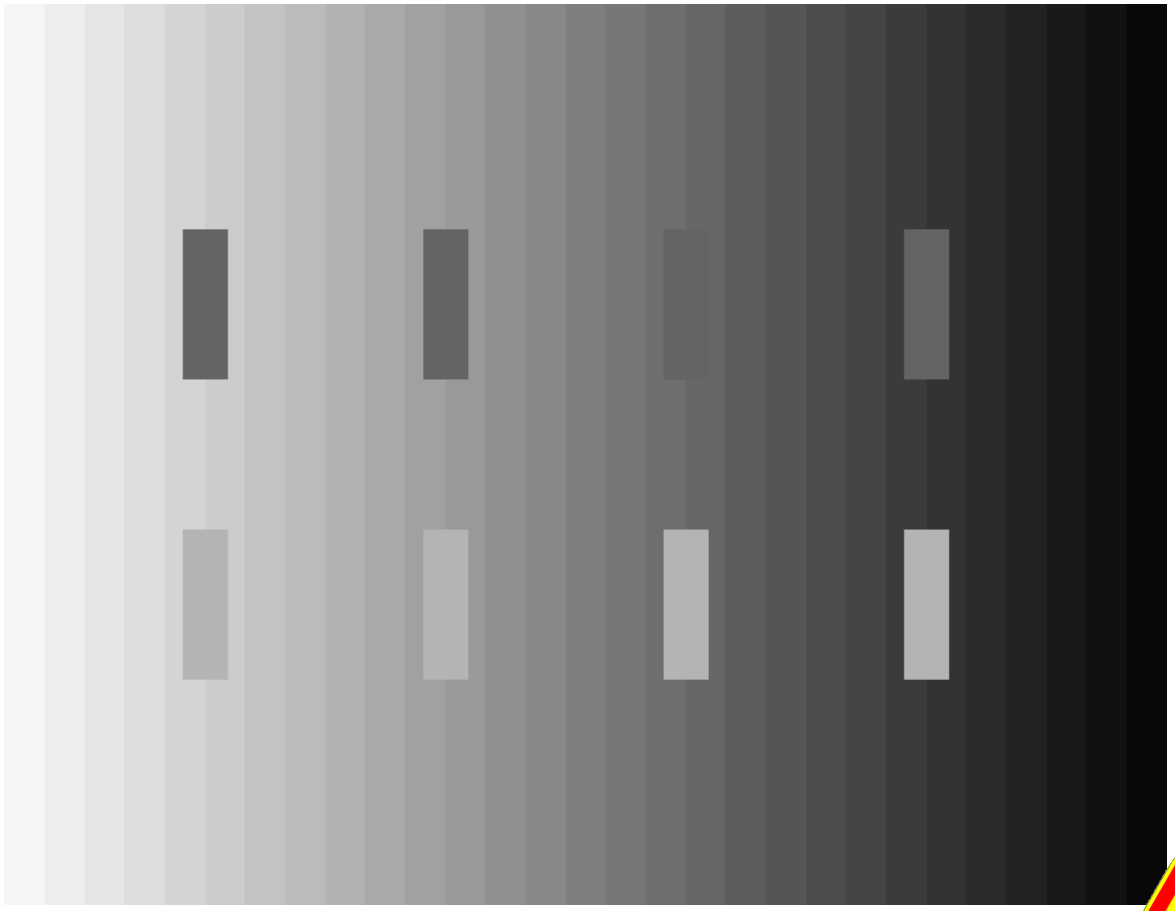
http://wearecolorblind.com

le modèle des couleurs opposées



(CIE LAB, YUV ...)

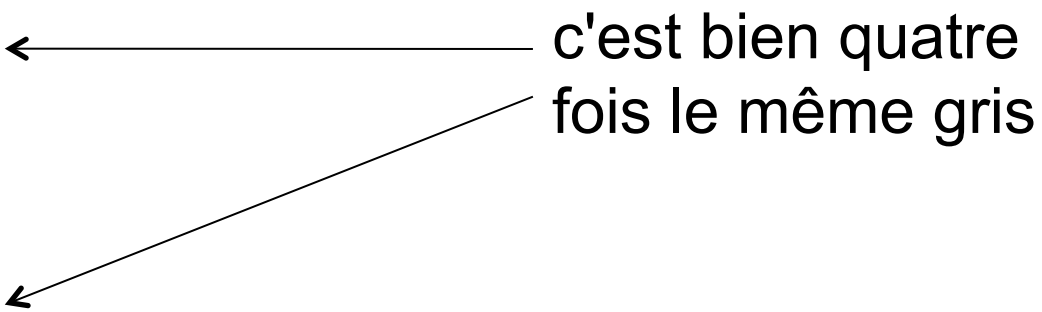
Perception des contrastes



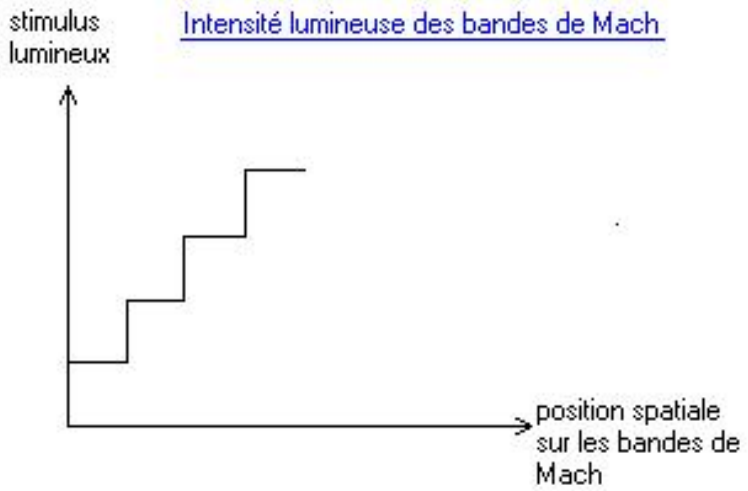
d'après [Ware]

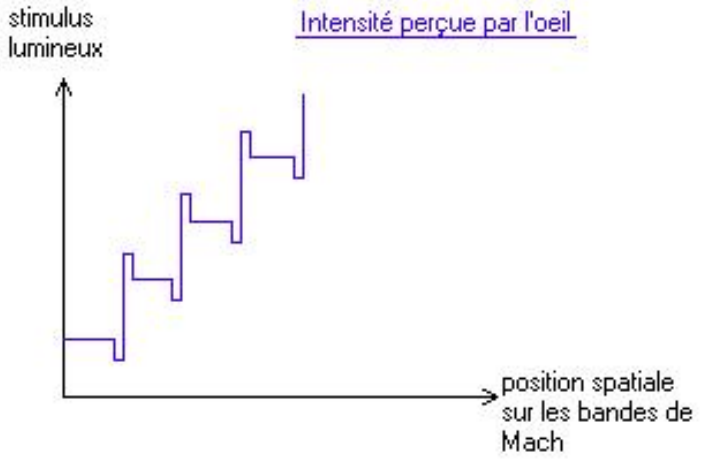
code Processing pour produire l'image

```
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");
```



Bandes de Mach





http://tecfa.unige.ch/tecfa/teaching/UVLibre/9900/bin26/mach.htm

Ecrans illisibles

http://asprise.com

Un autre

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

un excellent site

Color Usage Research Lab
NASA AMES RESEARCH CENTER

Using Color in Information Display Graphics
Design Methods, Color Science, and Color Guidelines

Design Process | Color Graphics Topics | Color Tool | Color Guidelines | Aerospace | Color Science | Utilities | Site Map

Home > Color Guidelines > Luminance Contrast Color Guidelines

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.

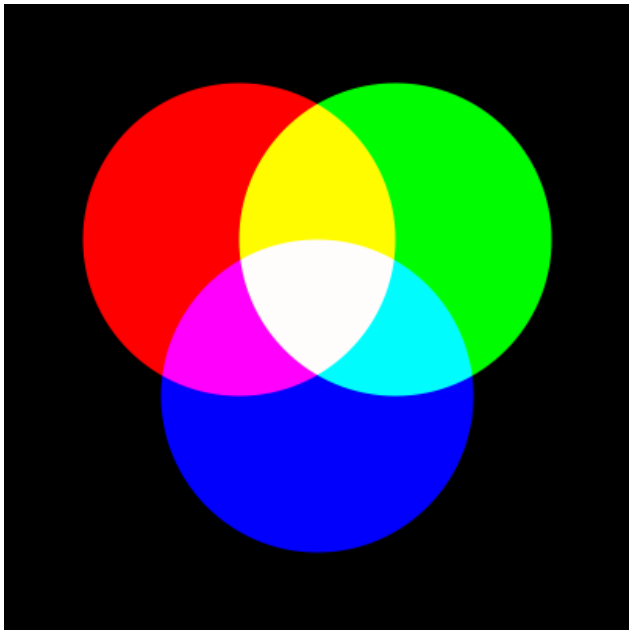
The problem it addresses is easily demonstrated. In spite of the large chromatic contrasts between the lines of text and the green background none is very legible at the point where the text and background luminances are equal. The black line has higher luminance contrast with the background and can 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.

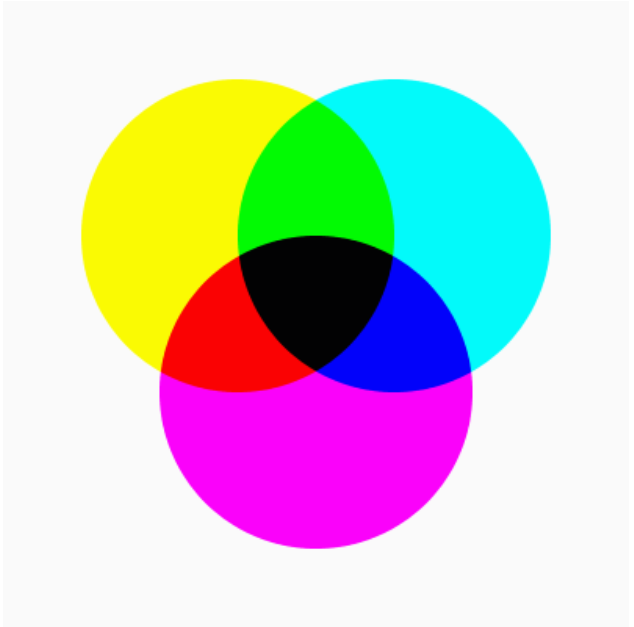
http://colorusage.arc.nasa.gov/

3. Production des couleurs

synthèse trichromatique

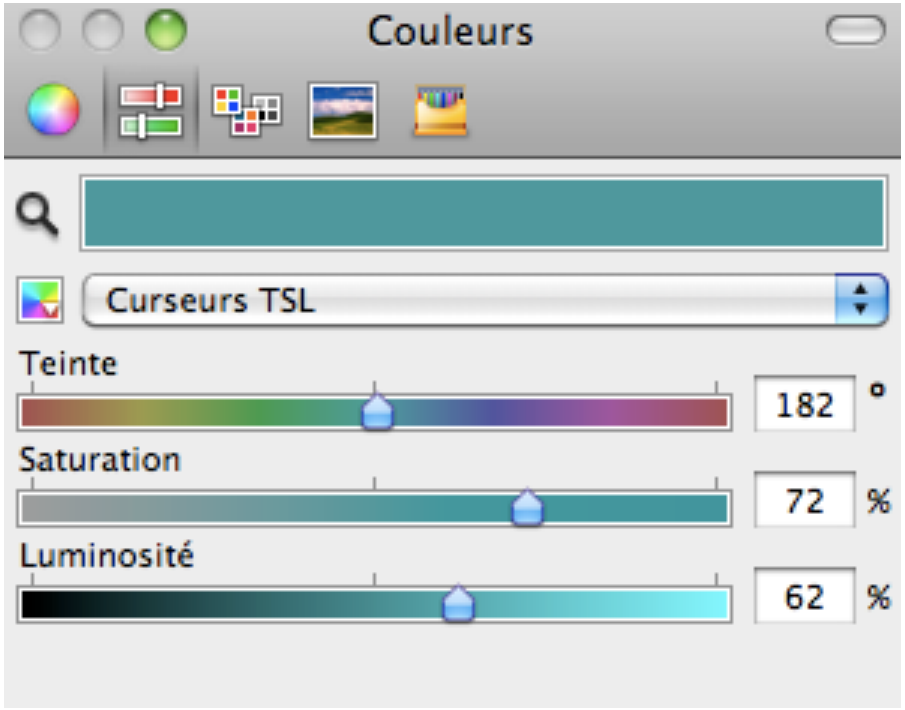


dosage additif
(projection)



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}
```

```
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}
```

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

TO DO : un sélecteur de couleur

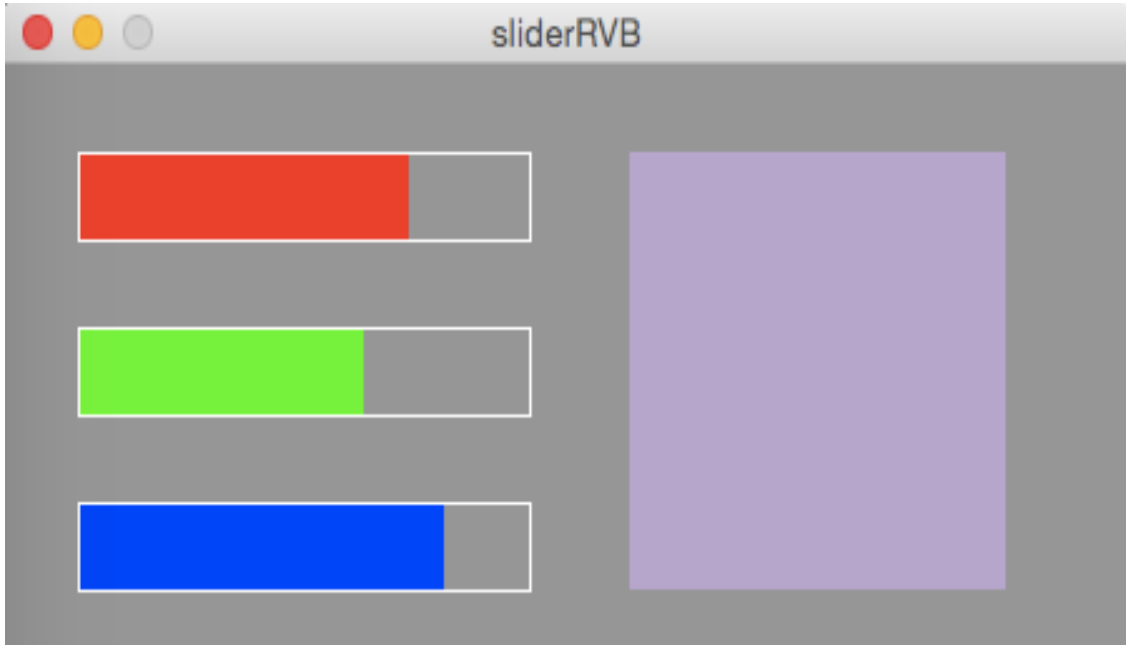
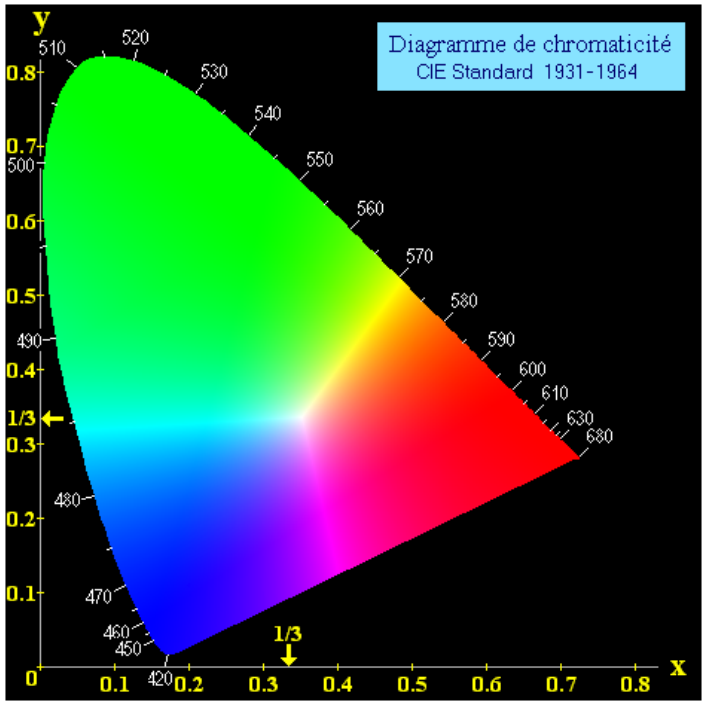
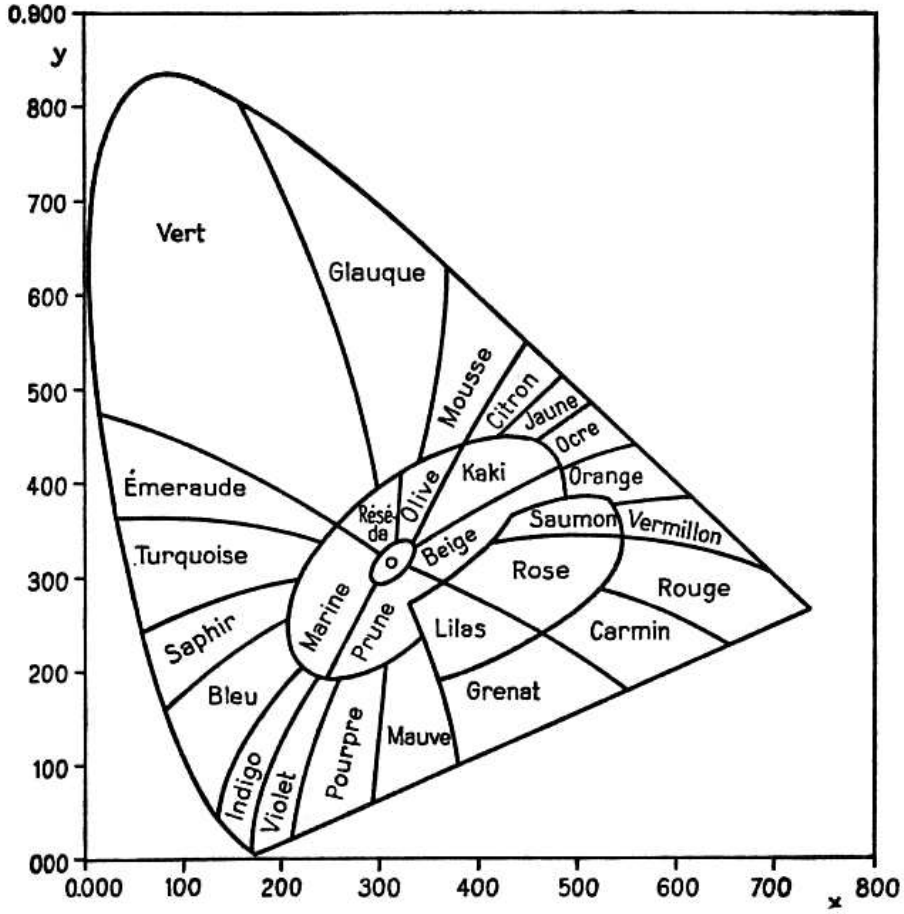


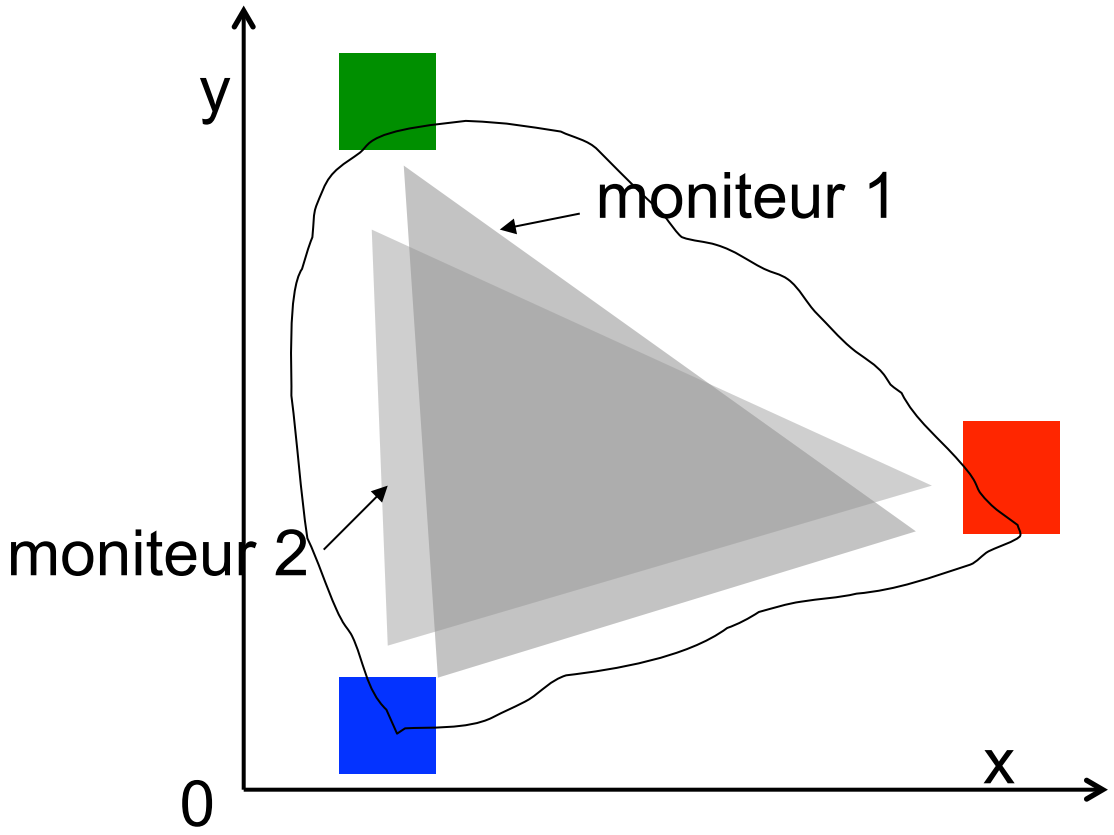
diagramme CIE-xyz





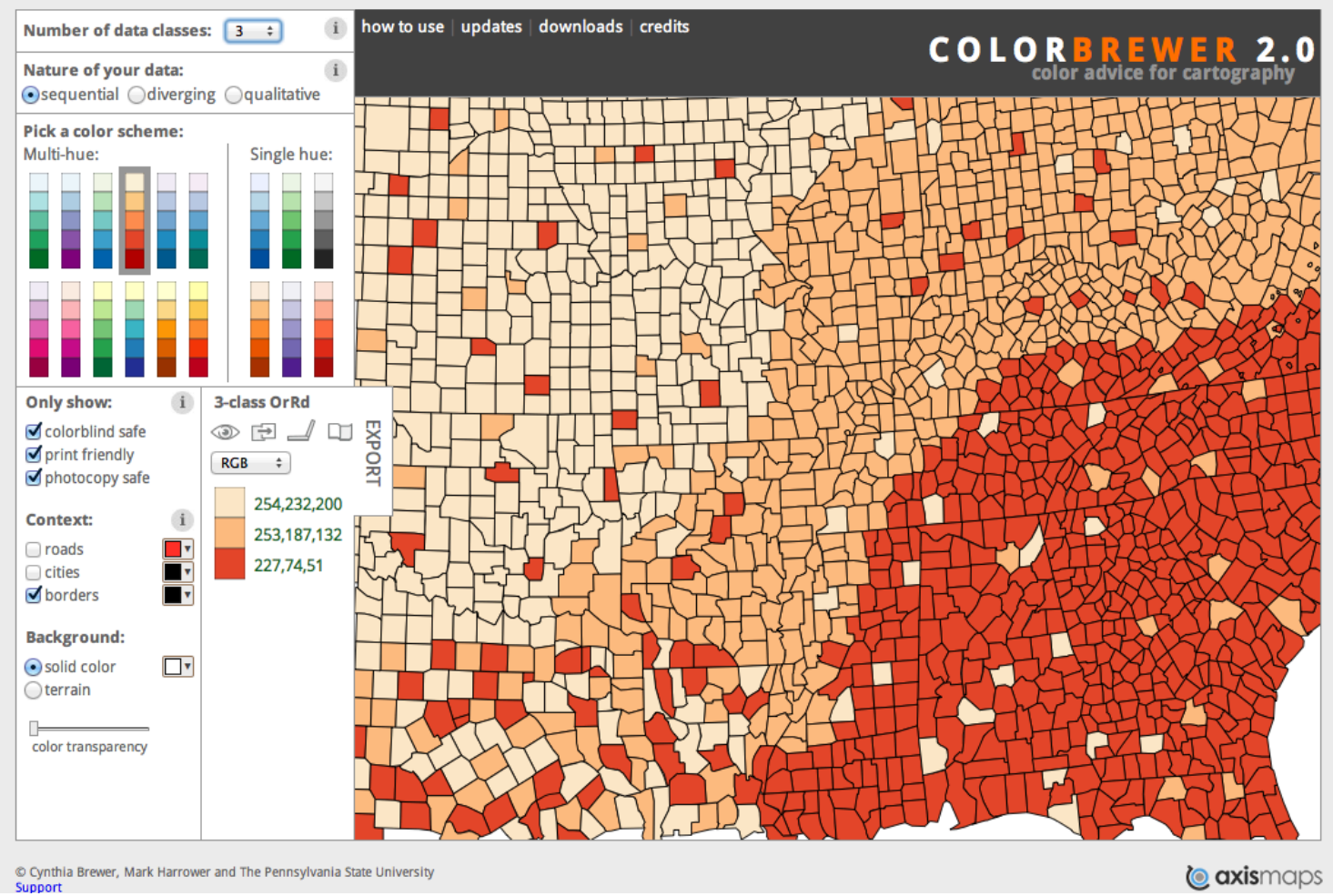
à voir : http://www.cie.co.at/

gamut d'un moniteur

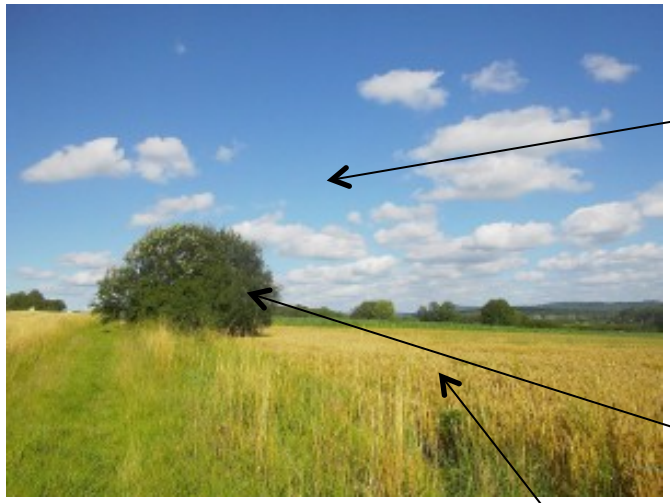


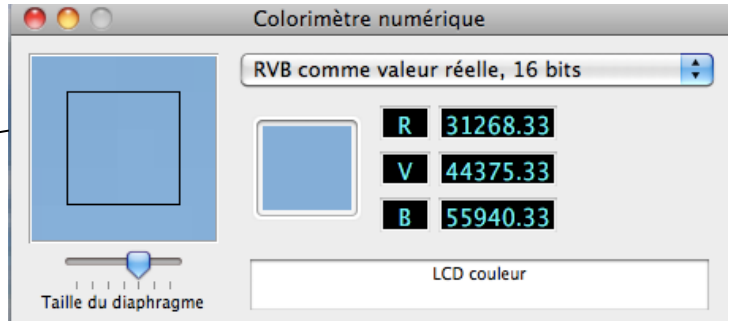
+ le blanc, défini par la température corps théorique
5000K blanc rougeâtre "chaud"
6500K blanc standard CIE D65
9300K blanc bleuté "froid"

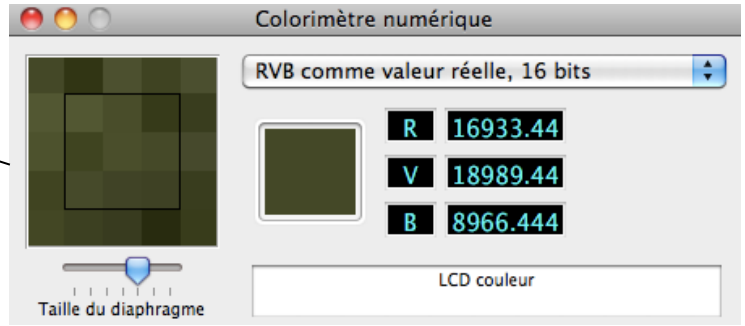
Bonne appli en ligne http://colorbrewer2.org/

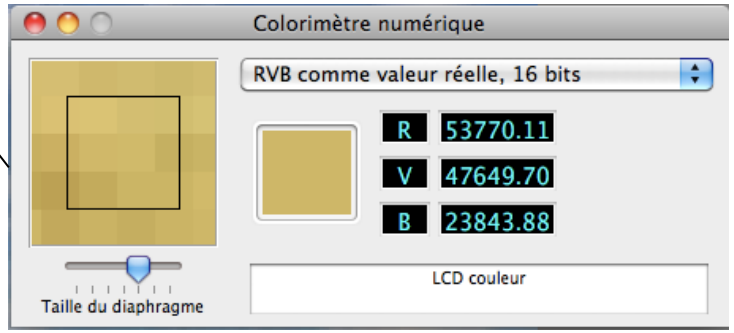


Bon conseil de Tufte : choisir des couleurs de la nature









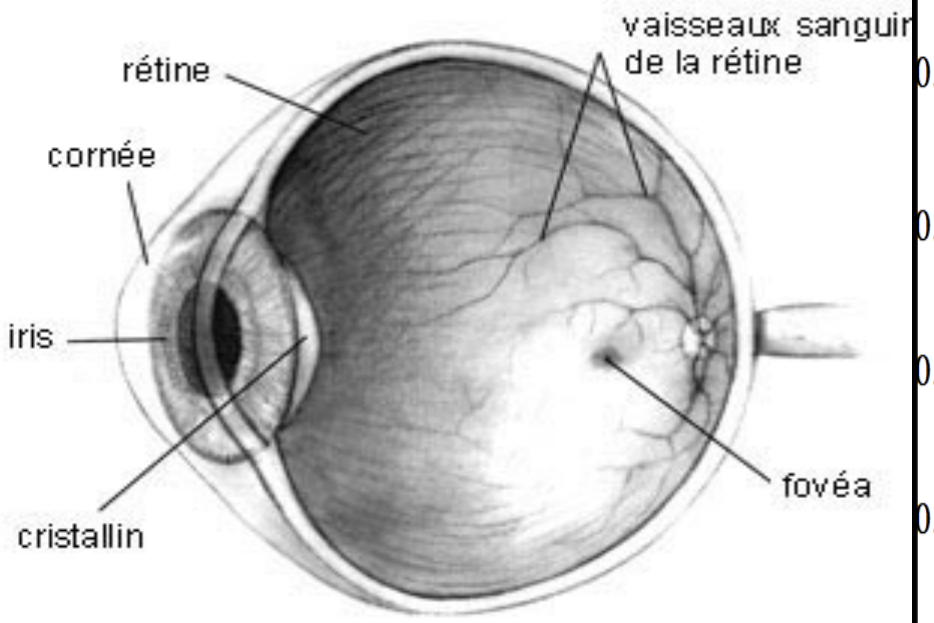
4. La lisibilité

saccades : ± 25 ms
fixations : ± 250 ms

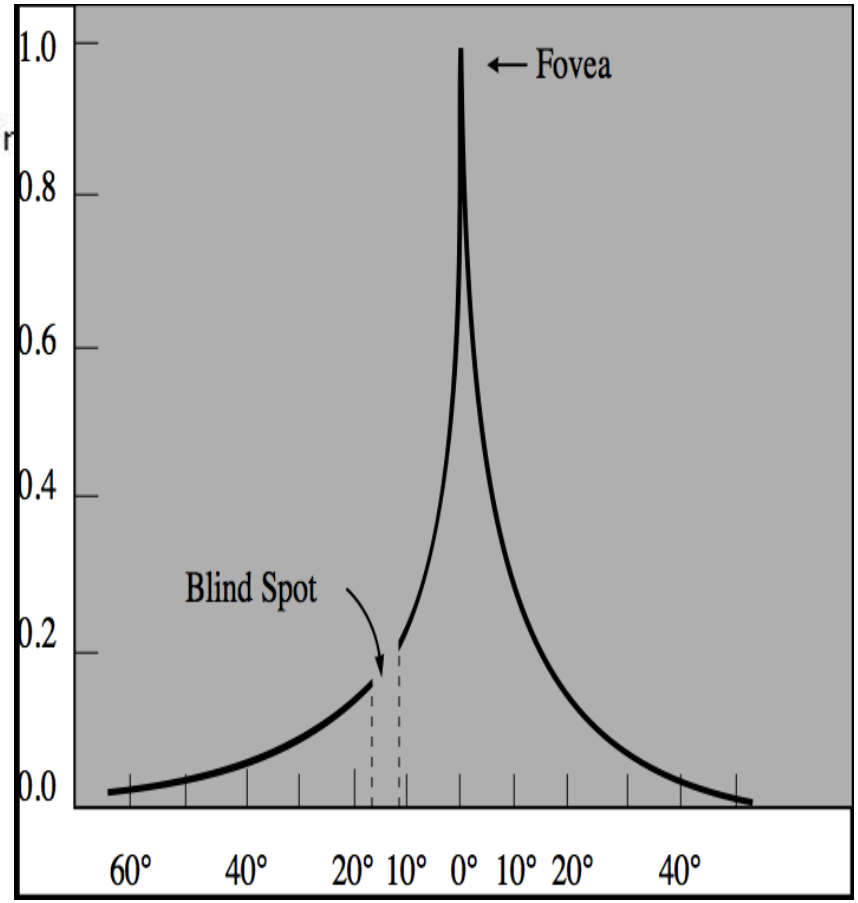
When a person is reading a sentence silently, the eye movements show that not every word is fixated. Every once in a while a regression (an eye movement that goes back in the text) is made to re-examine a word that may have not been fully understood the first time. This only happens with about 10% of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

L'oeil humain (bis)

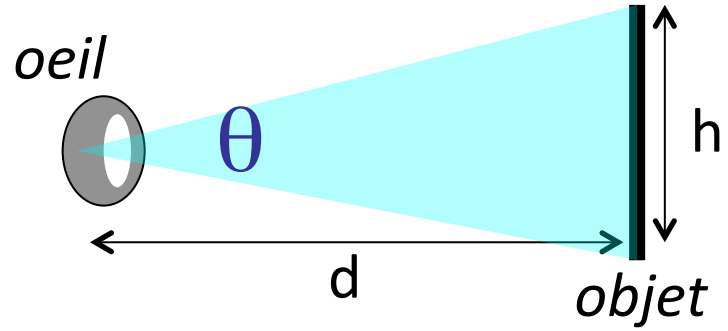


(wikipedia)



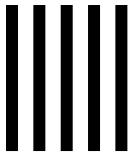
acuité / angle de vue

Acuité



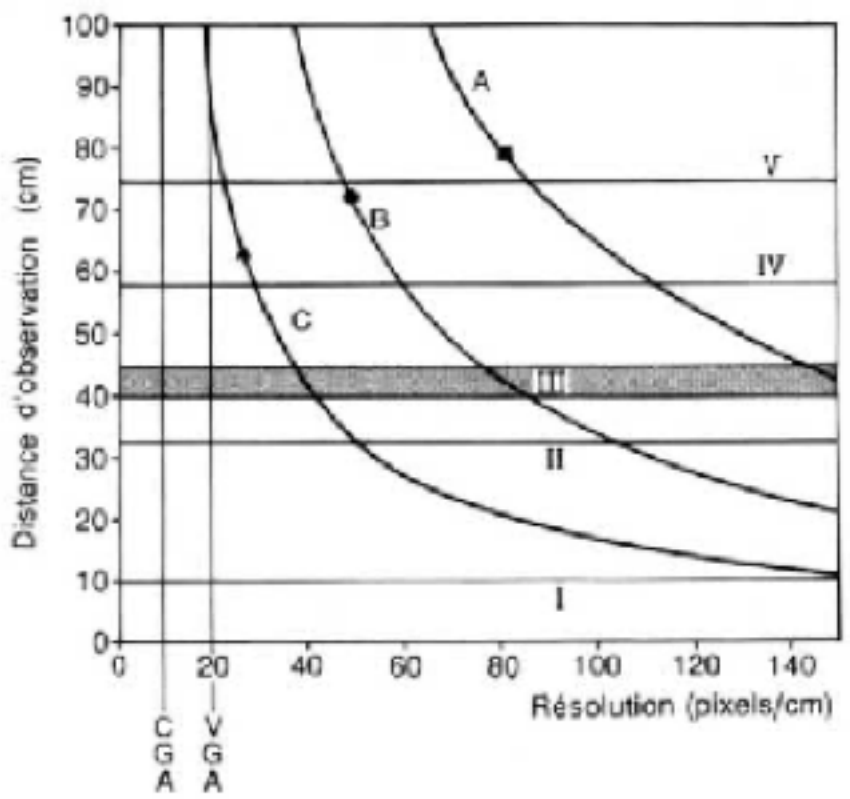
$\tan(\theta/2)=h/d \Rightarrow \theta$

points  1 min. arc = 1' = 1/60°

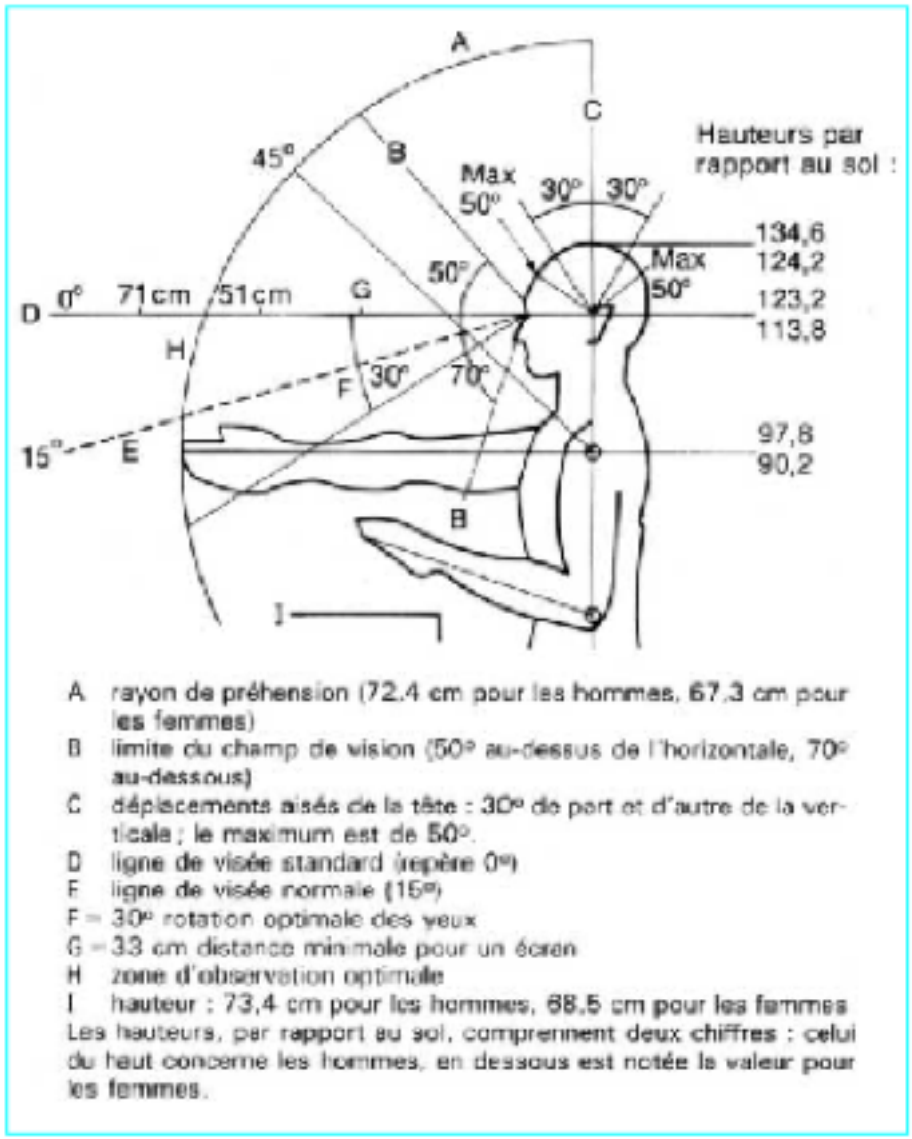
traits  1' à 2'

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*



A rayon de préhension (72,4 cm pour les hommes, 67,3 cm pour les femmes)
B limite du champ de vision (50° au-dessus de l'horizontale, 70° au-dessous)
C déplacements aisés de la tête : 30° de part et d'autre de la verticale ; le maximum est de 50°.
D ligne de visée standard (repère 0°)
F ligne de visée normale (15°)
F = 30° rotation optimale des yeux
G = 33 cm distance minimale pour un écran
H zone d'observation optimale
I hauteur : 73,4 cm pour les hommes, 68,5 cm pour les femmes
Les hauteurs, par rapport au sol, comprennent deux chiffres : celui du haut concerne les hommes, en dessous est notée la valeur pour les femmes.

Alain COUSIN. *Restitution des images - Notions de base sur les écrans*. Techniques de l'ingénieur E5650

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

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

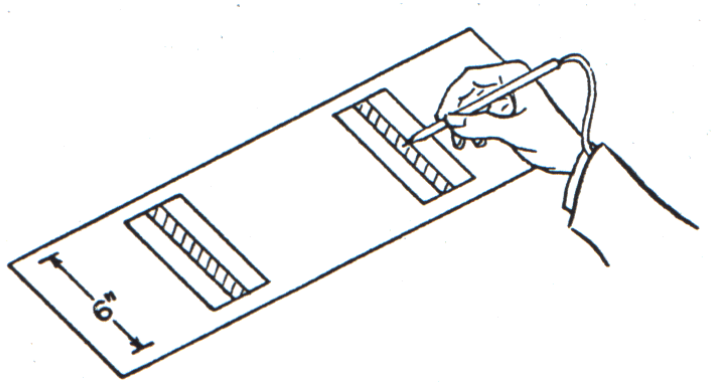
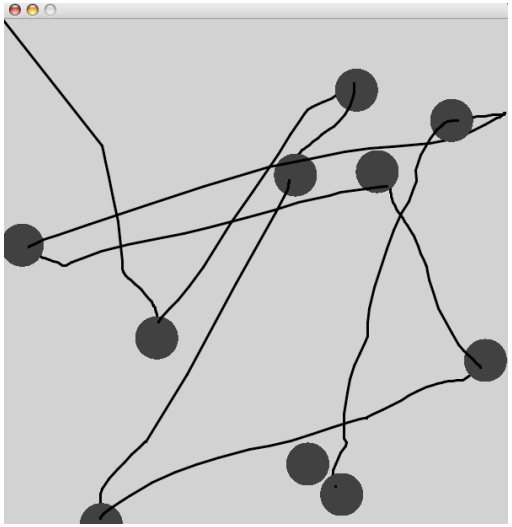
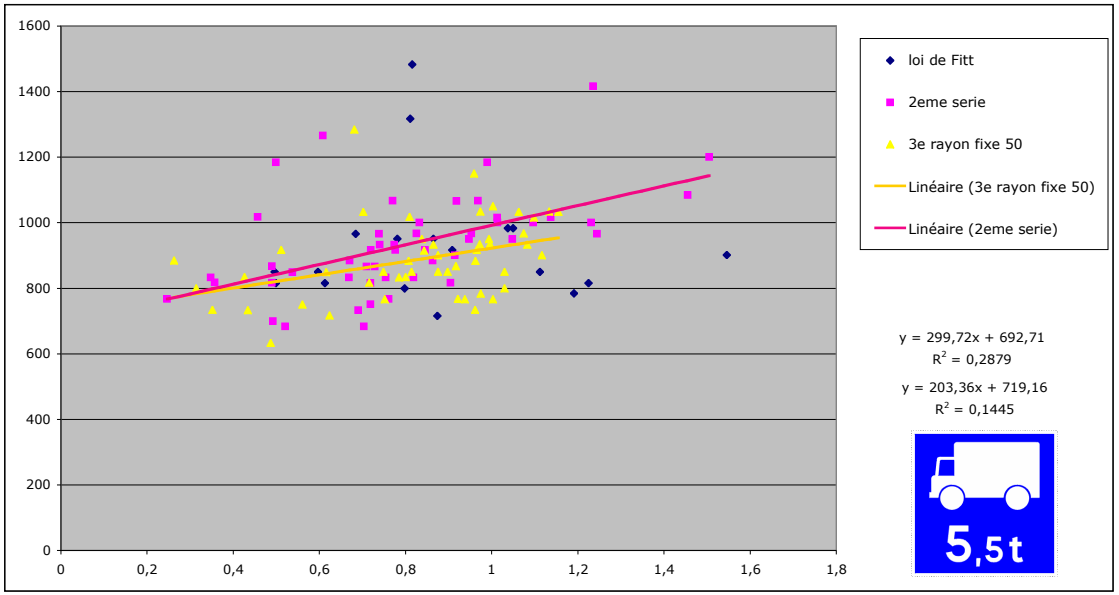


FIG. 1. Reciprocal tapping apparatus. The task was to hit the center plate in each group alternately without touching either side (error) plate.





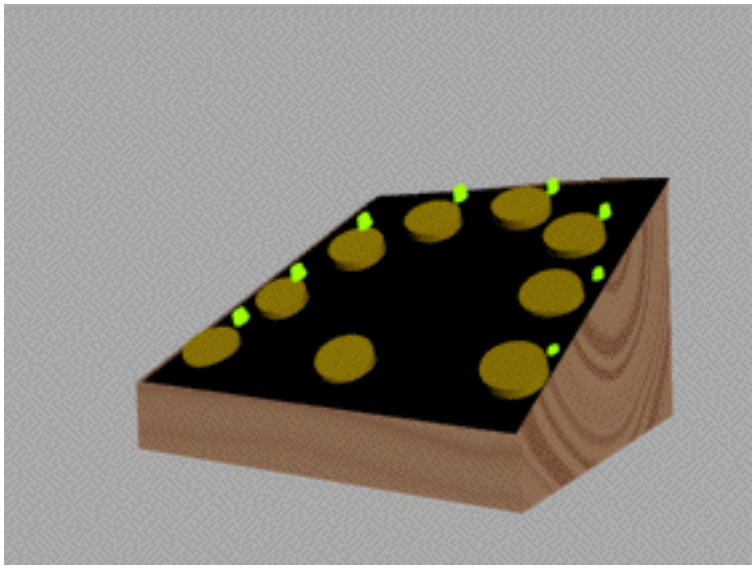
```
int NBEXPE = 10;
PrintWriter output;
float expe,expx,expy,expr,expdate,oexpx,oexpy,dist2,duree,distance;

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 donnés 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

Ex : choix dans un menu