

---

# CREATIVITY IN CONCEPTUAL SPACES

---

Antonio Chella, S. Gaglio, G. Oliveri, A. Augello, G. Pilato

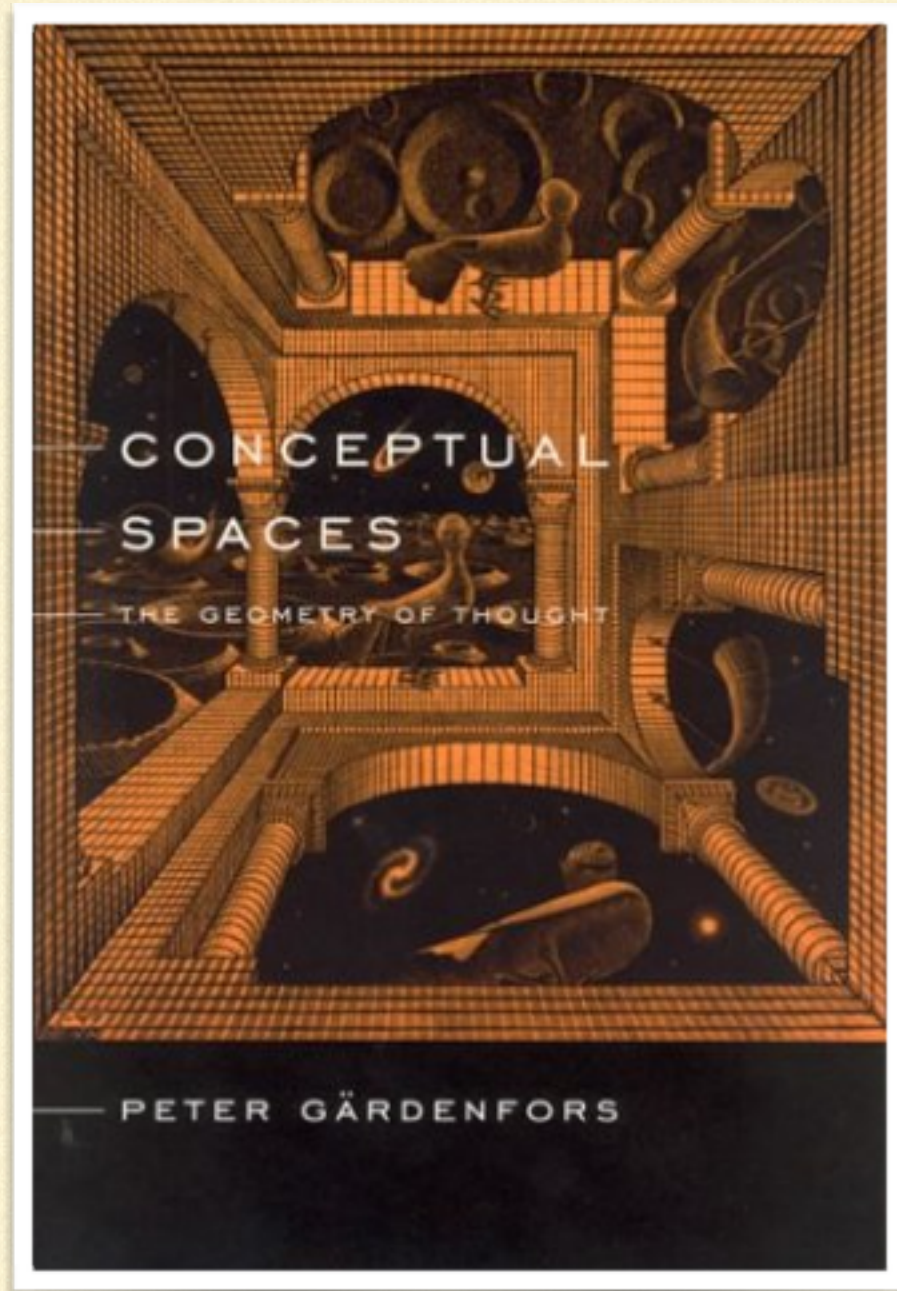
University of Palermo & ICAR - CNR, Palermo

[antonio.chella@unipa.it](mailto:antonio.chella@unipa.it)





# CONCEPTUAL SPACES (GÄRDENFORS 2000)



- Information is organized by quality dimensions
- ... that are sorted into domains (space, time, temperature, weight, color, shape ... )
- Domains are endowed with a topology or metric
- Conceptual spaces represent human cognition (not scientific models)
- Similarity is represented by distance in a conceptual space

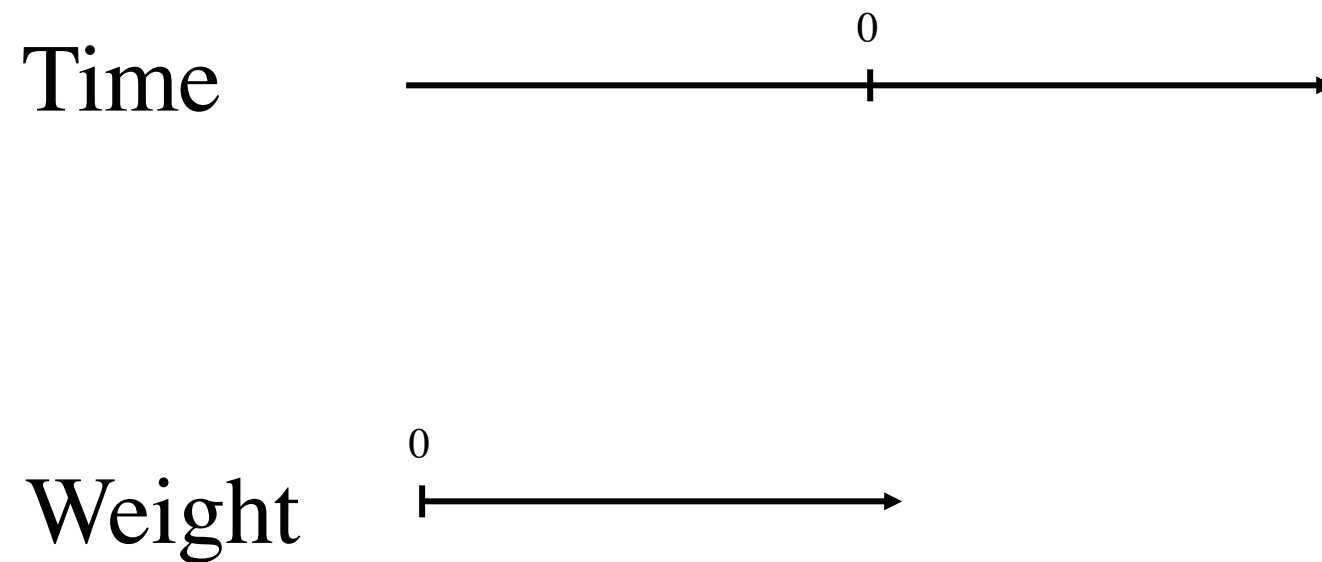


---

# CONCEPTUAL SPACES

---

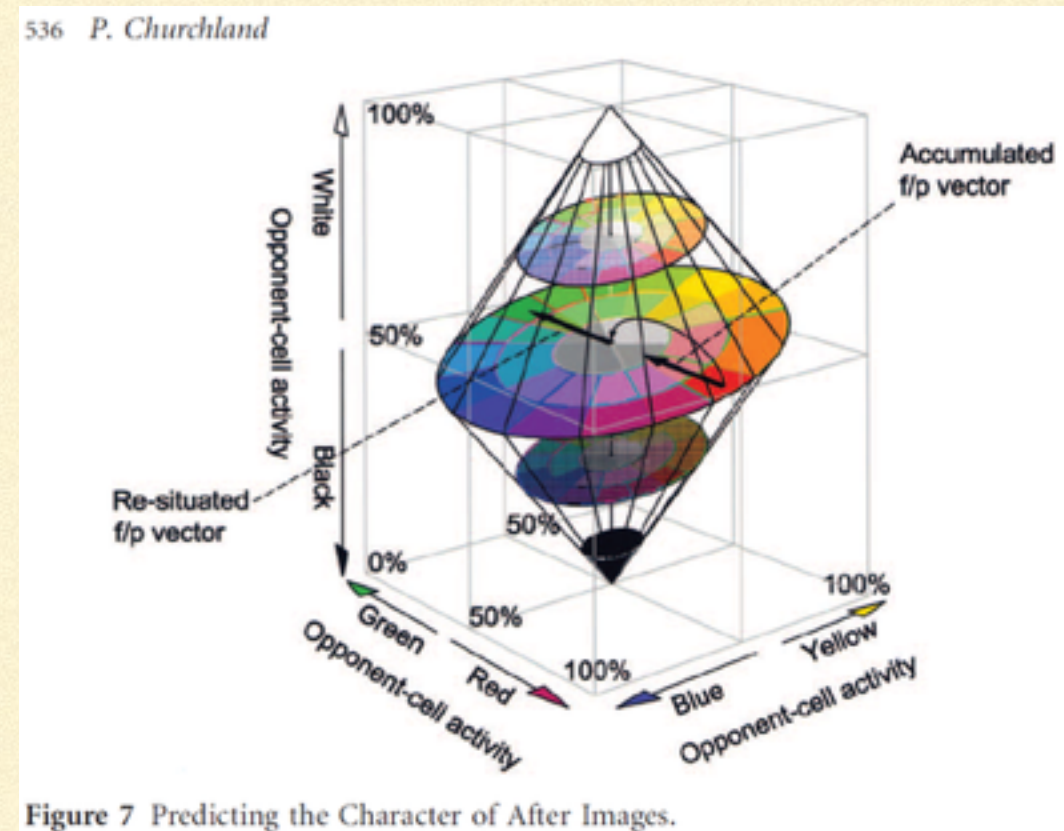
- Linear quality dimensions





# COLOR SPACE

- Color circle, color spindle

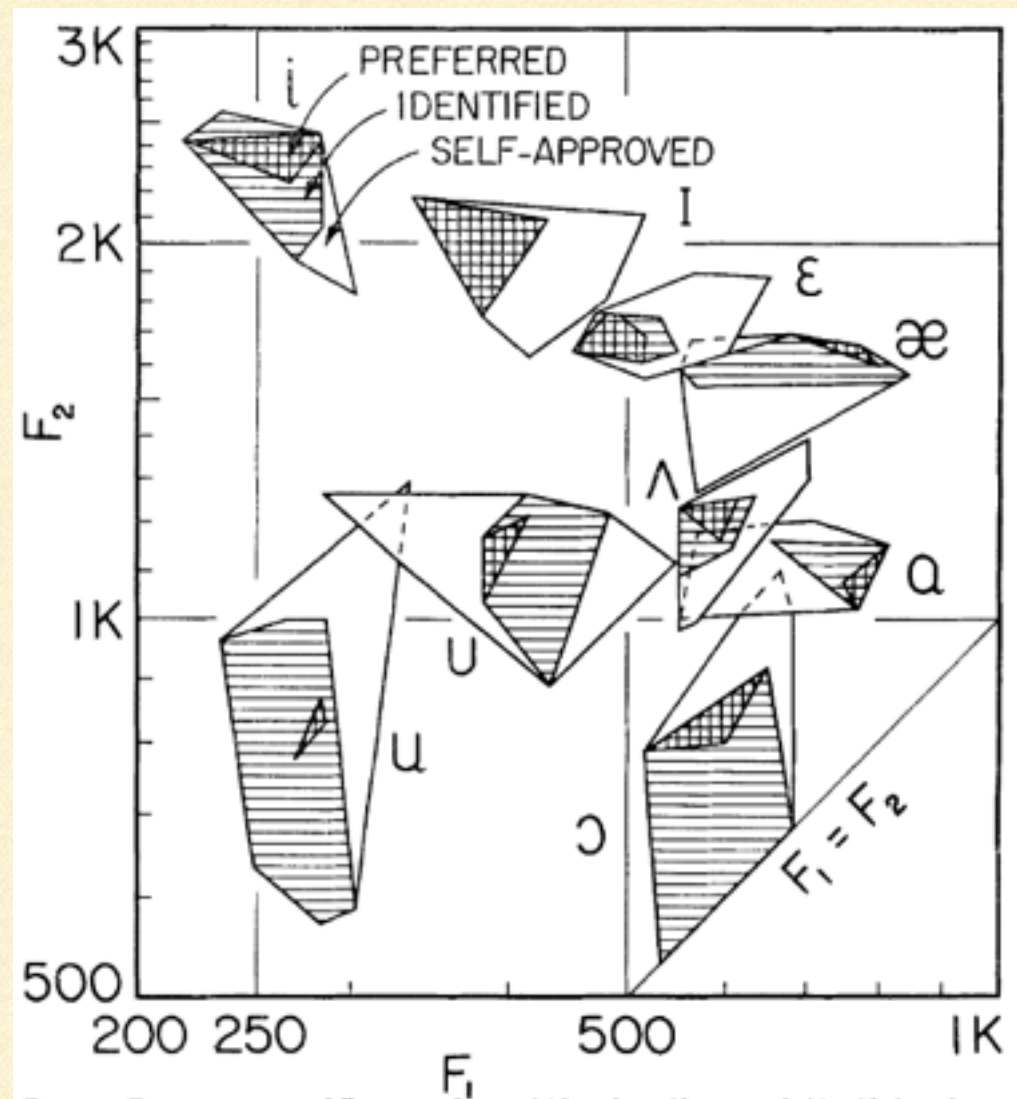


(Churchland 2005)



# VOWEL SPACE

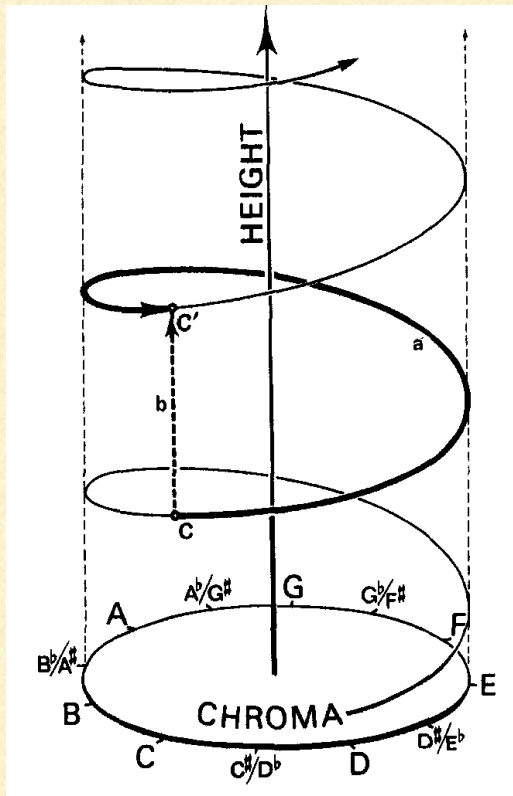
- Vowel space



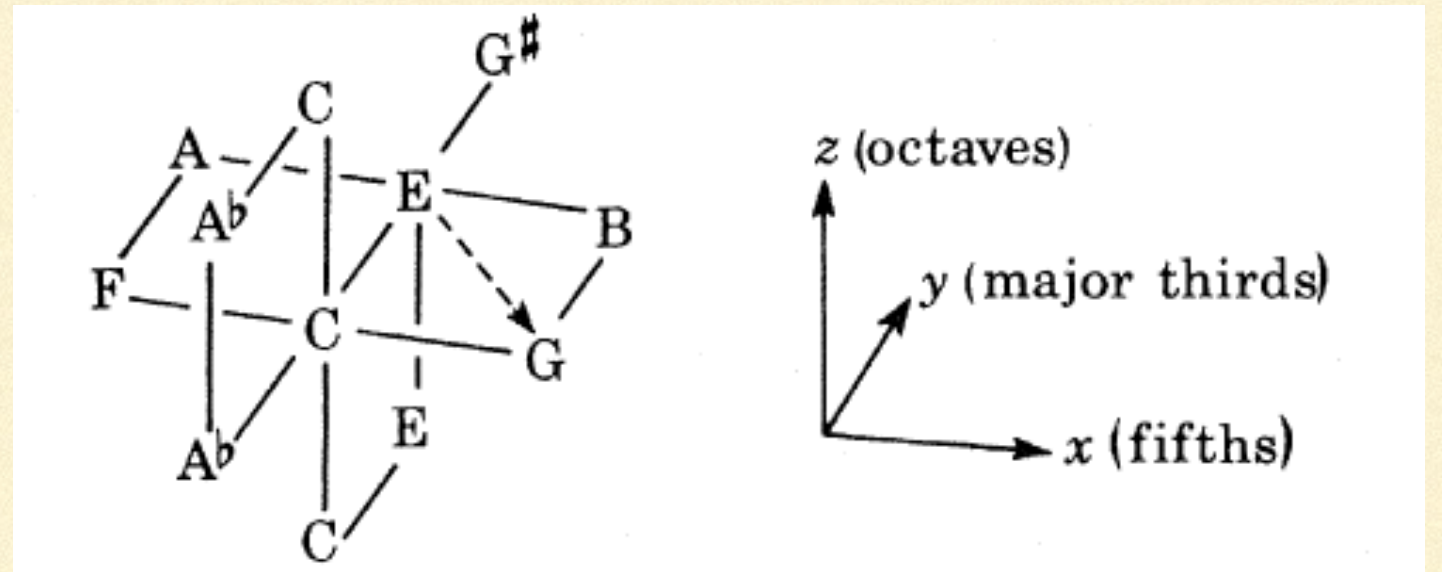
(Fairbanks & Grubb 1961)



# PITCH SPACE



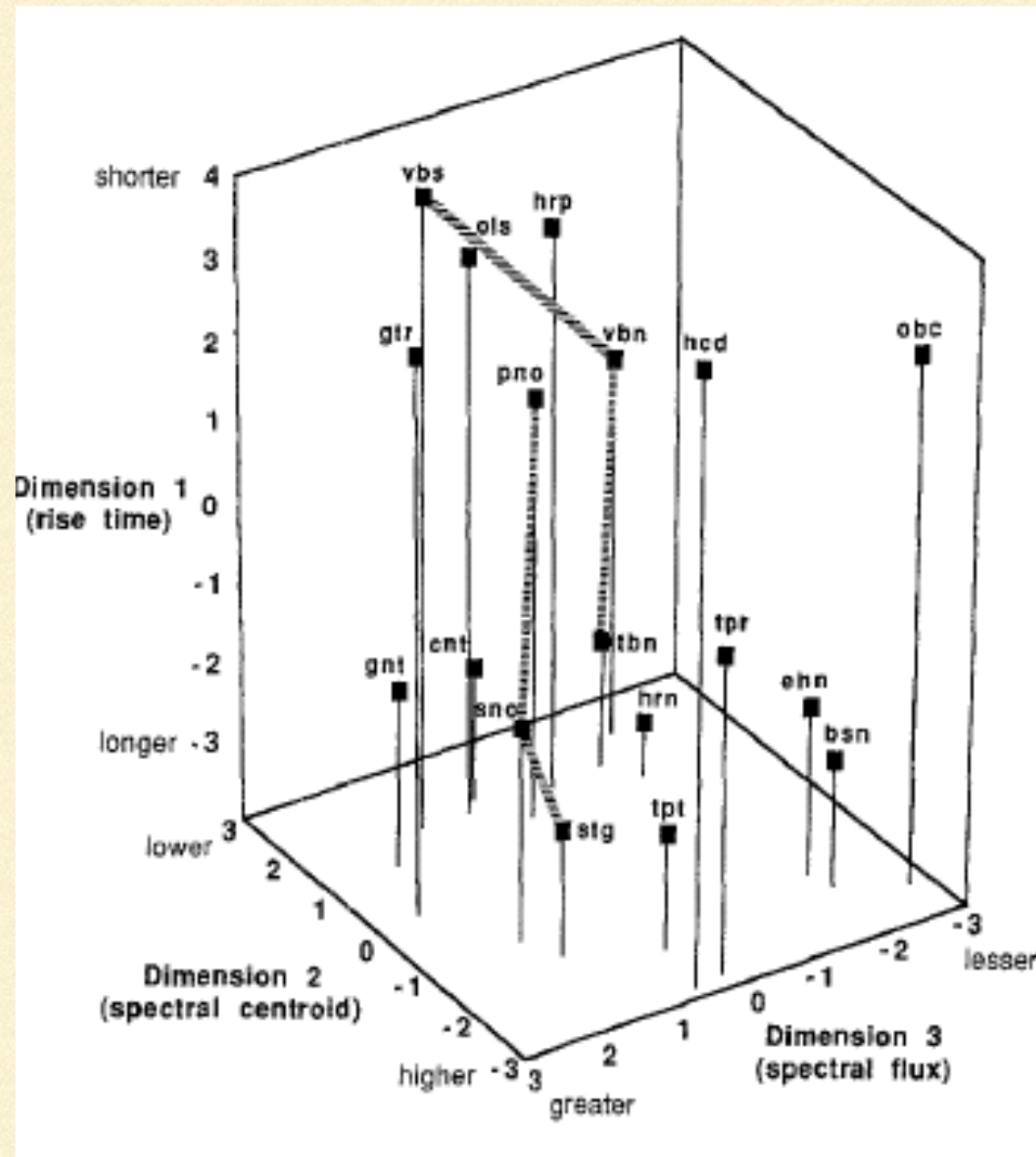
(Shepard 1965)



(Longuet-Higgins 1979)



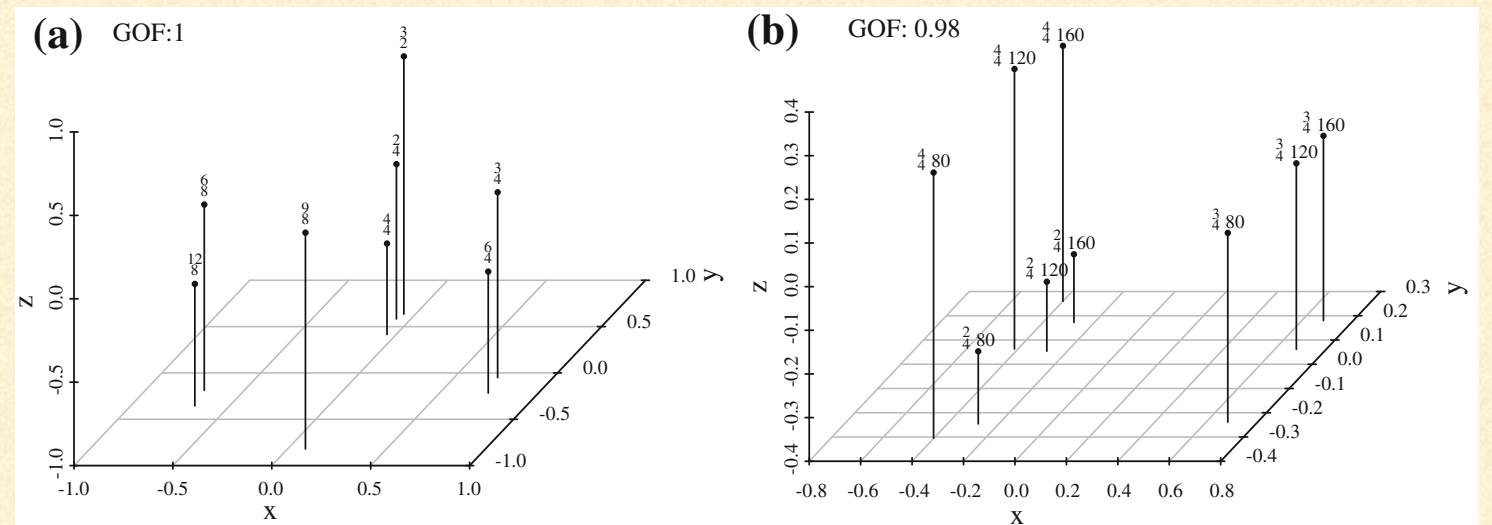
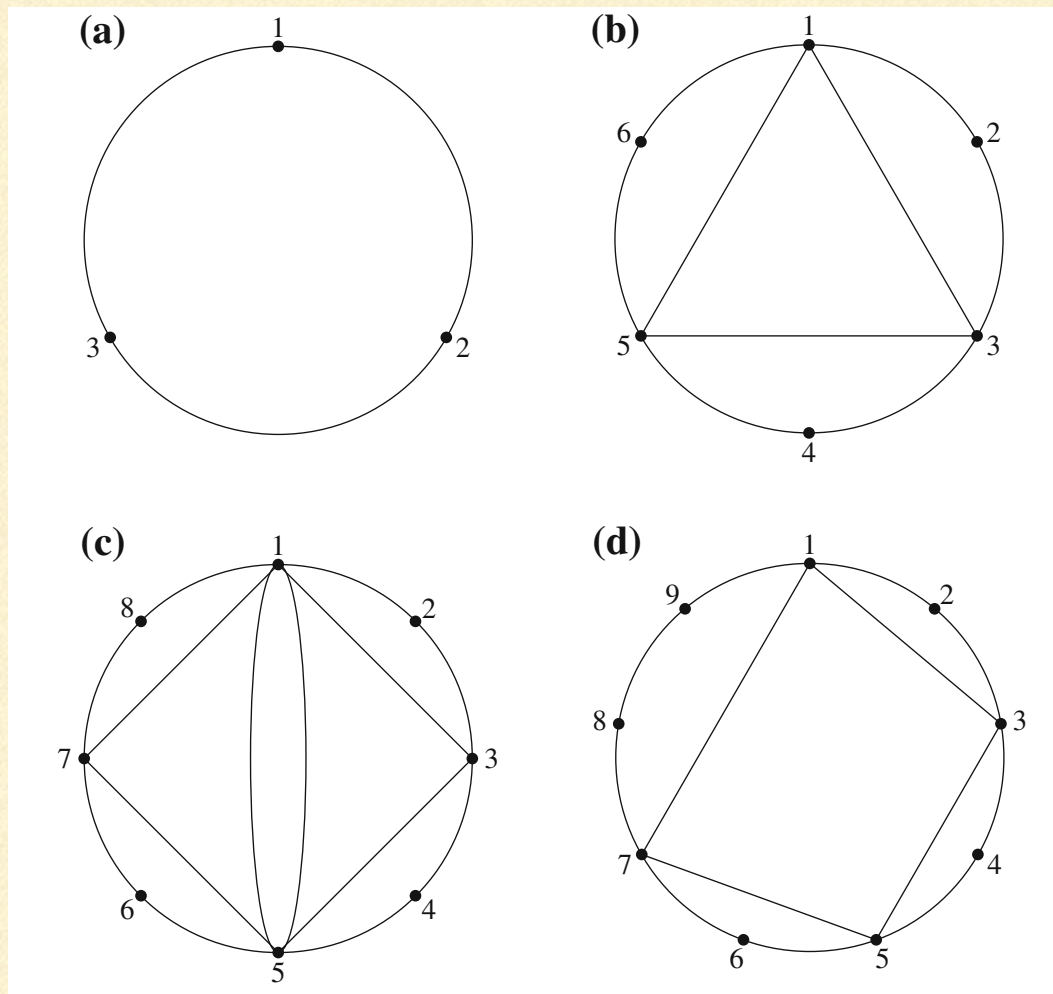
# TIMBRE SPACE



(MacAdams et al., 1995)



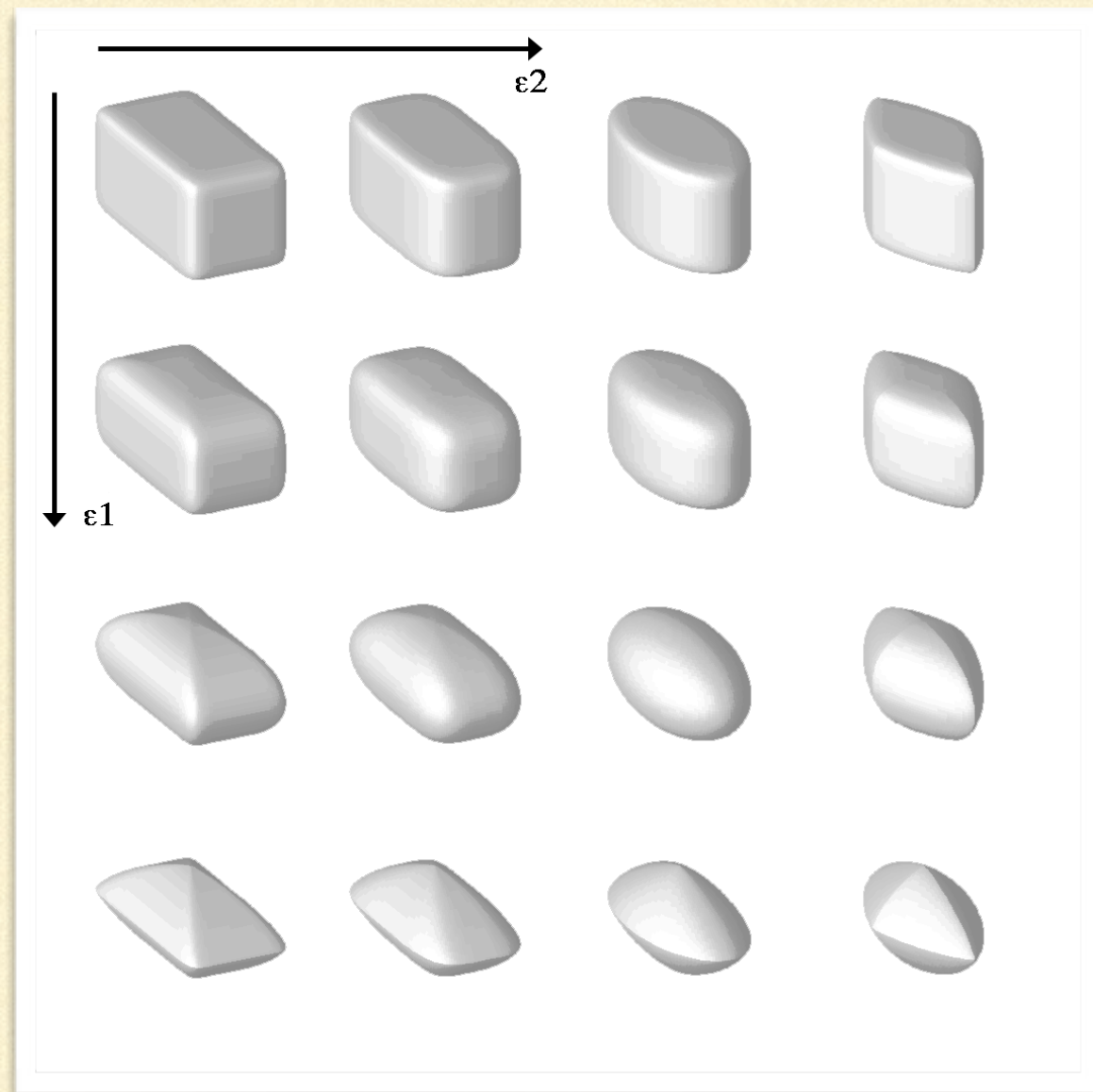
# METRE SPACE



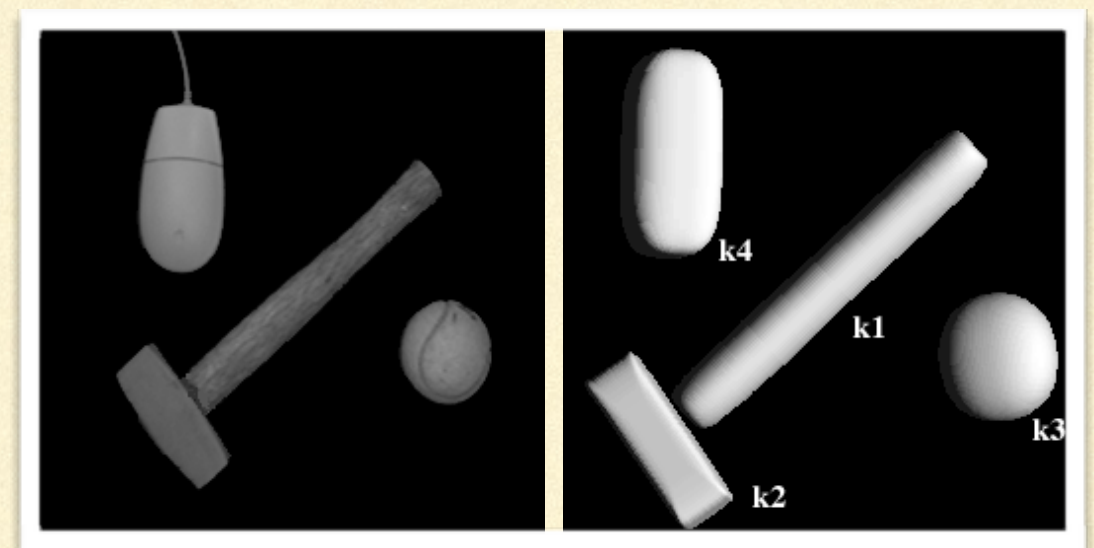
J. Forth, G.A. Wiggins, A. McLean (2010) after London (2004/2012)



# SHAPE SPACE



- A point is a “superquadric”
- An object is a composition of superquadrics



(Chella, Frixione, Gaglio 1997)



---

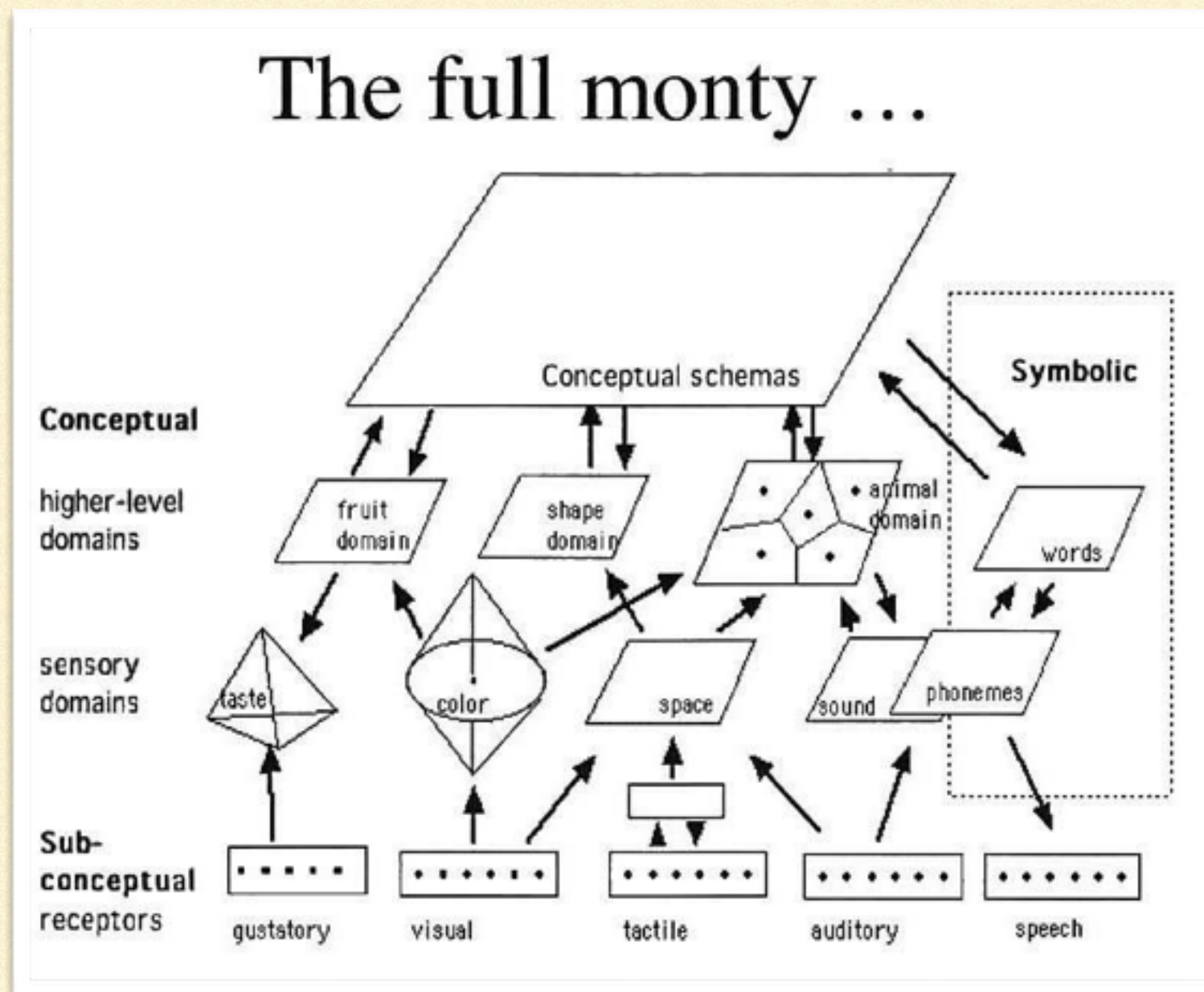
# CONCEPTUAL SPACE

---

- **Property:** a convex region in a single domain  
**Concept:** a set of convex regions in a number of domains together with:
    - (1) prominence values of the domains
    - (2) information about how the regions in different domains are correlated
- | <i>APPLE</i>     |                                                |
|------------------|------------------------------------------------|
| <i>Domain</i>    | <i>Region</i>                                  |
| <b>Fruit</b>     | <b>Values for skin, flesh and seed type</b>    |
| <b>Color</b>     | <b>Red-green-yellow</b>                        |
| <b>Taste</b>     | <b>Values for sweetness, sourness etc</b>      |
| <b>Shape</b>     | <b>"Round" region of shape space</b>           |
| <b>Nutrition</b> | <b>Values for sugar, vitamin C, fibres etc</b> |
-



# CONCEPTUAL SPACE



Courtesy by Gärdenfors



---

# CREATIVITY VS ANALOGY

---

- Some forms of creativity can be described in terms of analogical reasoning: e.g. Copycat (Hofstadter)
  - Analogical reasoning:
    - Symbolic reasoning: e.g. SME (Gentner)
    - Iconic/diagrammatic reasoning
    - Neural networks (Holyoak, Hummel)
-

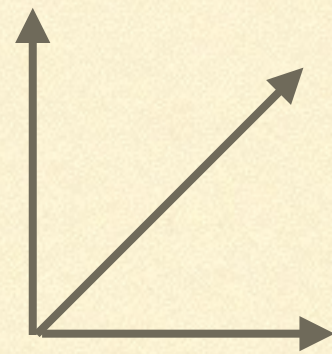


---

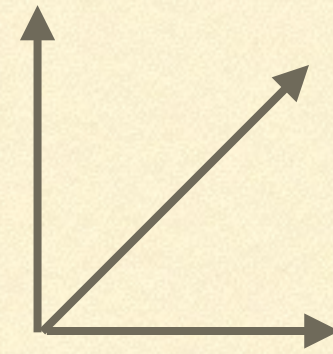
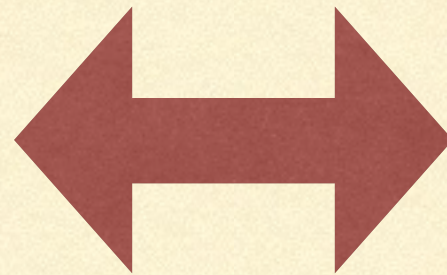
# OUR PROPOSAL

---

Some forms of creativity (related with analogical reasoning) can be described in terms of mapping between conceptual spaces



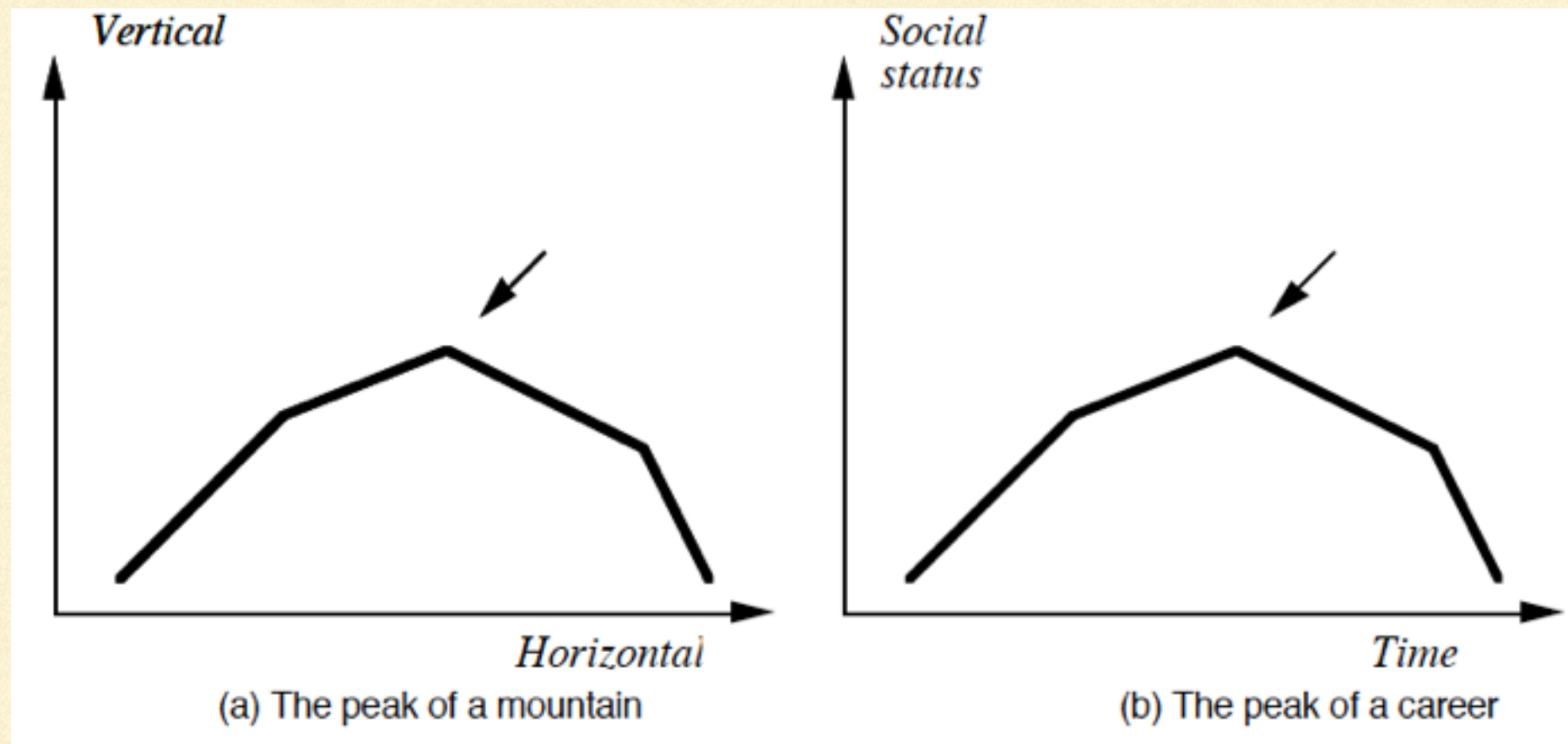
CS1



CS2



# ANALOGY AS A MAPPING



(Gärdenfors 2000)



# VOYELLES (RIMBAUD, 1883)

Voyelles

A noir, E blanc, I rouge, U vert, O bleu : voyelles,  
Je dirai quelque jour vos naissances latentes :  
A, noir corset velu des mouches éclatantes  
Qui bombinent autour des puanteurs cruelles,  
Golfe d'ombre ; E, frissonnant des vapeurs et des tentes,  
Lances des glaciers fiers, rois blancs, frissons d'ombelles ;  
I, pourpres, sang craché, rire des lèvres belles  
Dans la colère ou les vrasses pénitentes ;  
U, cycles, vibrations diront des mers vides,  
Paix des pâtes semées d'animaux, paix des rides  
Que l'alchimie imprime aux grands fronts fatigués ;  
O, suprême Clairon plein des stupides étranges,  
Silences traversés des tonnerres et des Anges :  
— Ô l'Oméga, rayon violet de Ses Yeux ! — A. Rimbaud



# VOYELLES

A noir, E blanc, I rouge, U vert, O bleu

536 P. Churchland

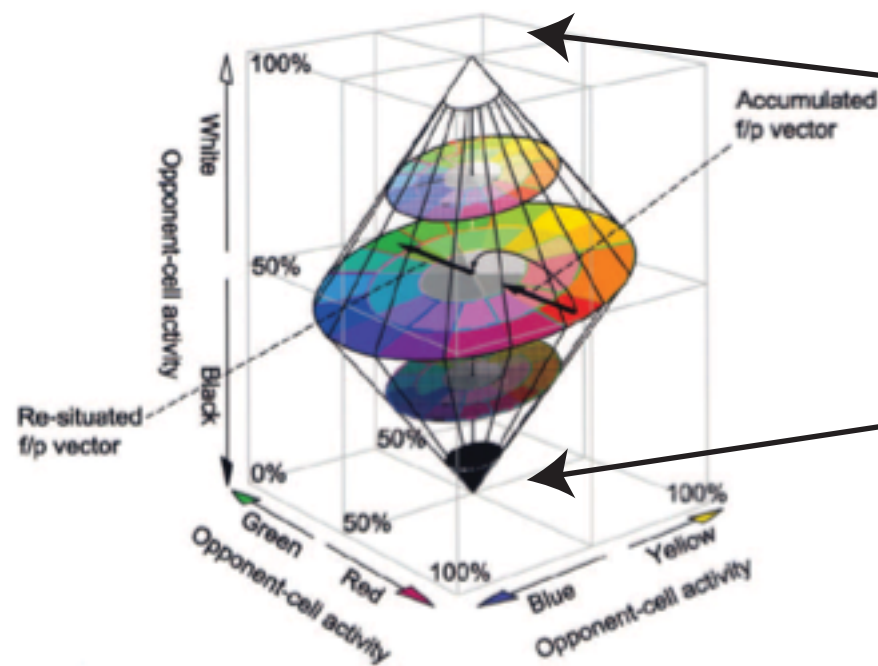
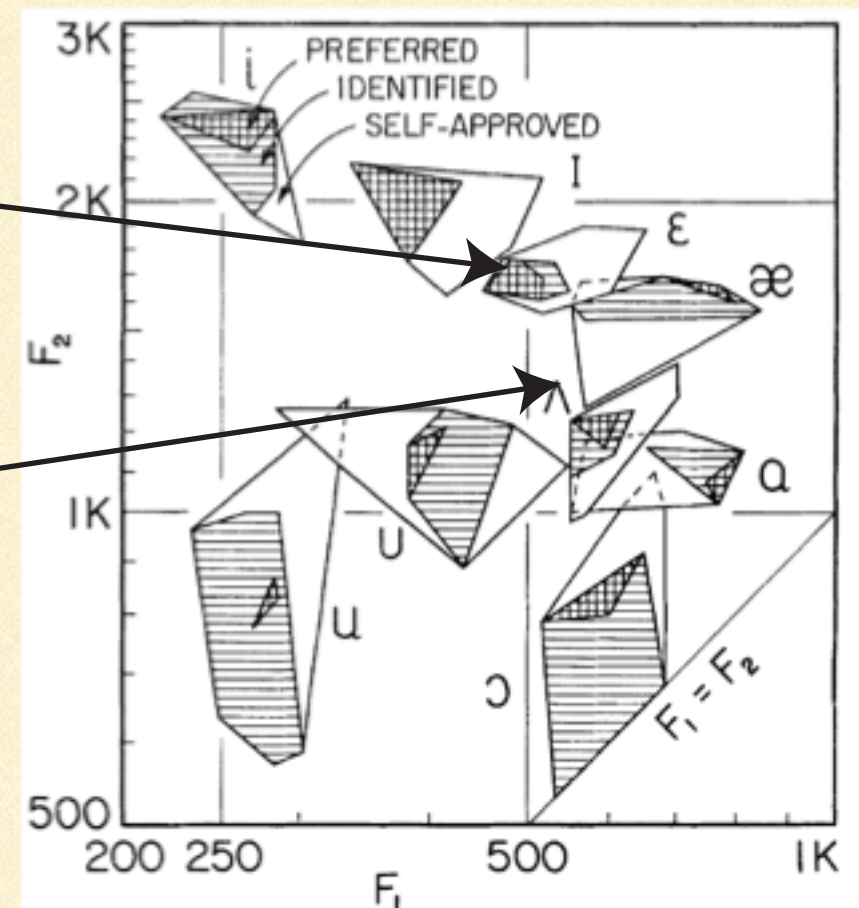


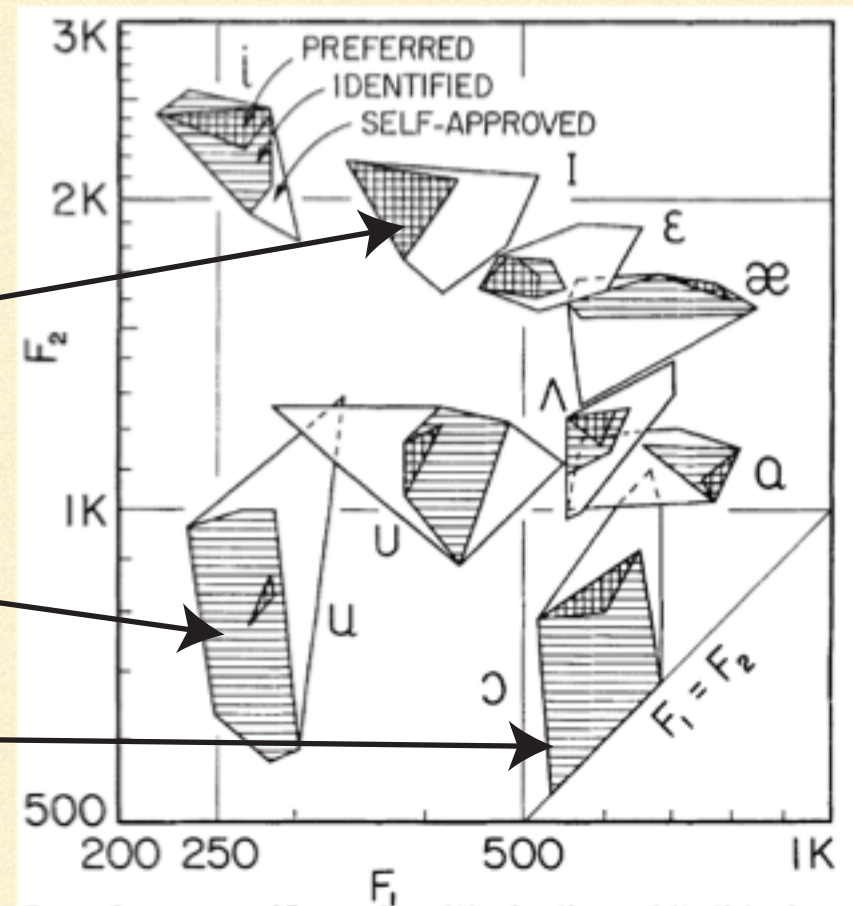
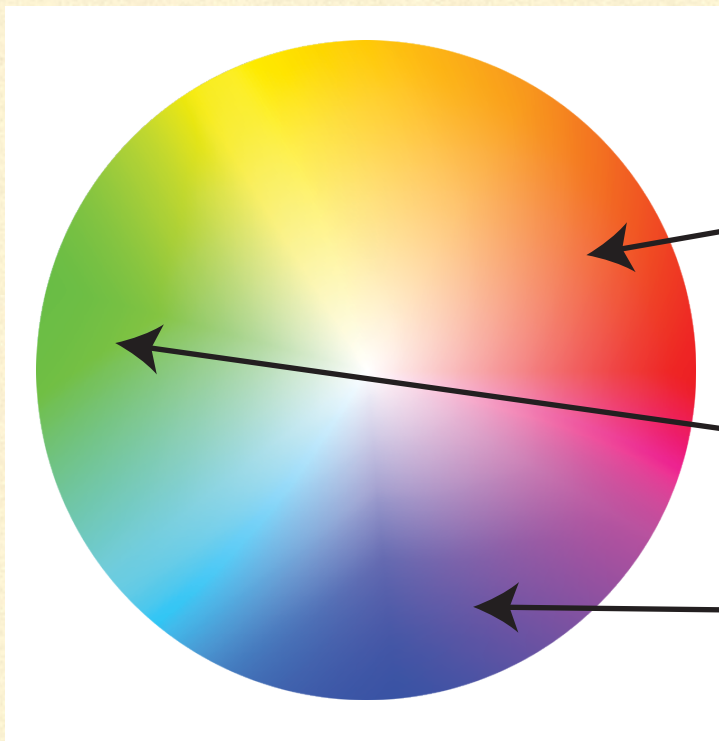
Figure 7 Predicting the Character of After Images.





# VOYELLES

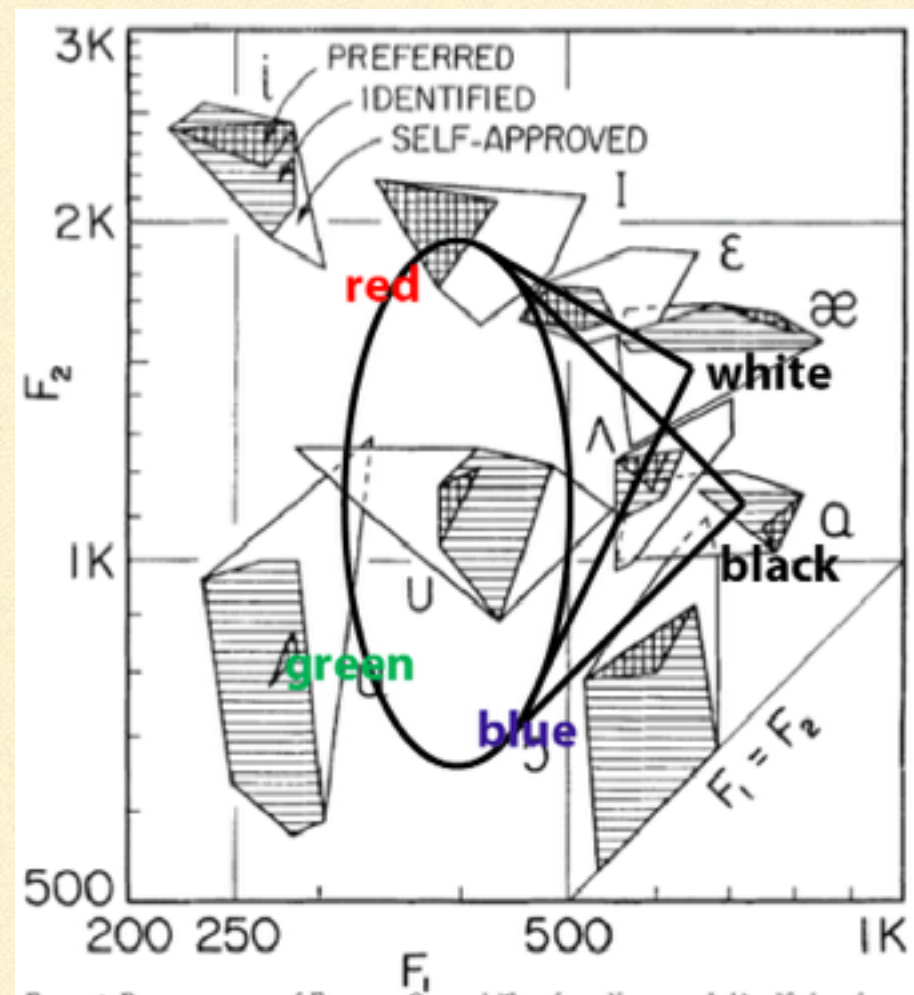
A noir, E blanc, I rouge, U vert, O bleu





# VOYELLES

A noir, E blanc, I rouge, U vert, O bleu





---

# MUSIC AND VISION PERCEPTION

---

- Two faces of the same coin?
  - Gestalt
  - Synesthesia
-



---

# EXAMPLE: SOUNDS VS. SHAPES

---



kiki



bouba

(Ramachandran & Hubbard 2001)

---



---

# EXAMPLE: SOUNDS VS. SHAPES

---



bouba



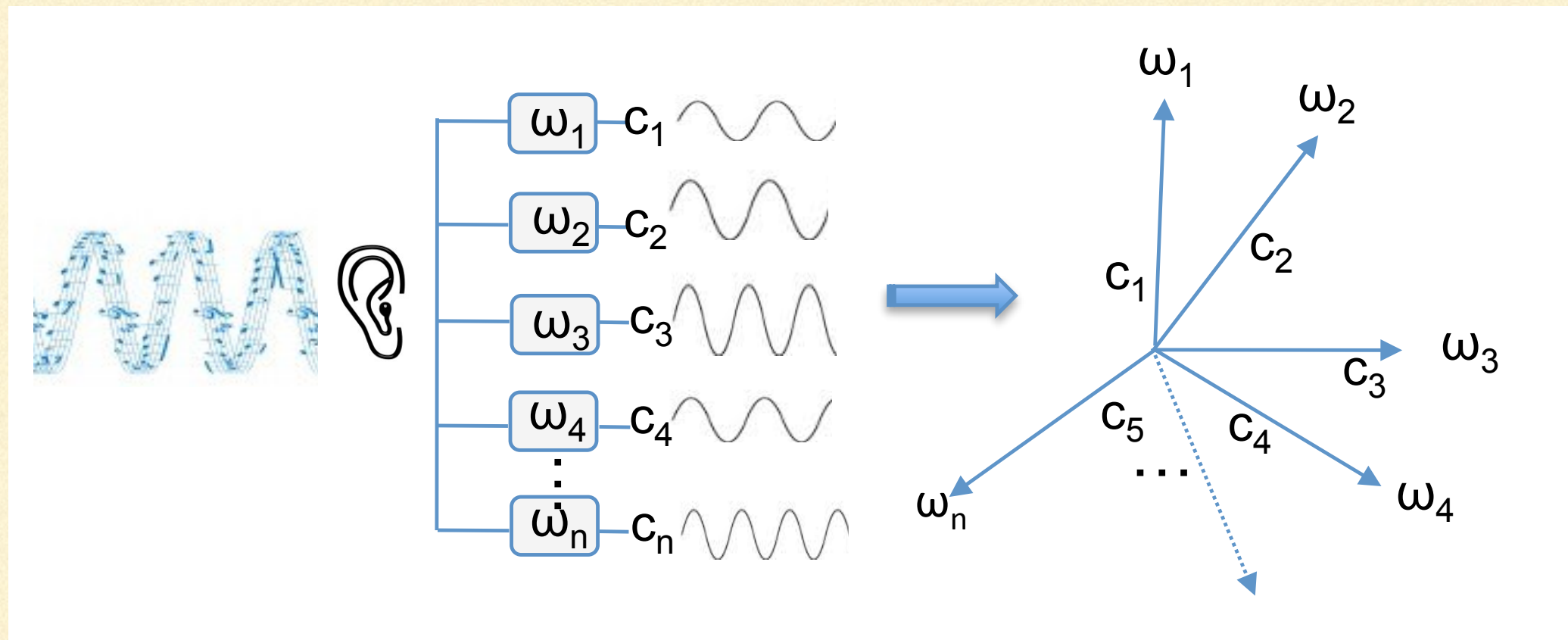
kiki

(Ramachandran & Hubbard 2001)

---

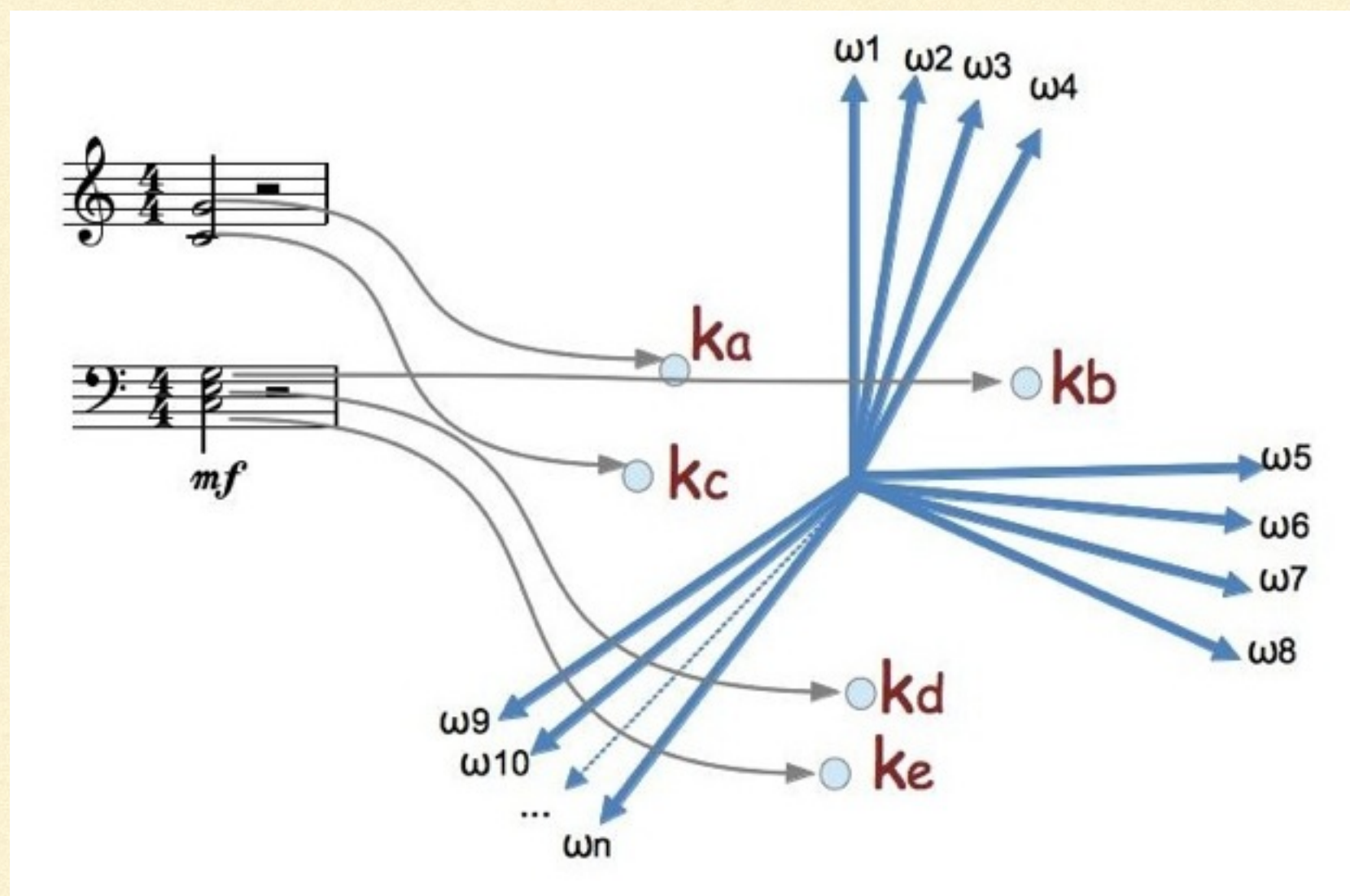


# SOUND SPACE



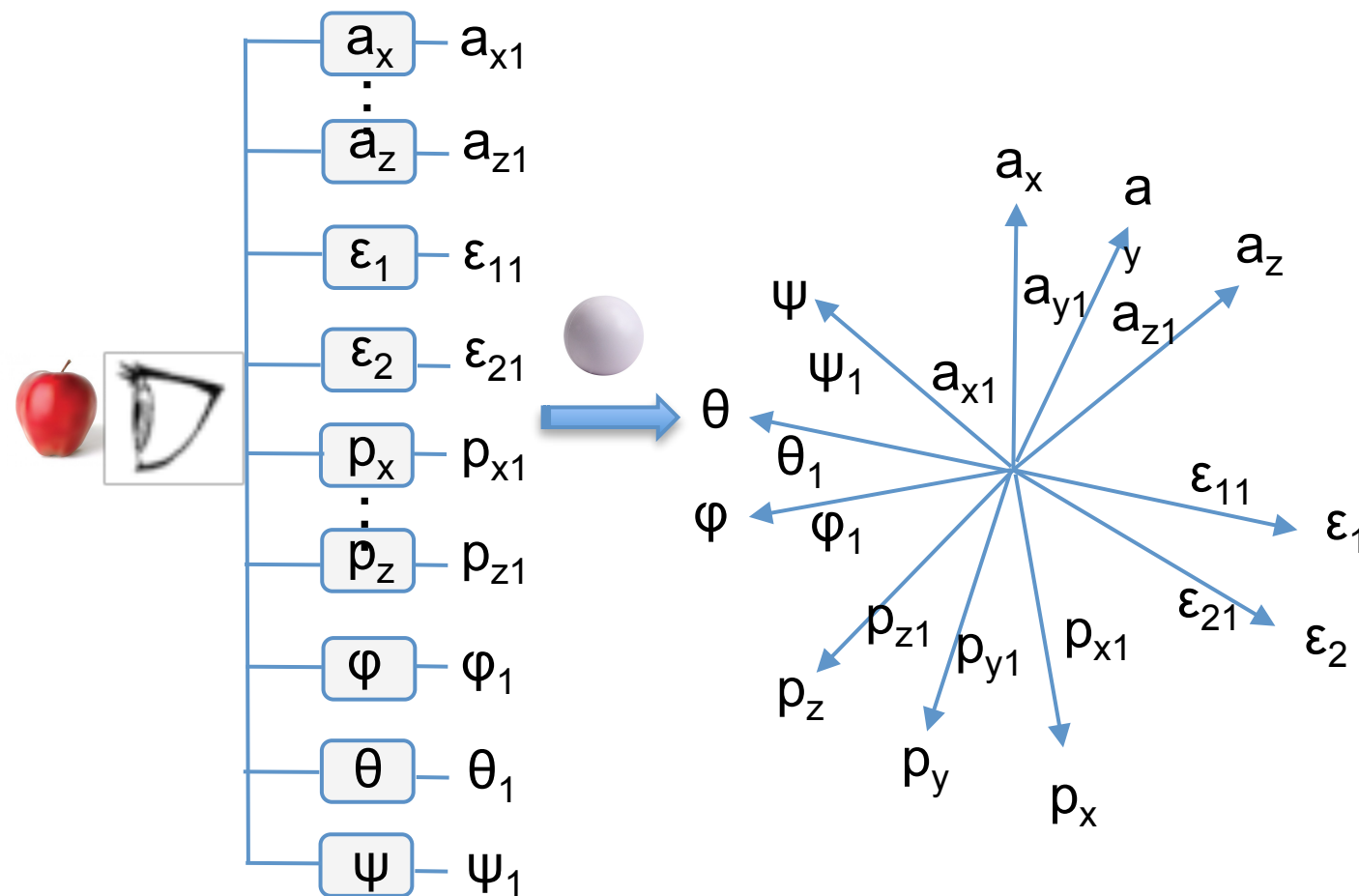


# PITCH SPACE



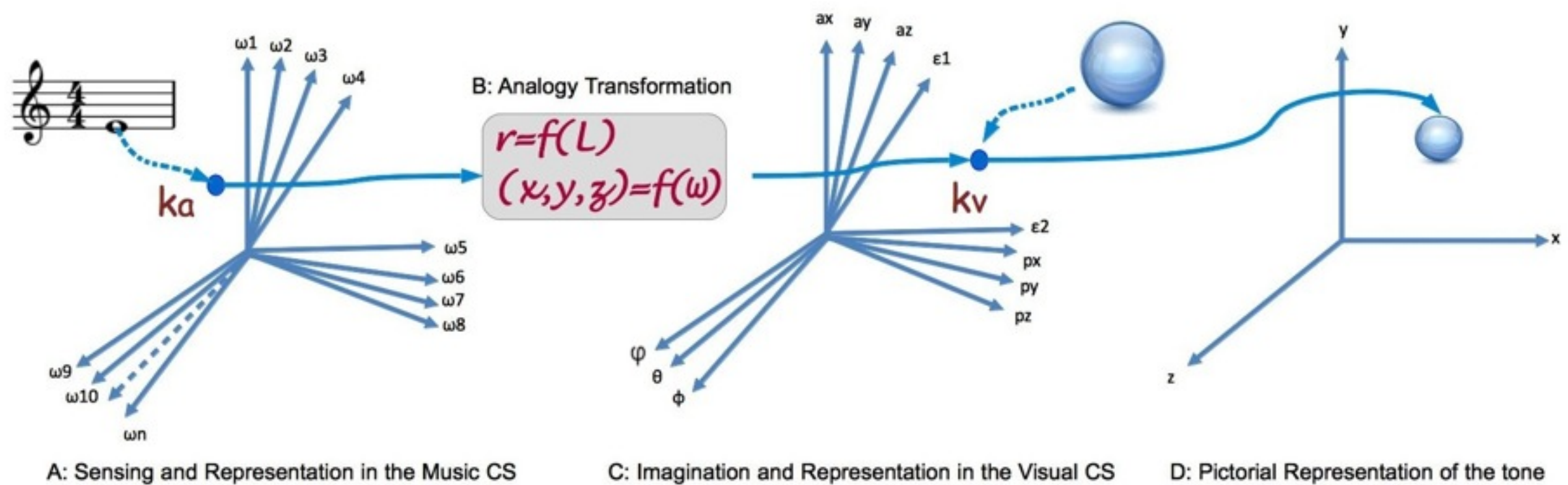


# SHAPE SPACE (SPHERES SPACE)





# MAPPING BETWEEN SPACES





# MAPPING BETWEEN SPACES

Music Sensing



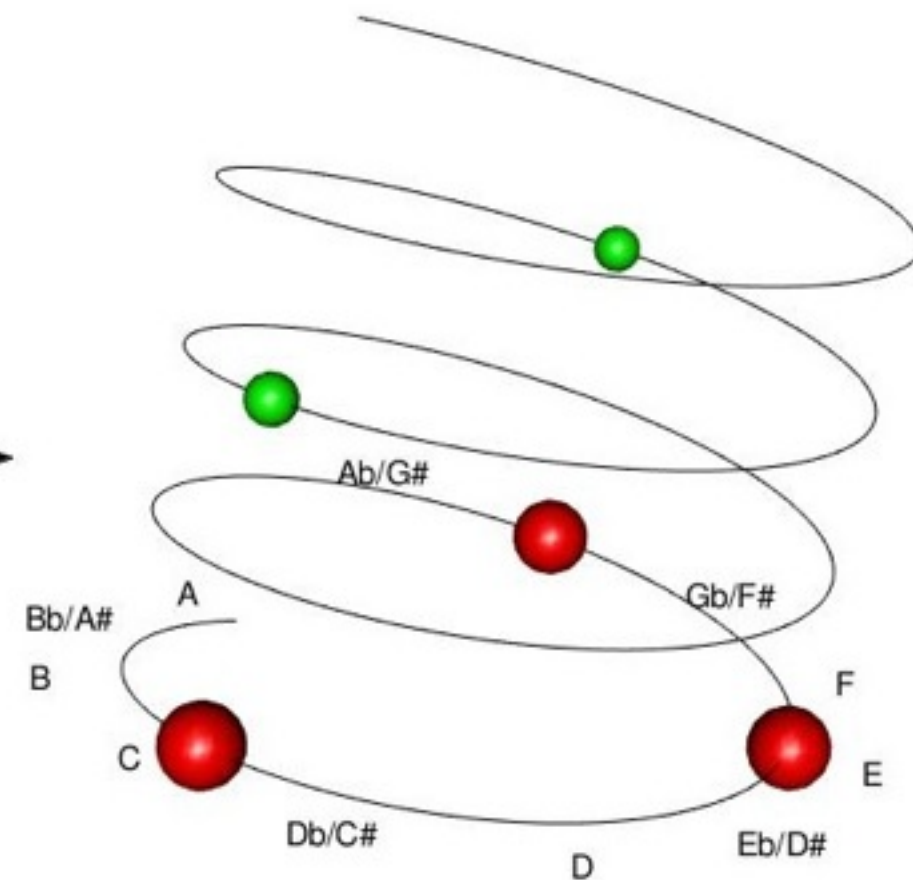
Analogy Transformation based  
on the Helical Representation

$$r_{sphere} \cong L$$

$$x = r_{cyl} \cos(2\pi\omega)$$

$$y = r_{cyl} \sin(2\pi\omega)$$

$$z = c\omega$$



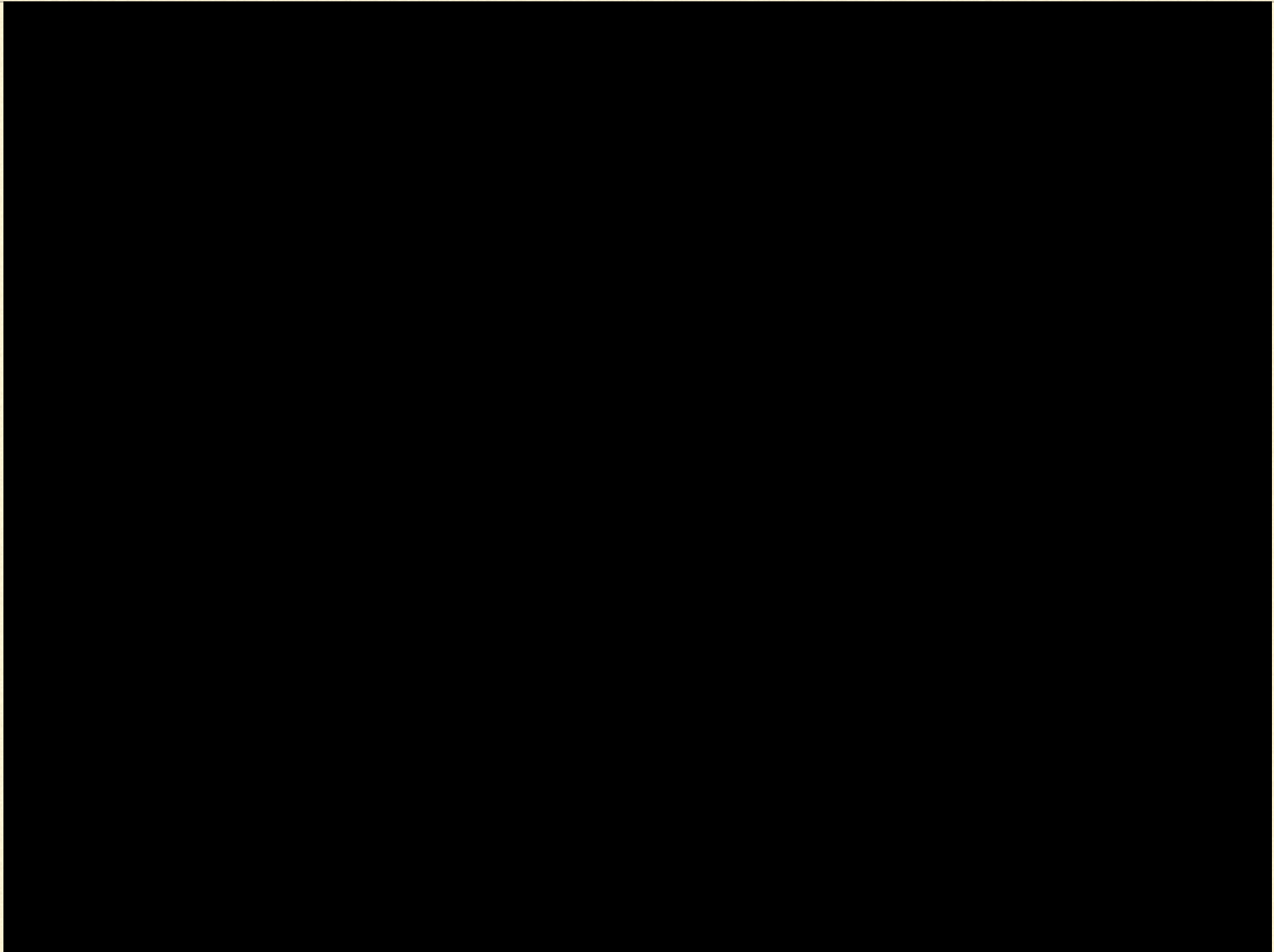
Visual Representation of the sensed music



---

# THE TOOL 0.1

---





---

# CONCLUSIONS

---

- Some forms of creativity can be described in terms of analogical reasoning
  - Analogical reasoning (and then creativity) can be modeled as a mapping between conceptual spaces
  - Psychological tests needed:
    - Professional composers
    - Common people
-

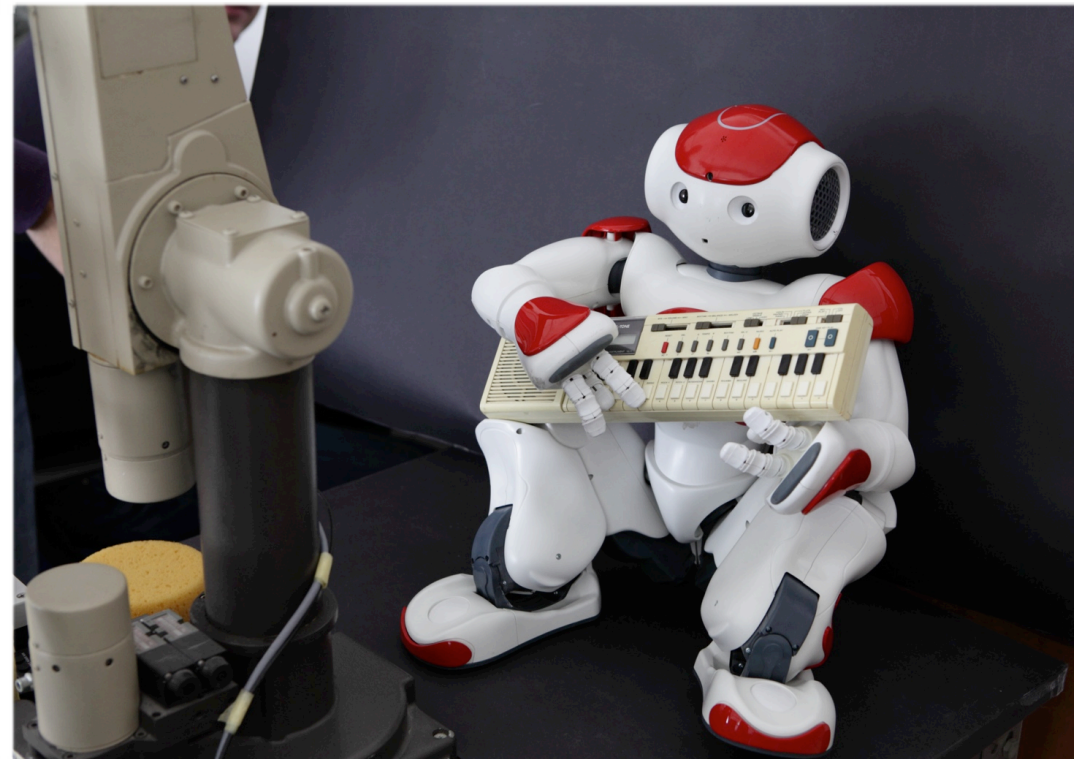




UNIVERSITÀ  
DEGLI STUDI  
DI PALERMO

Prof.  
**Antonio Chella**  
**RoboticsLab**

DEPARTMENT OF CHEMICAL, MANAGEMENT,  
COMPUTER, MECHANICAL ENGINEERING  
Viale delle Scienze - Building 6 - 90128 Palermo (IT)  
Phone +39 091 23862601  
[antonio.chella@unipa.it](mailto:antonio.chella@unipa.it)



THANK YOU FOR YOUR ATTENTION!