CREATIVITY IN CONCEPTUAL SPACES

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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

SHAPES 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

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**APPLE**

<table>
<thead>
<tr>
<th>Domain</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td>Values for skin, flesh and seed type</td>
</tr>
<tr>
<td>Color</td>
<td>Red-green-yellow</td>
</tr>
<tr>
<td>Taste</td>
<td>Values for sweetness, sourness etc</td>
</tr>
<tr>
<td>Shape</td>
<td>&quot;Round&quot; region of shape space</td>
</tr>
<tr>
<td>Nutrition</td>
<td>Values for sugar, vitamin C, fibres etc</td>
</tr>
</tbody>
</table>
CONCEPTUAL SPACE

The full monty ...

Symbols:

- Conceptual schemas
- Conceptual domains
- Higher-level domains
- Sensory domains
- Sub-conceptual receptors

Gustatory
Visual
Tactile
Auditory
Speech

Animals

Fruit
Shape
Space
Color
Taste
Sound
Phonemes
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)

A noir, é blanc, Io nga, U vient O ledqu’ voyelle,
Je dirai quelque jour nos naissances latentes ;
À noir, cent belle des moules éclatantes
Qui bombinent autour des quantains amours.

Golfe d’ombre, e flammes des rapins et des tentes
Flames des glaciers fiers, rois blancs, feux montants ;
Et, pourpre sang caché, miroir des lunes tellus
Dans la caldeura, les roses persistantes ;

U cycles, trembleurs divins des mers vides ;
Fais des pêches sénès d’animaux, pois des vides
Que l’alchimie imprimeaux grand fants édius ;

O imprime Clarine, plein des stades étranges,
Silhuns traverses des mords et des Anges ;

O l’Oméga, rayon violet de ses Jumeaux !
VOYELLES

A noir, E blanc, I rouge, U vert, O bleu
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) vs. (bouba) (Ramachandran & Hubbard 2001)
EXAMPLE: SOUNDS VS. SHAPES

bouba  kiki

(Ramachandran & Hubbard 2001)
SOUND SPACE
PITCH SPACE
SHAPE SPACE (SPHERES SPACE)
MAPPING BETWEEN SPACES

A: Sensing and Representation in the Music CS
B: Analogy Transformation
\[ r = f(L) \]
\[ (x, y, z) = f(\omega) \]
C: Imagination and Representation in the Visual CS
D: Pictorial Representation of the tone
MAPPING BETWEEN SPACES

Music Sensing

Analogy Transformation based on the Helical Representation

\[
\begin{align*}
    r_{\text{sphere}} & \equiv L \\
    x &= r_{\text{cyl}} \cos(2\pi \omega) \\
    y &= r_{\text{cyl}} \sin(2\pi \omega) \\
    z &= c \omega
\end{align*}
\]

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
THANK YOU FOR YOUR ATTENTION!