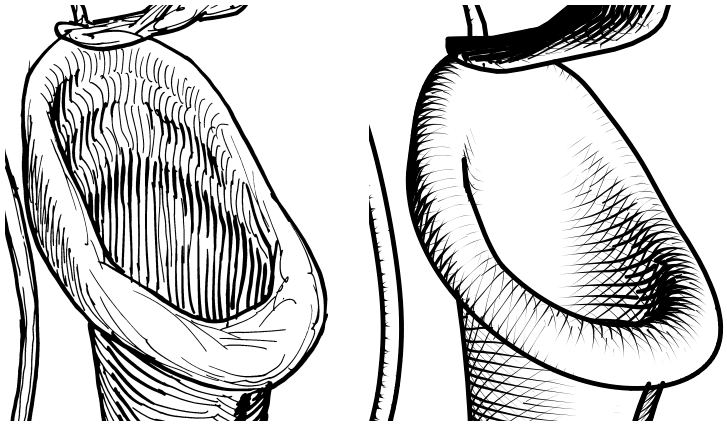
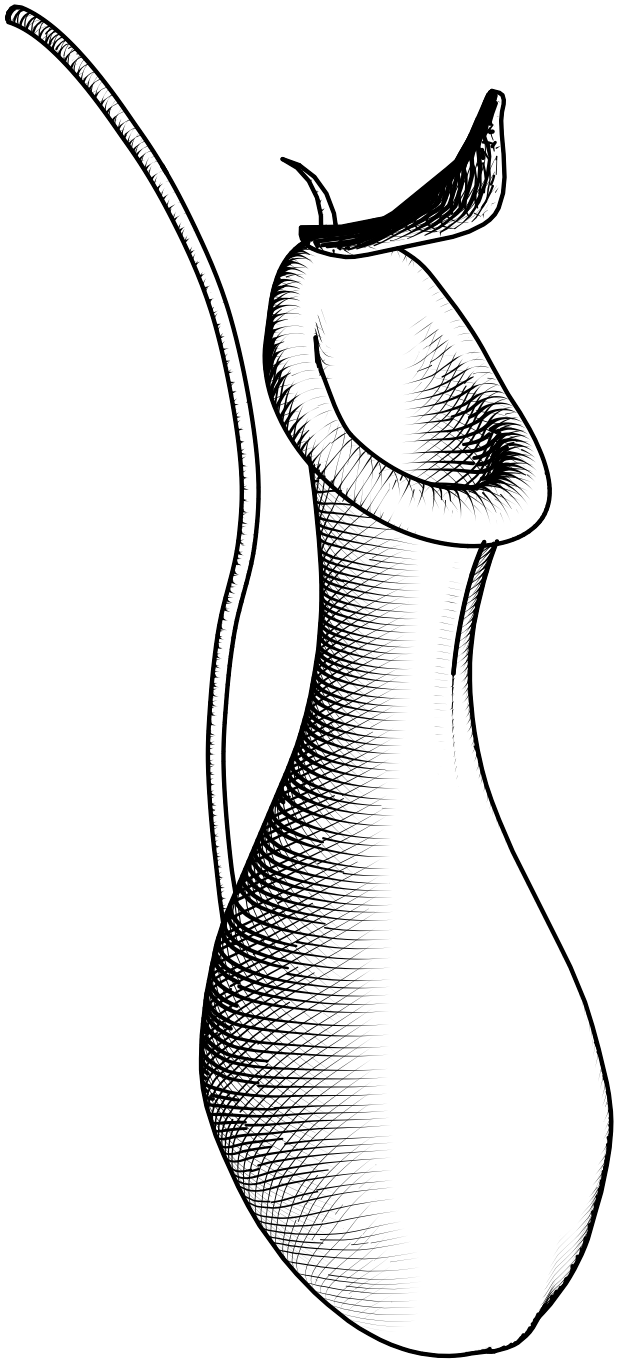
Non-Photorealistic Rendering in Context: An Observational Study

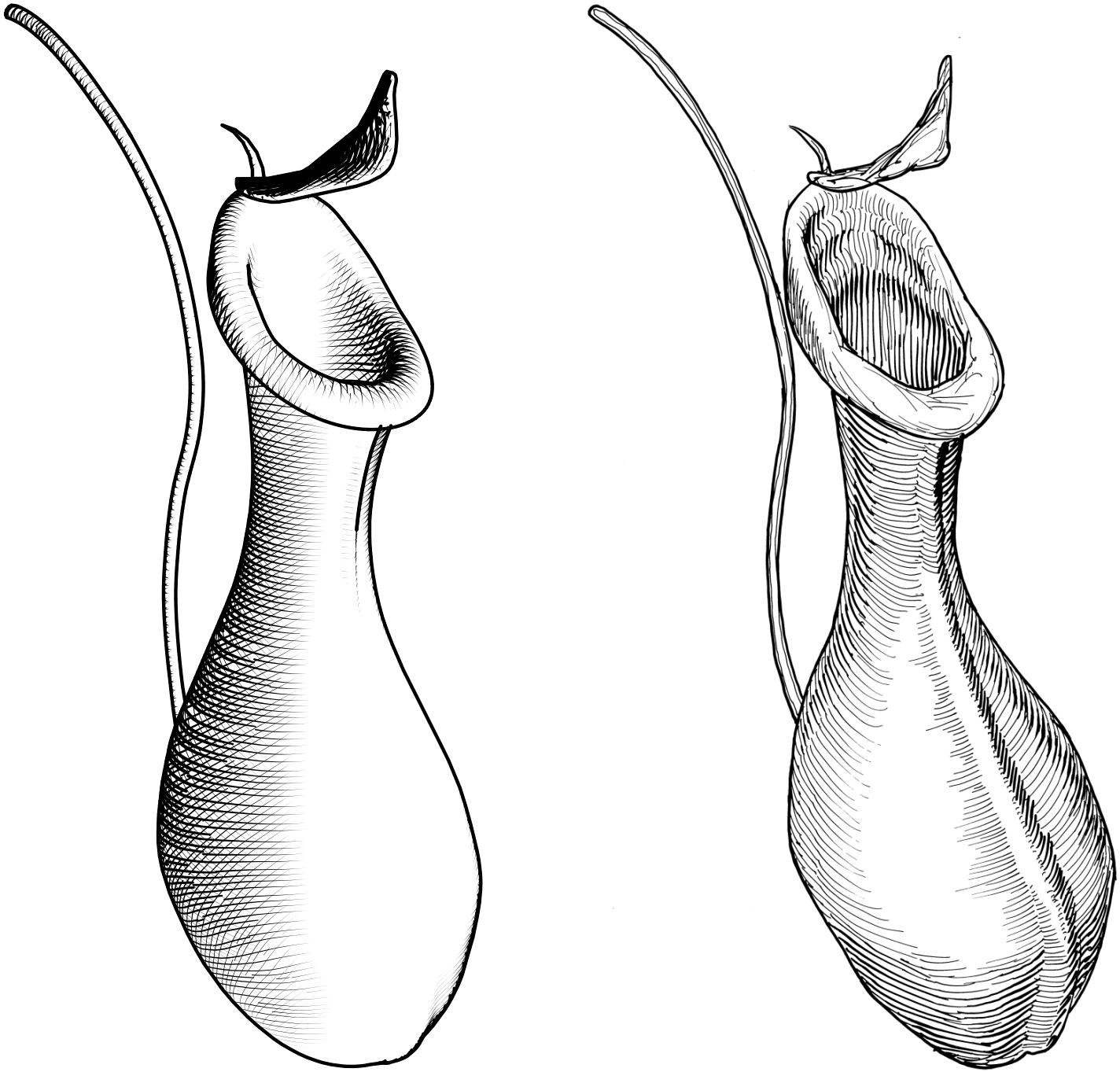
Tobias Isenberg
Petra Neumann
Sheelagh Carpendale
Mario Costa Sousa
Joaquim A. Jorge



Department of Computer Science
Faculty of Science
University of Calgary

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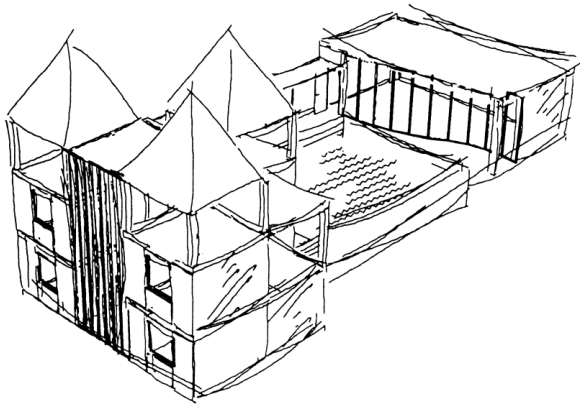


Introduction

- NPR inspired by artistic and illustrative depiction
- few evaluations of state-of-the-art
- comparative study of hand-drawn and NPR illustrations
- restriction to scientific illustrations
- restriction to pen-and-ink styles
- qualitative study

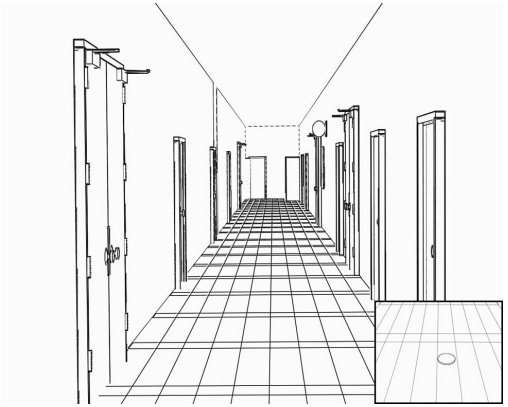
Related Work

NPR in architecture



[Schumann et al. 1996]

space perception



[Gooch and Willemsen 2002]

psychology of NPR



[Duke et al. & Halper et al. 2003]

influence on gaze direction



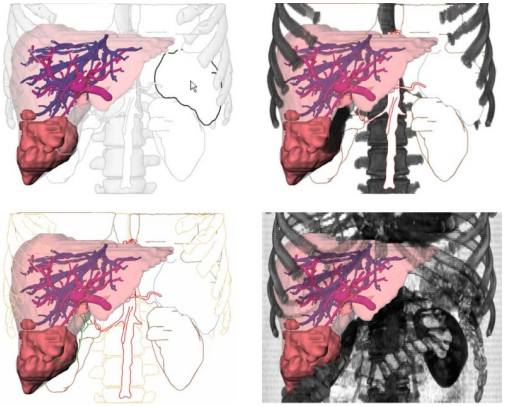
[Santella and DeCarlo 2004]

facial illustration



[Gooch et al. 2004]

medical visualization



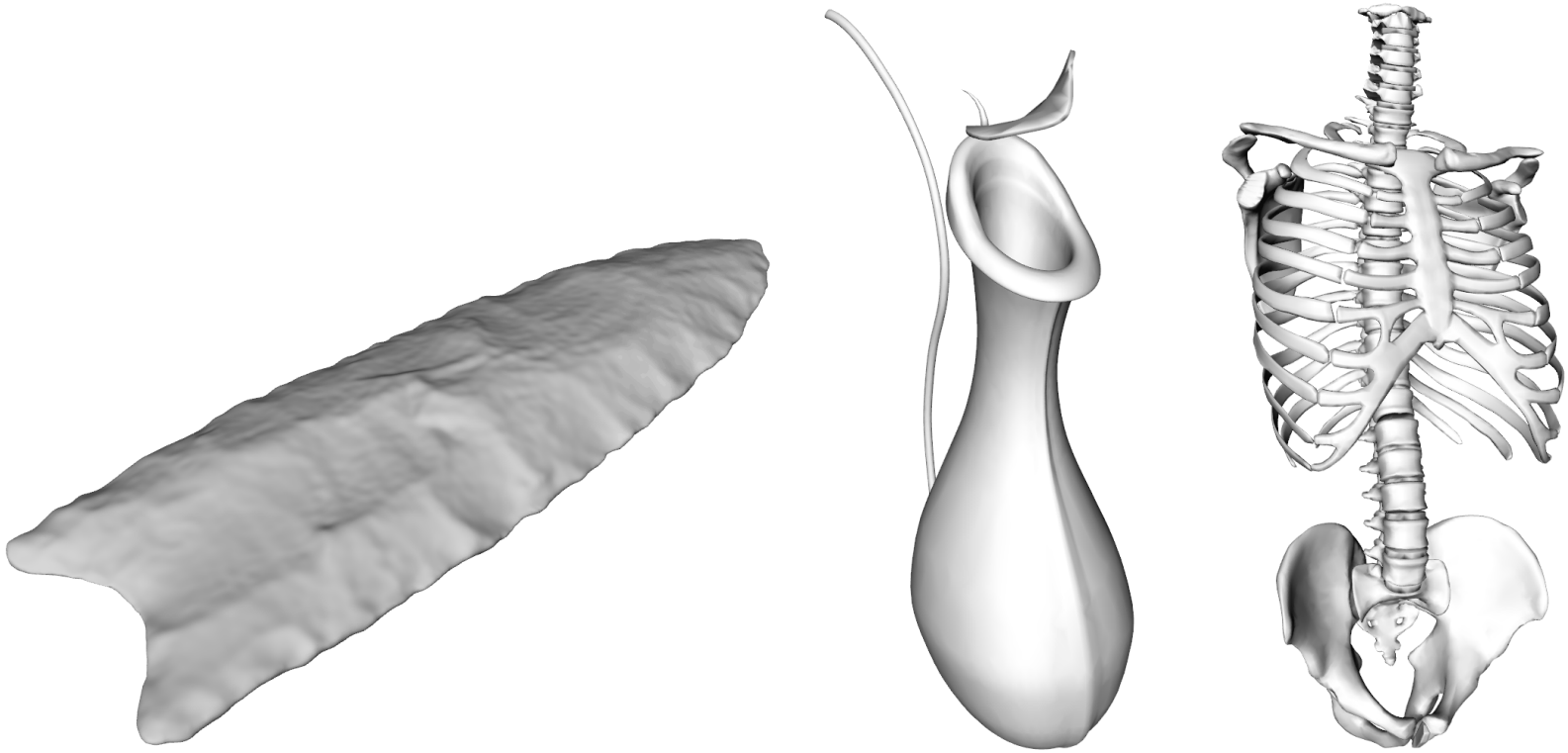
[Tietjen et al. 2005]

Study Rationale

- viewing/evaluating/understanding illustrations: complex process, difficult to analyze
- exploratory observation:
  - no predetermined hypothesis
  - ethnographic technique: pile sorting
  - criteria & terminology determined by participants
  - important goal: not to bias participants
- observing participants' actions & opinions
- qualitative results

Study Setup: Images

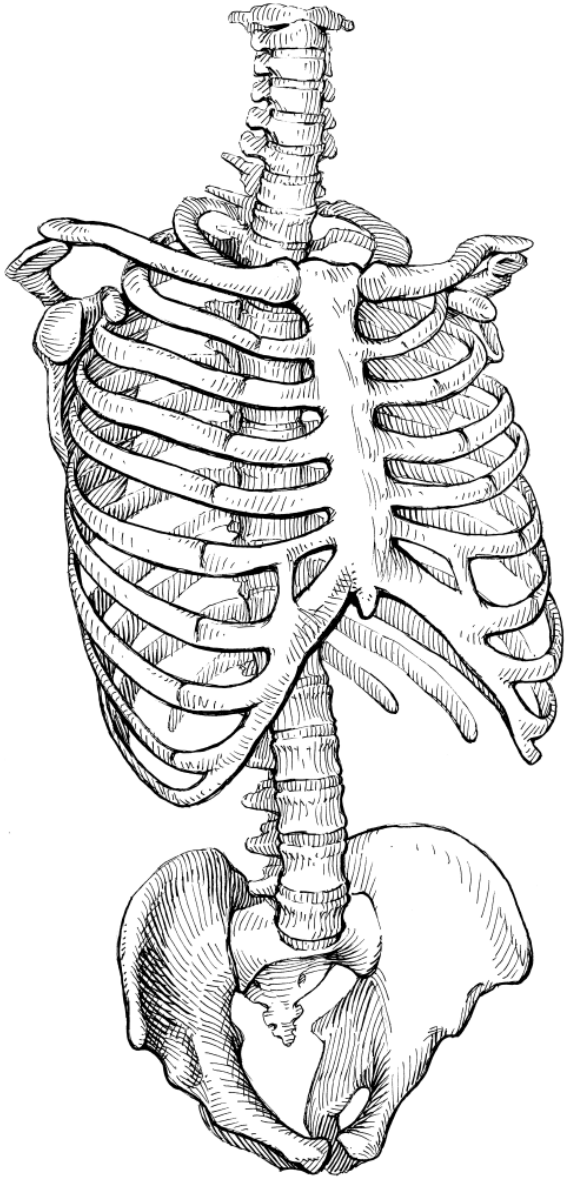
- 30 images of 3 "models" generated: archaeological, botanical, and medical model



- 5 professional illustrators and 5 NPR algorithms

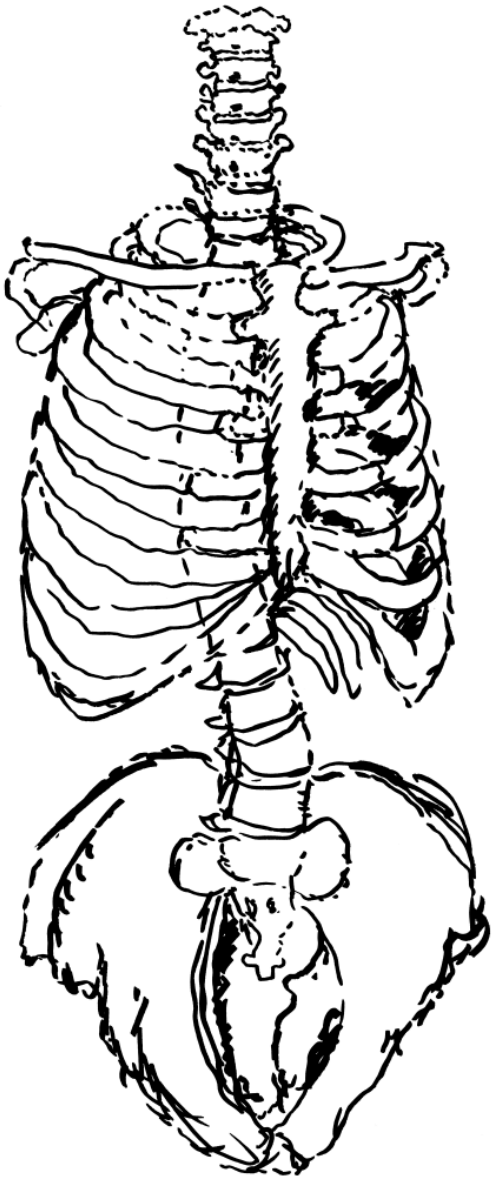
Study Setup: Professional Illustrators

- William M. Andrews:
  hatching or stippling w/ silhouettes
- Davide Brunelli:
  sketchy hatched outlines
- Humberto Costa Sousa Filho:
  silhouette, scratchboard w/ hatching
- Andrew E. B. Swift:
  hatching w/ silhouettes
- Lynda Smith Touart:
  stippling w/ outlines



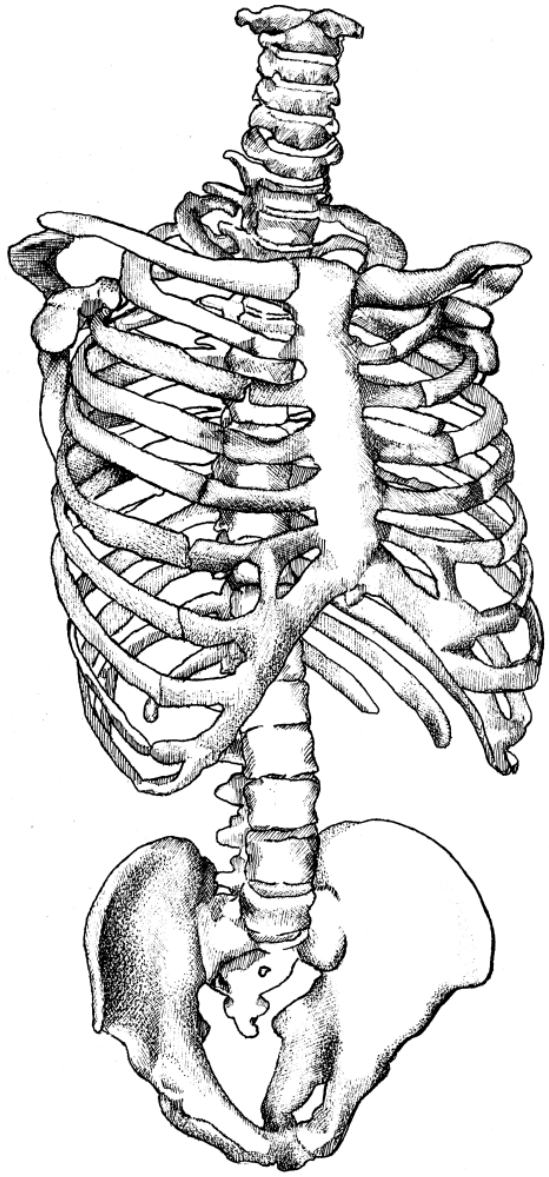
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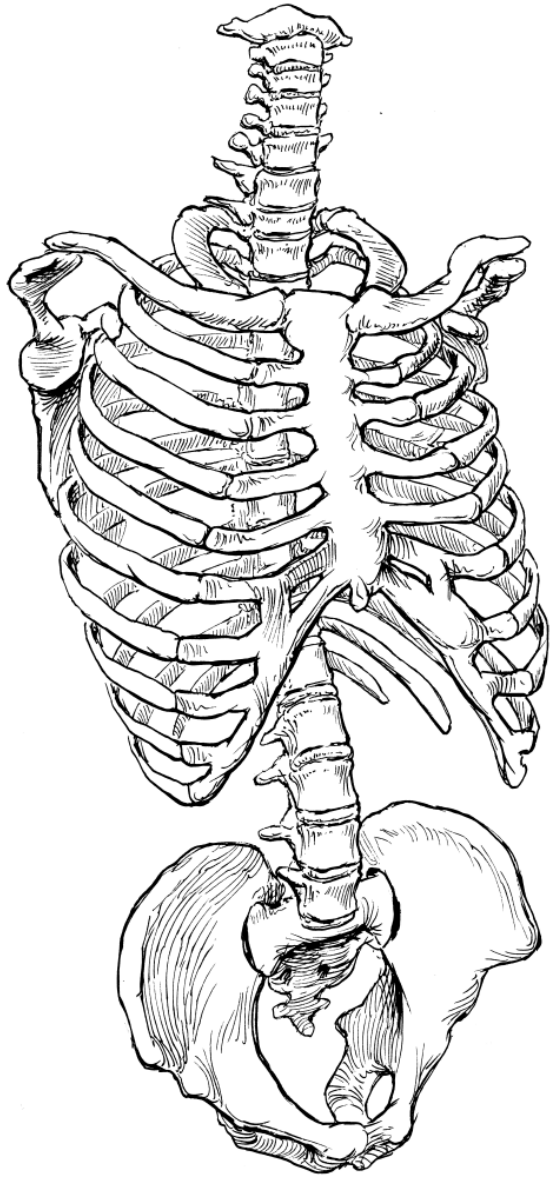
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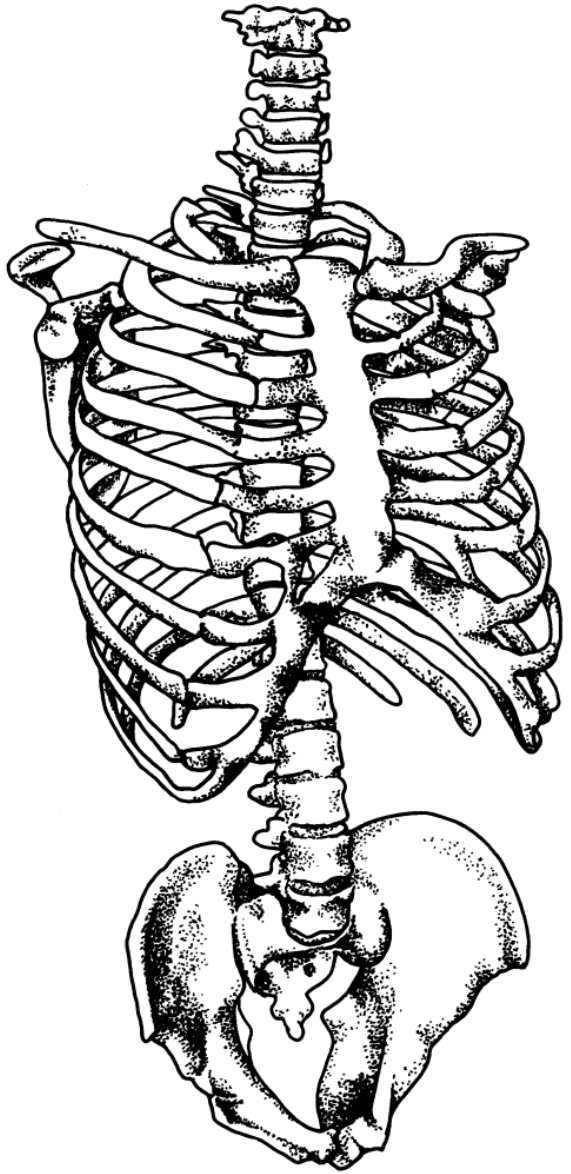
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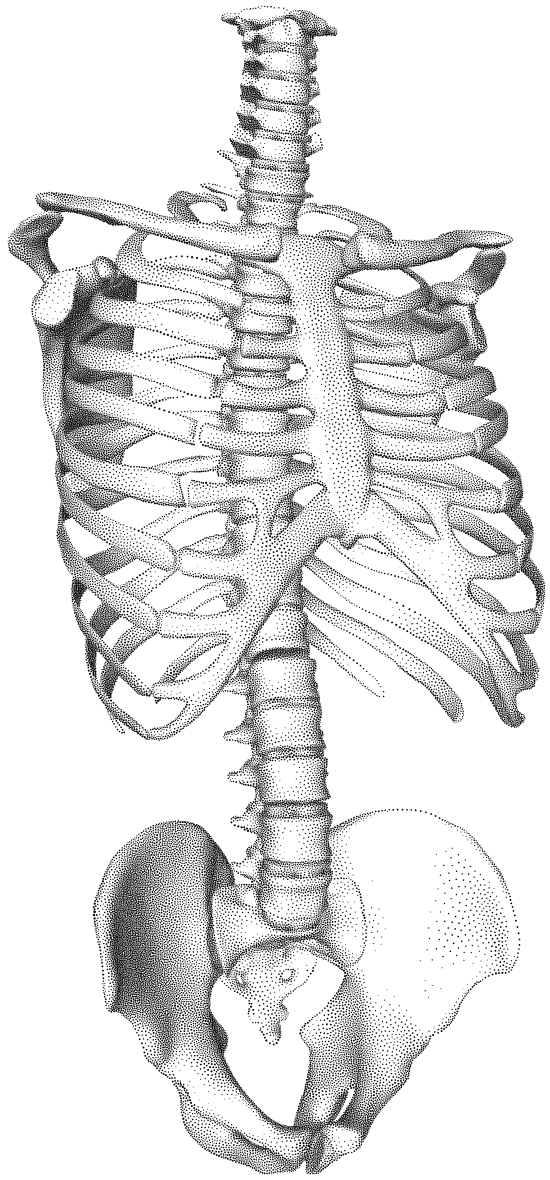
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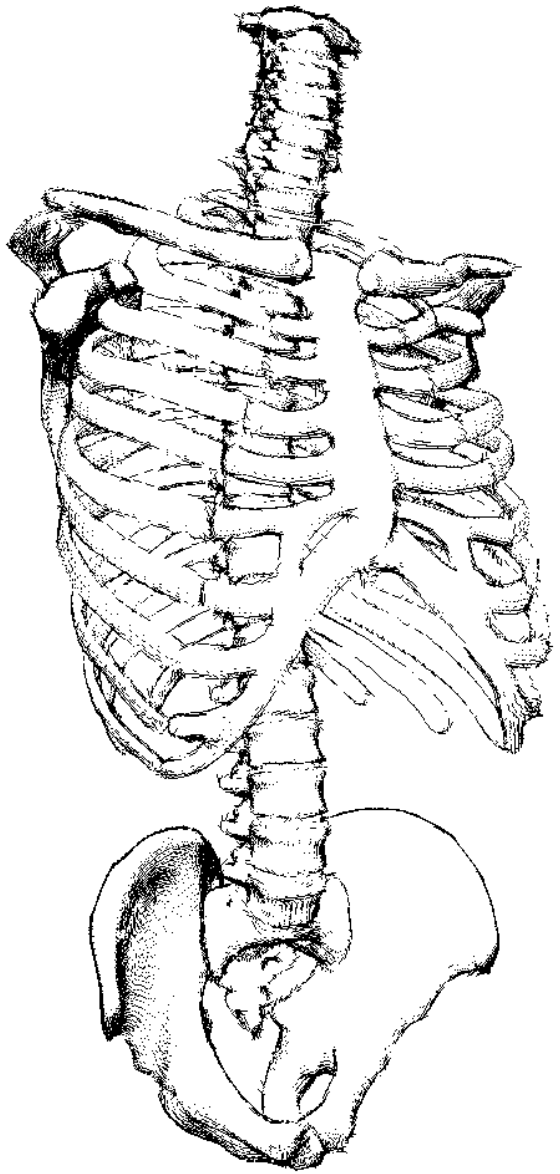
Study Setup: NPR Pen-and-Ink Algorithms

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- [Sousa et al. 2003 & 2004]:
  precise ink marking
- [Zander et al. 2004]:
  cross-hatching with silhouettes
- [Schlechtweg et al. 2005]:
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- [Schlechtweg et al. 2005]:
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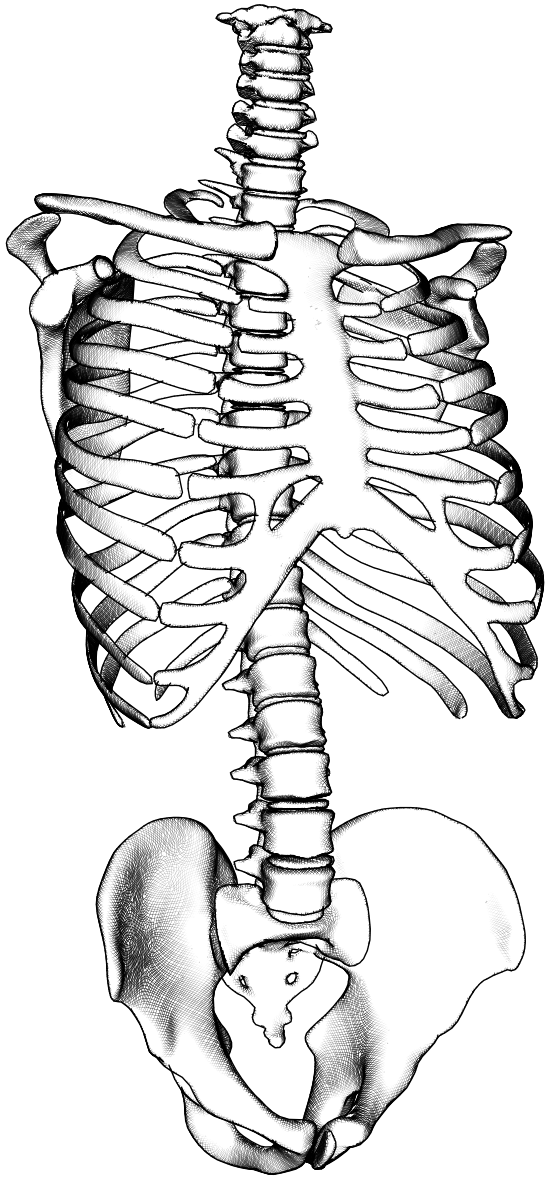
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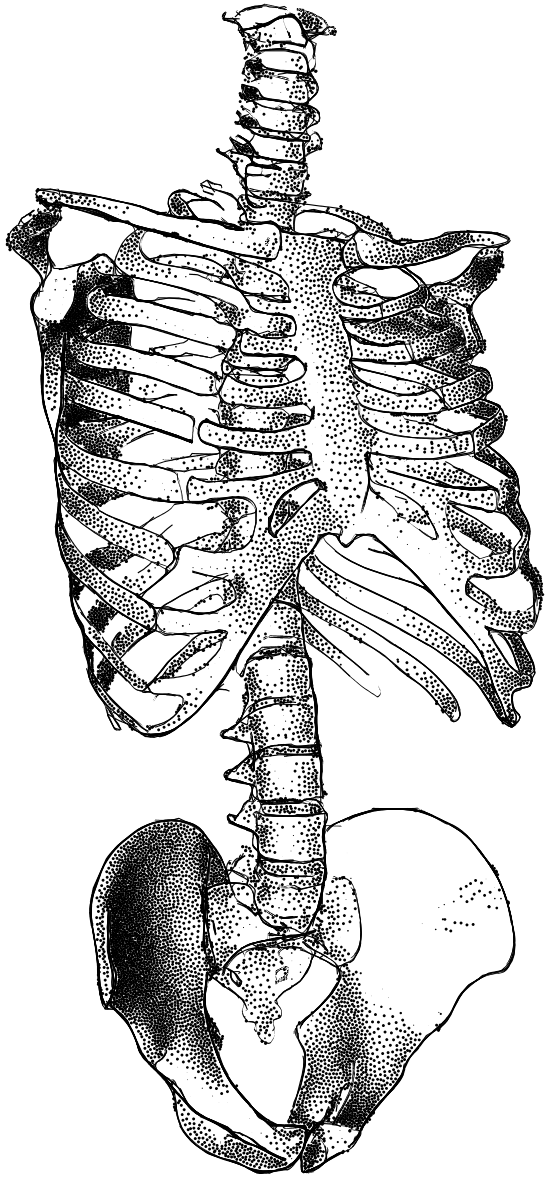
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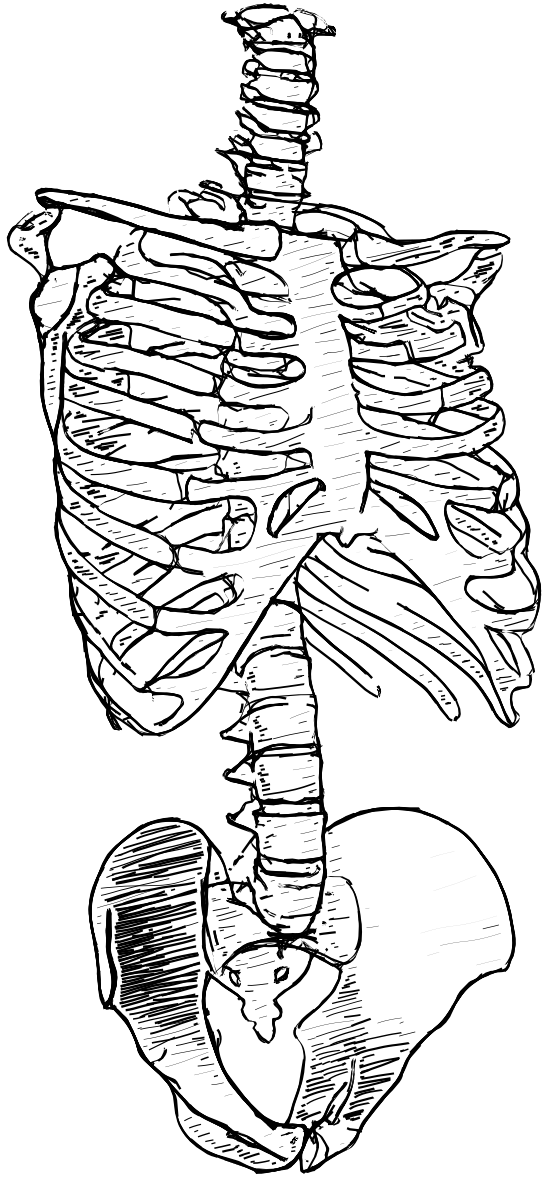
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Study Setup: Participants

- four main groups:
  1. domain experts:
     scientists etc. who know their field
  2. professional illustrators:
     know how to make good illustrations
  3. illustration end users:
     learn with the produced illustrations
  4. NPR researchers:
     develop methods to produce illustrations with computers

- in our study: groups 2–4; mainly graduate students

- 8 participants per group; $\sum$ 24 participants

Study Setup: Procedure

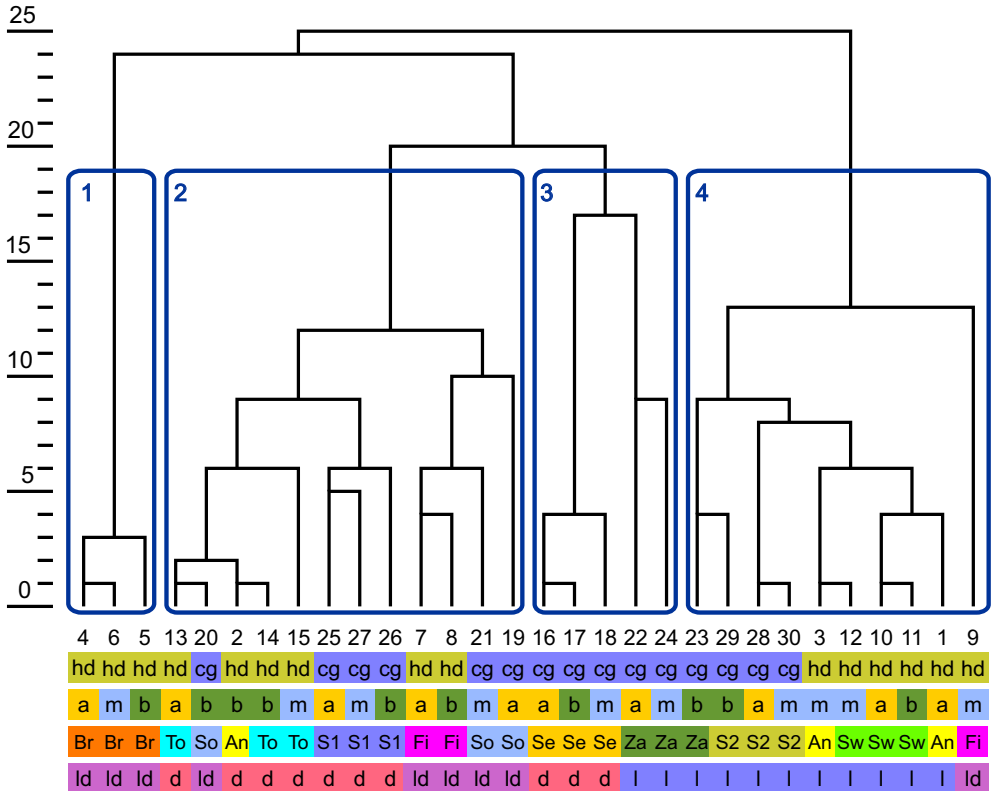
- about 1 hour or less for each session
- three stages
  1. unconstrained pile-sorting:
     grouping objects,
     free choice of criteria
  2. semi-structured interview:
     discussion of the piles
     and predefined questions
  3. post-session questionnaire:
     demographics and
     previous experiences



- data acquisition through video and note taking

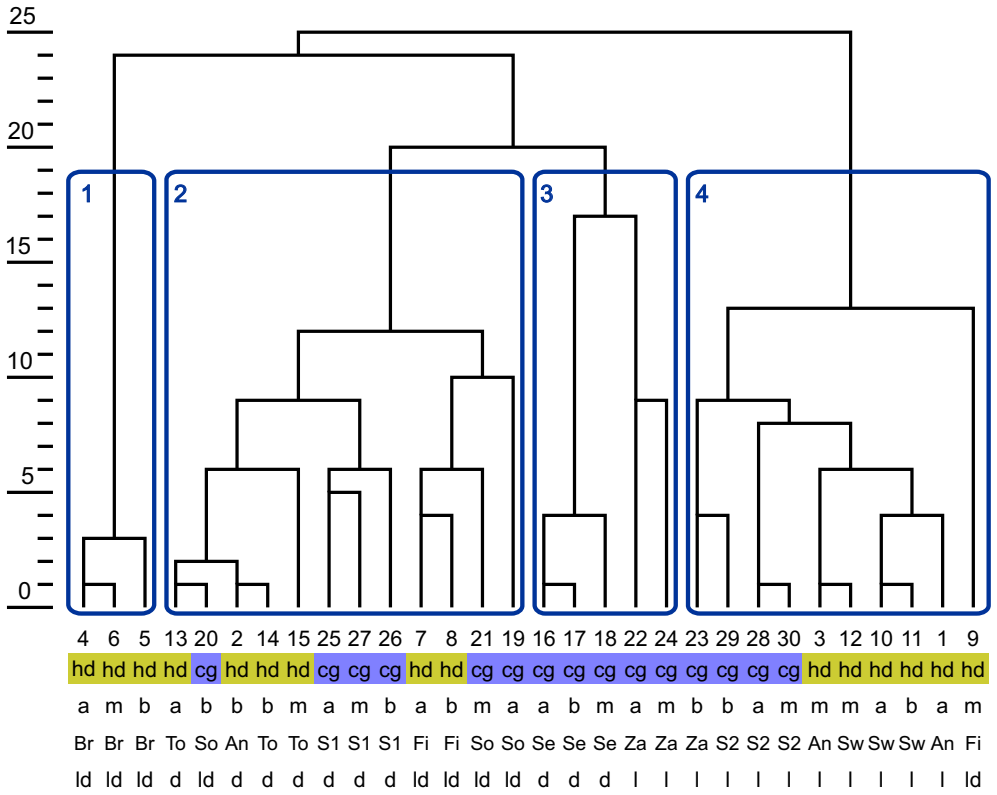
Results

- categorization by drawing/rendering style by most people
- less often used criteria: realism/detail, aesthetics, information contents, and orientation
- no significant differences between how the three groups categorized
- cluster graph from correlation table



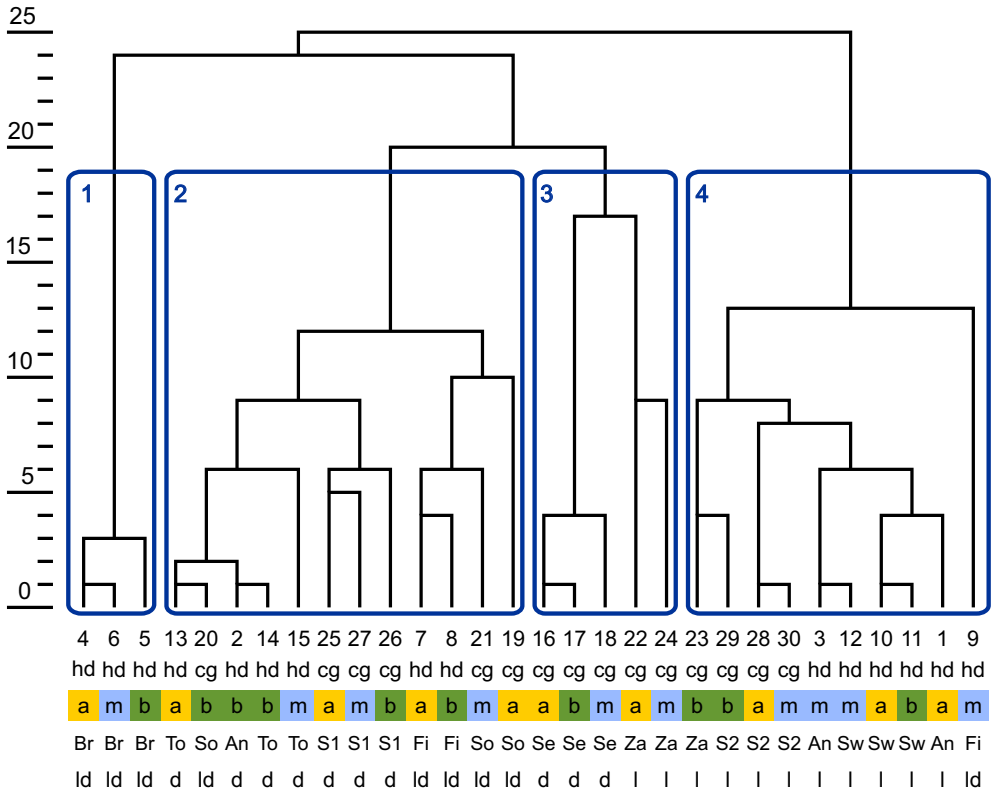
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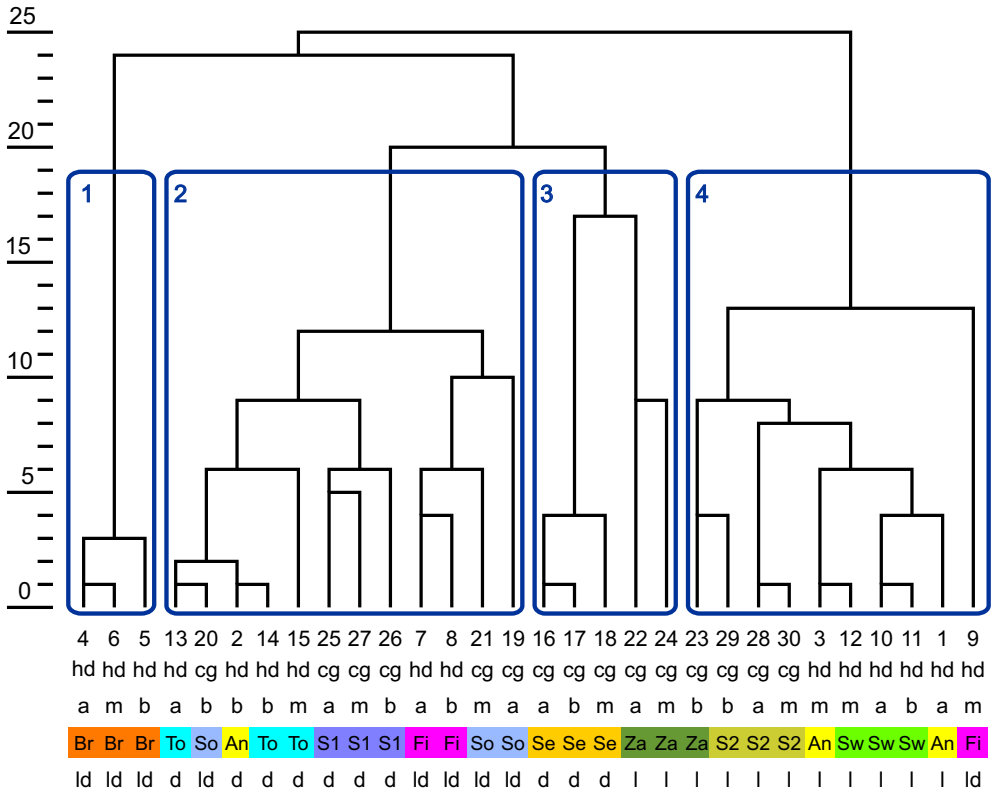
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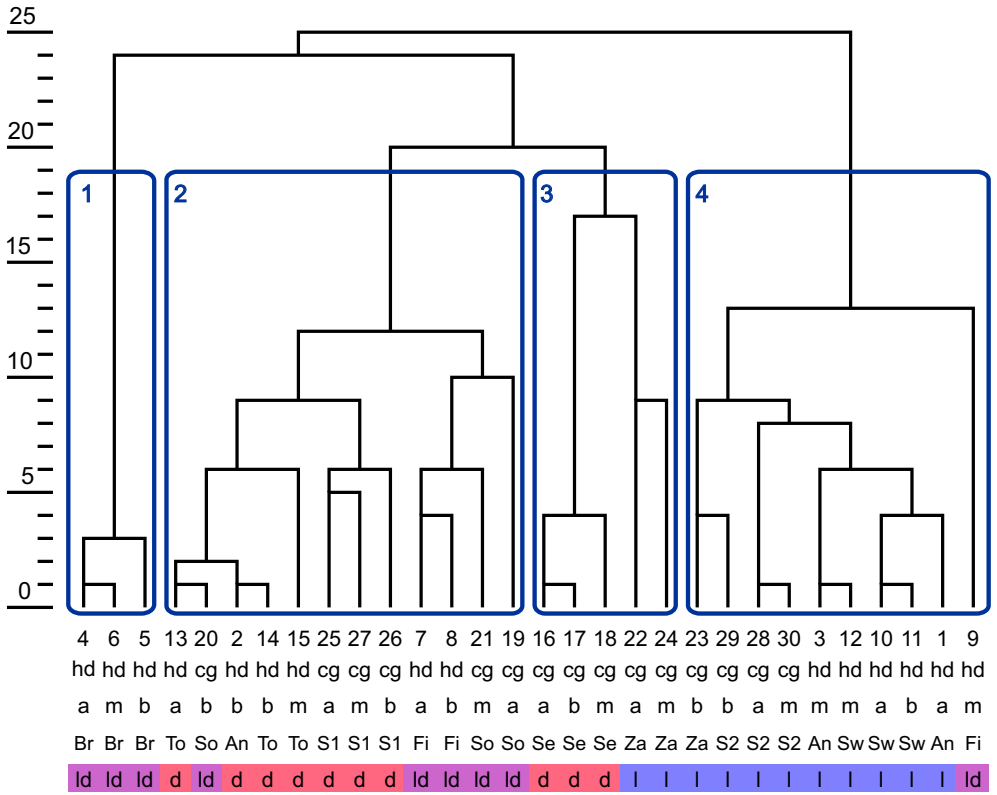
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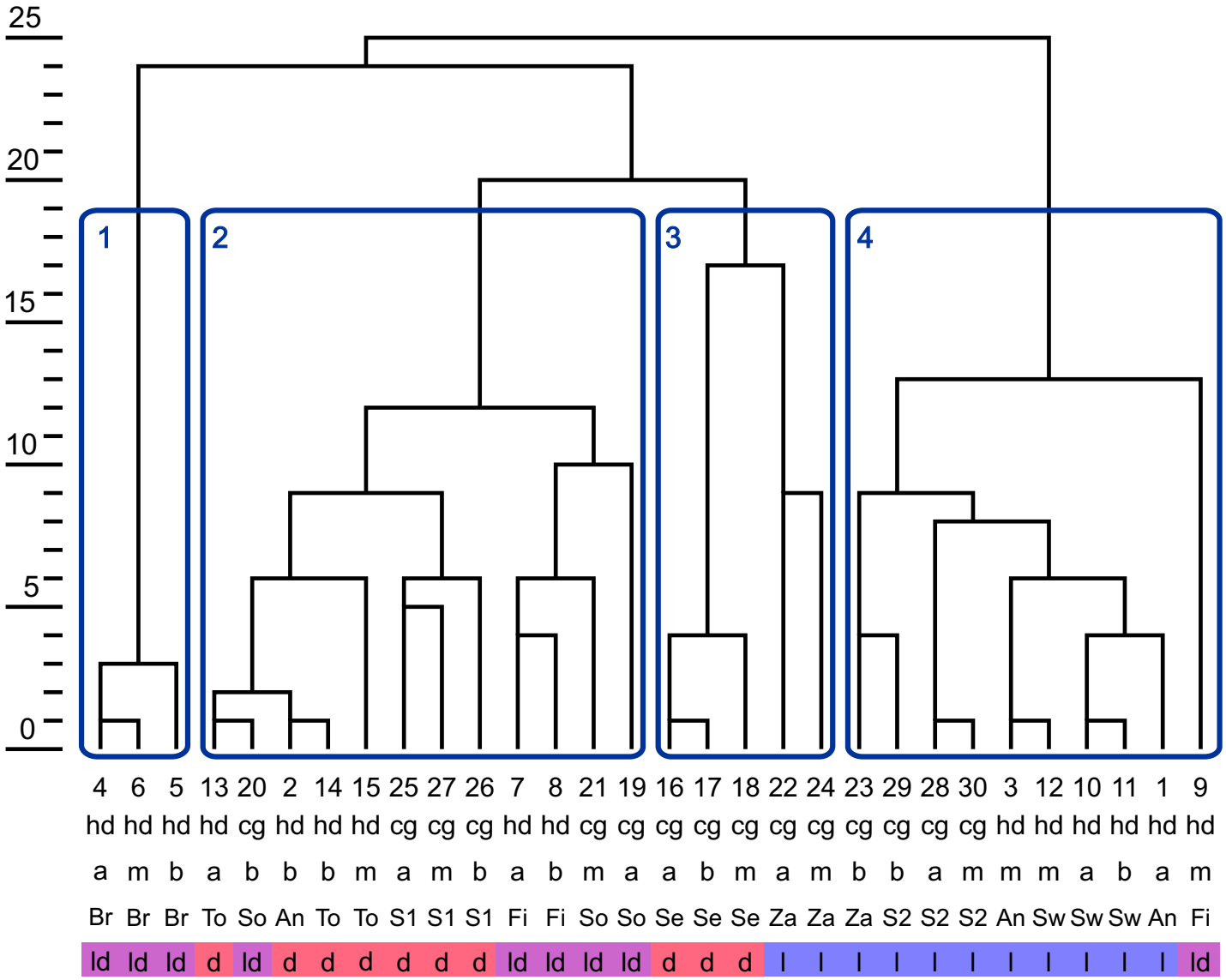
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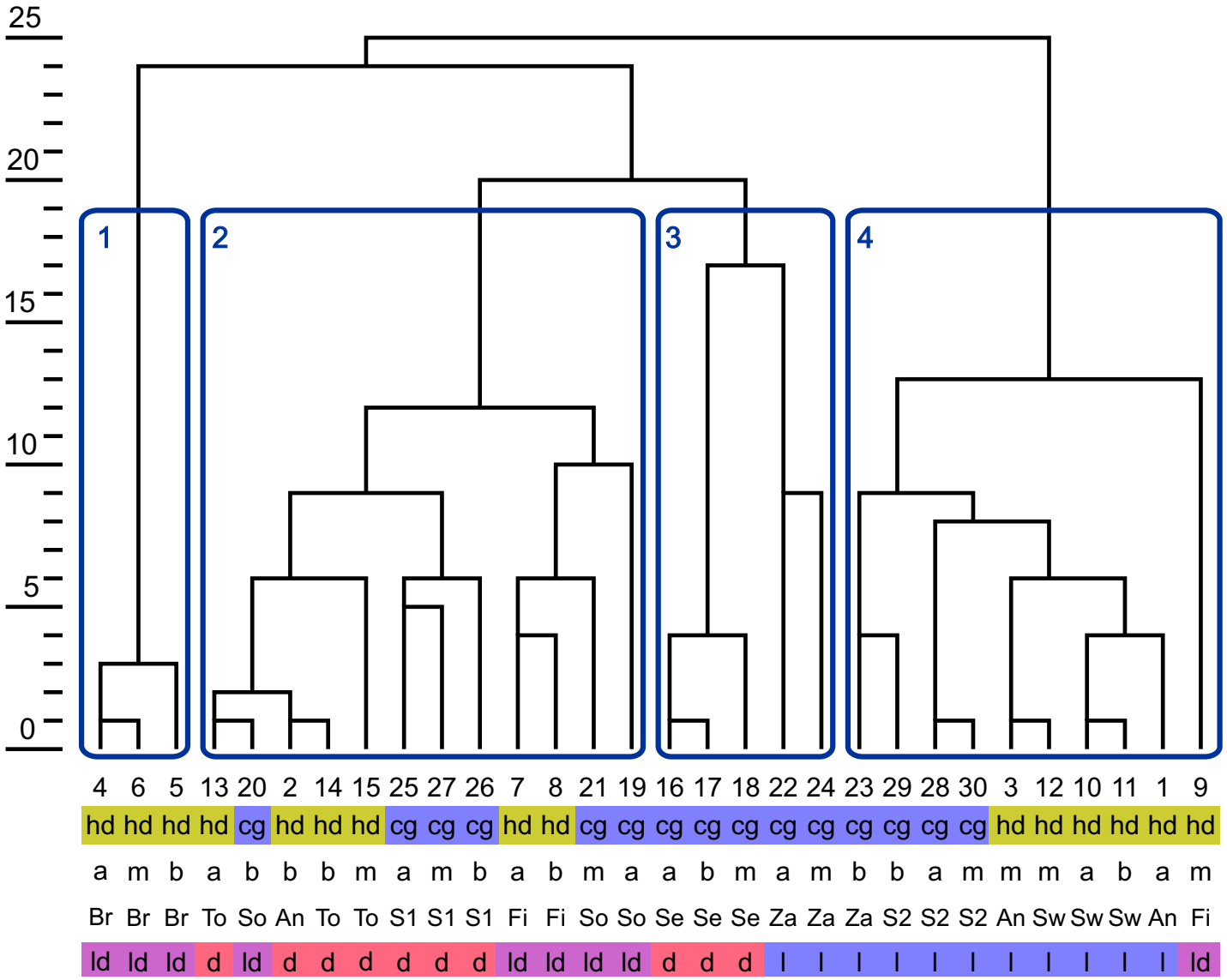
Discussion: pile-sorting to facilitate open discussion



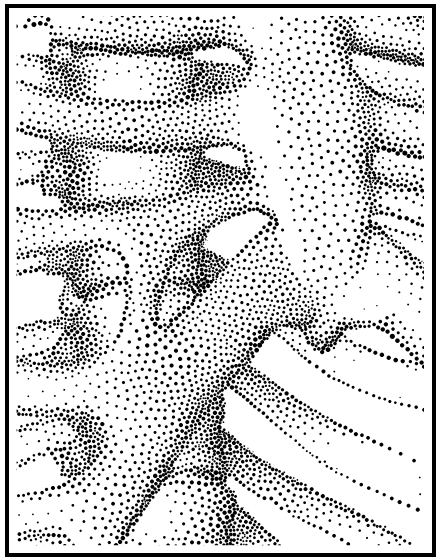
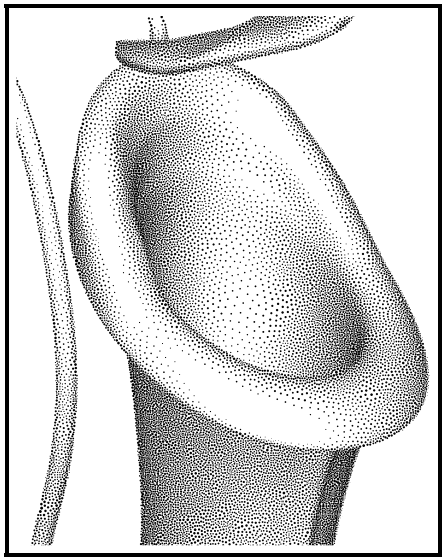
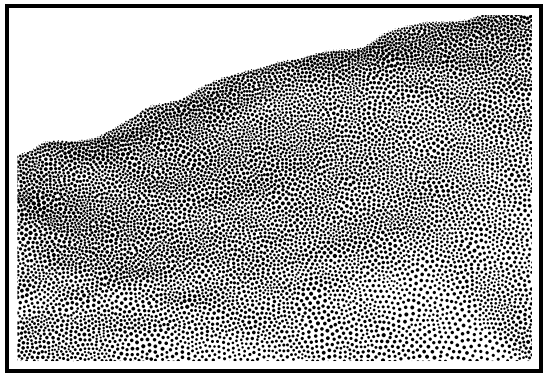
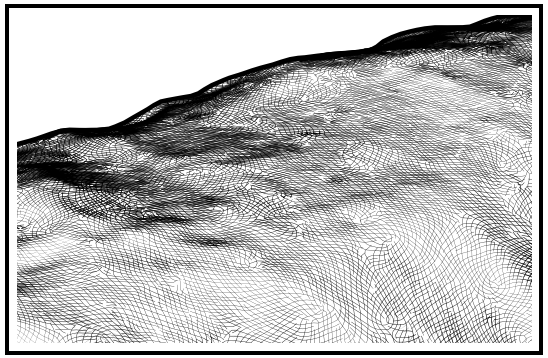
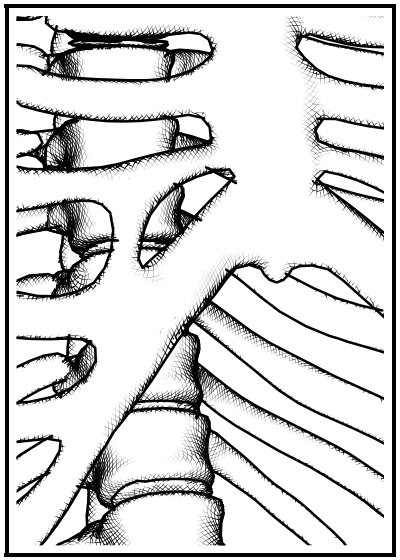
Discussion: categories by style (hatching vs. stippling)



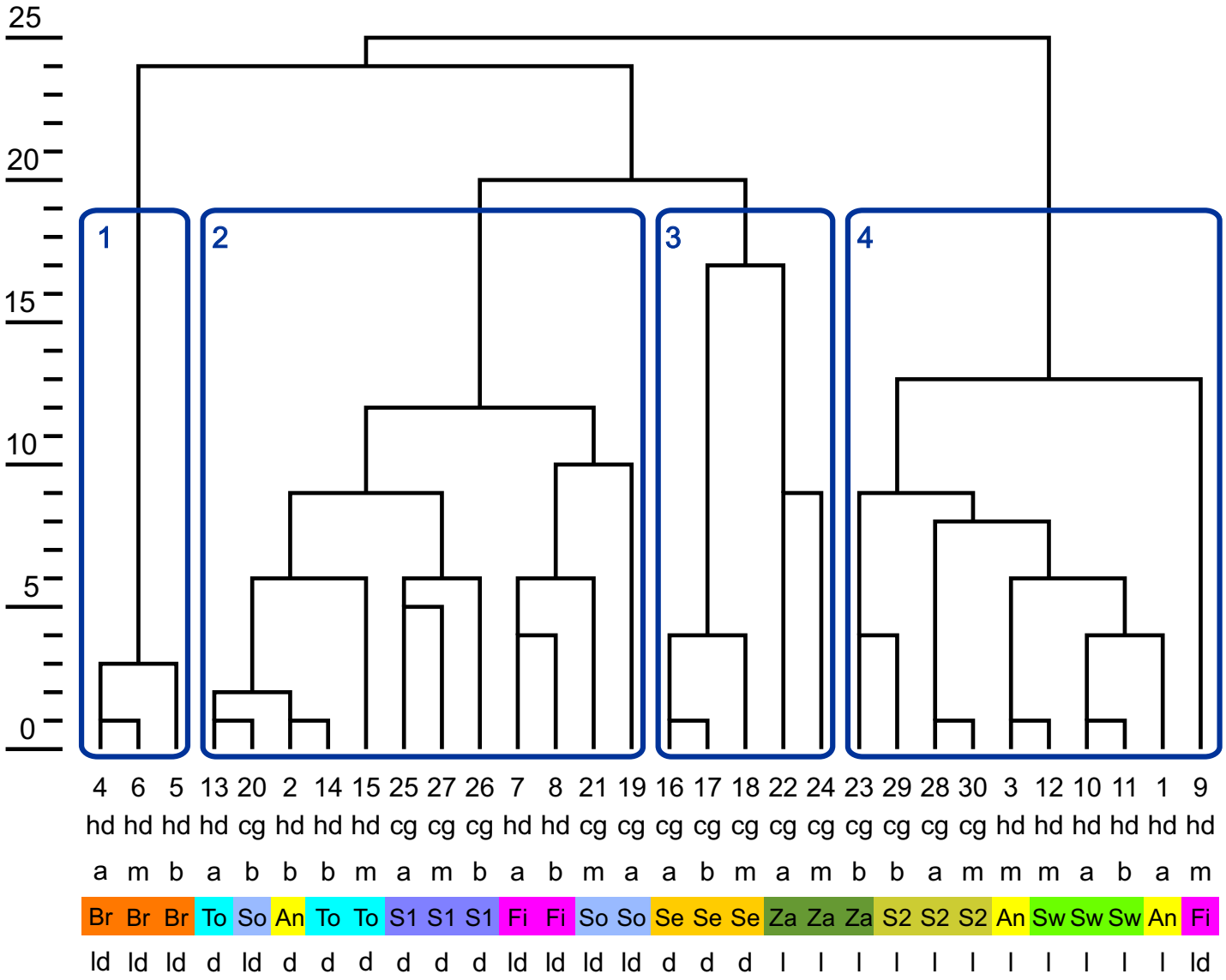
Discussion: amount of detail important (Cluster 3)



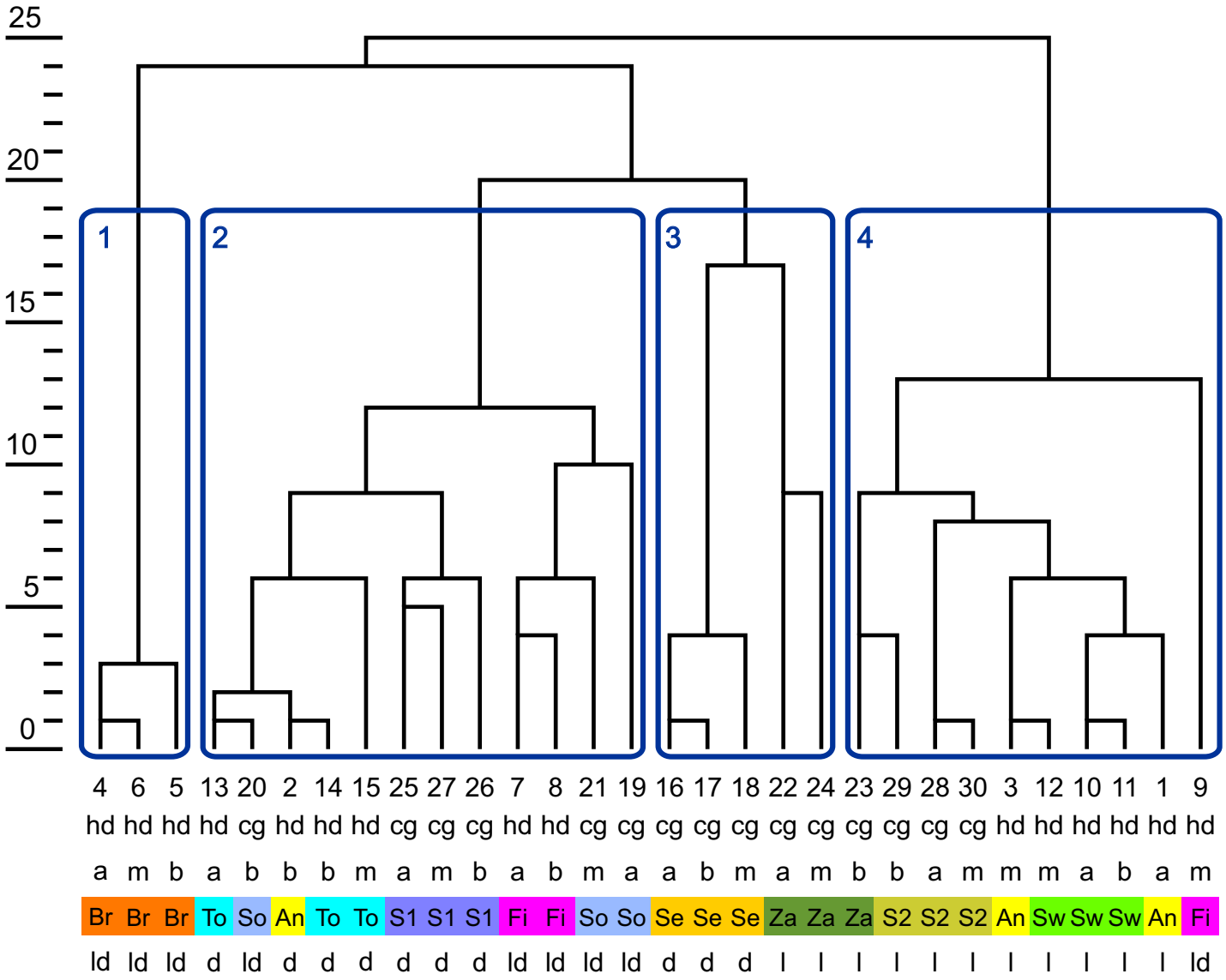
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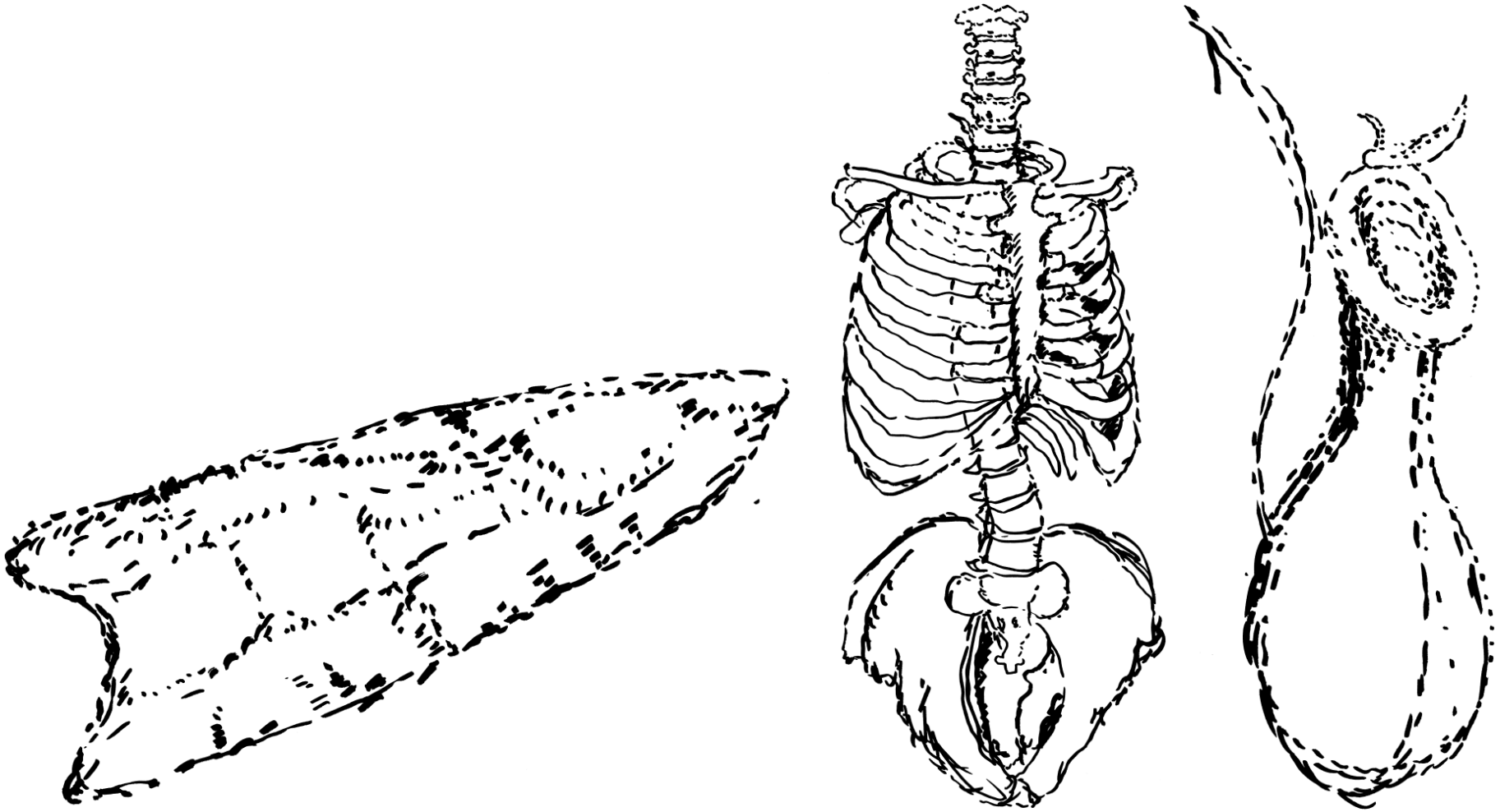
Discussion: some categorization by artists/algorithm



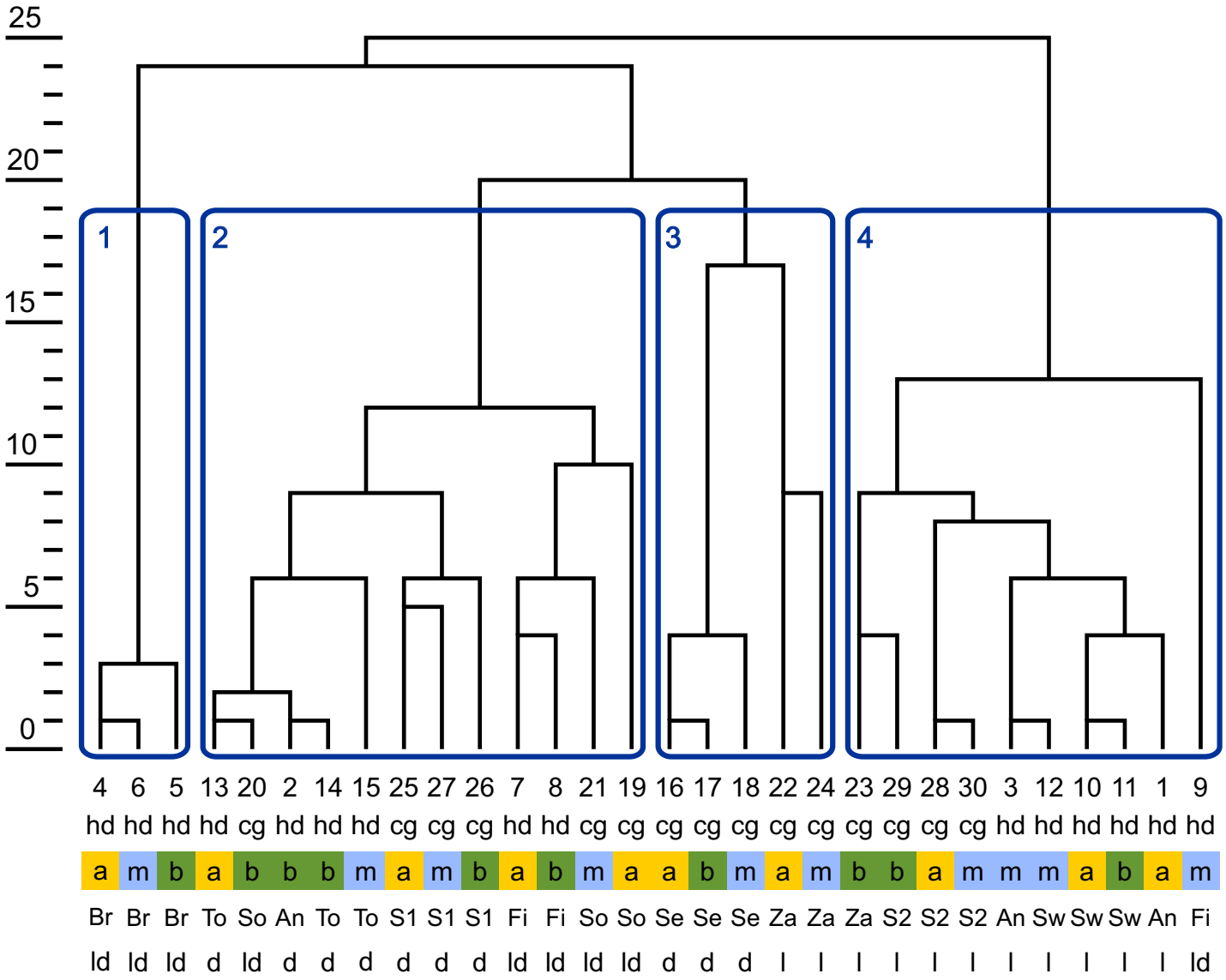
Discussion: Cluster 1: very distinct style—loose and sketchy



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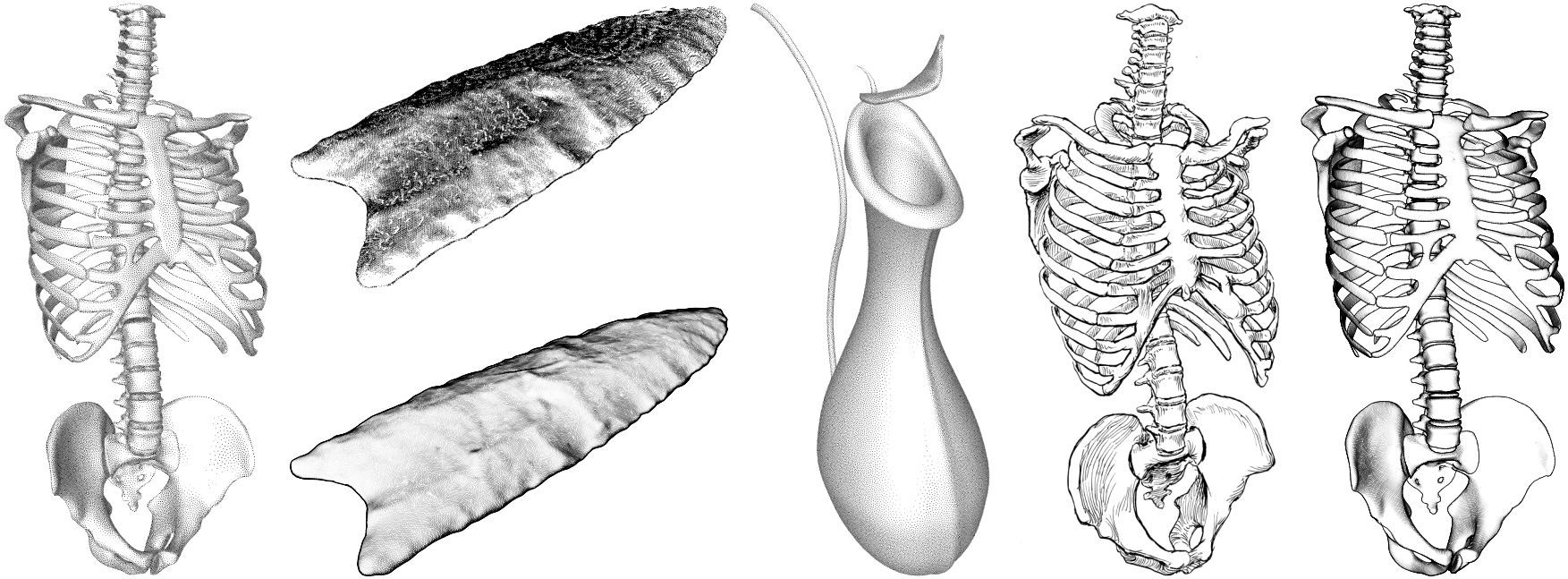
Discussion: no clustering w. r. t. model



Possible contexts for images

- science & art textbooks, in classes & museums, other publications, also art displays, comics, games & software

- usage in university textbooks:

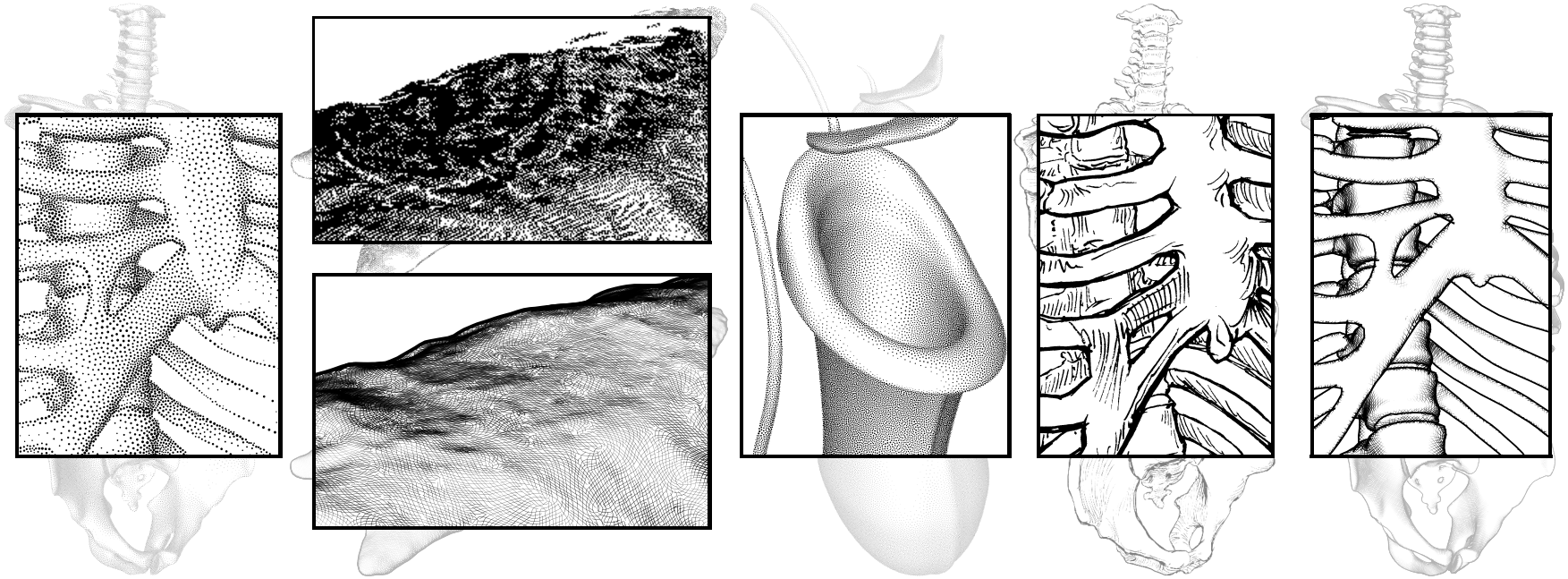


- children's textbooks: more hand-drawn; conflicting opinions

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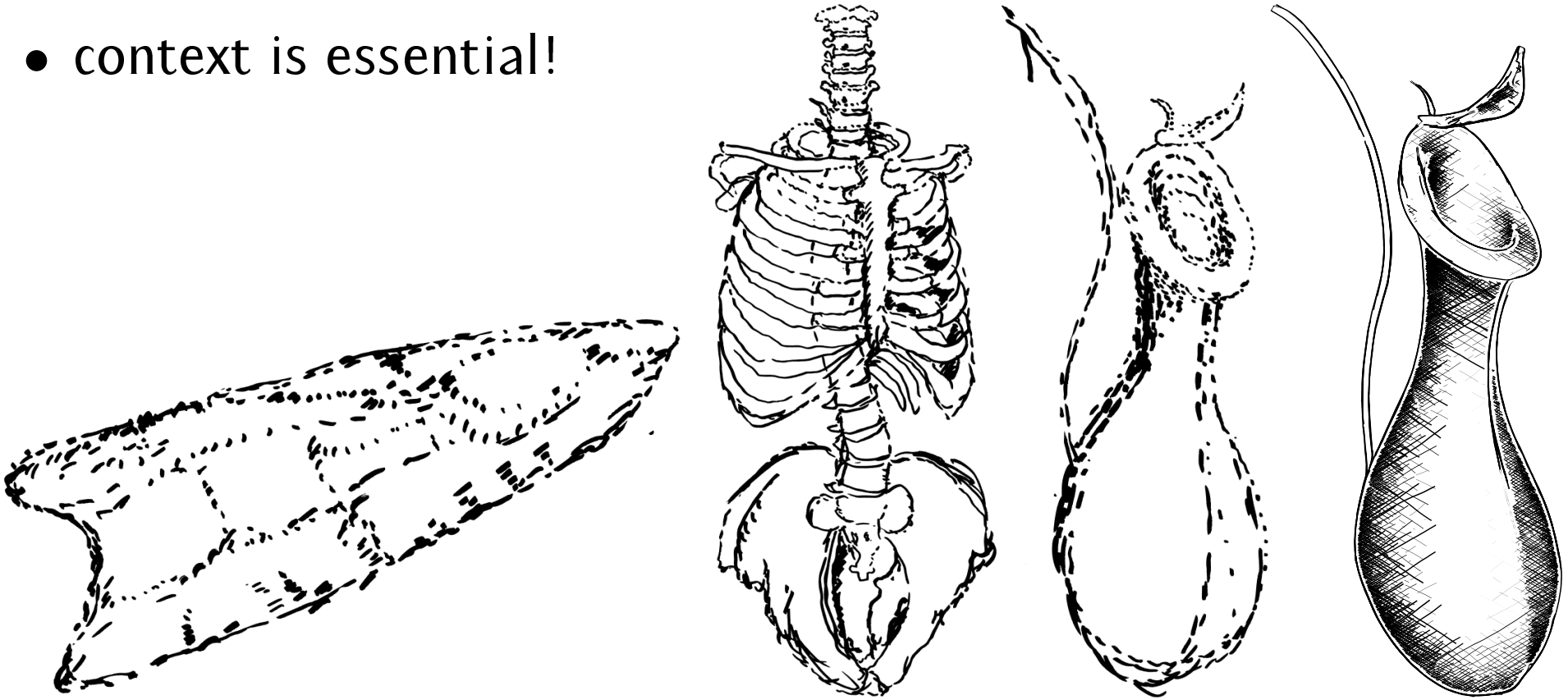
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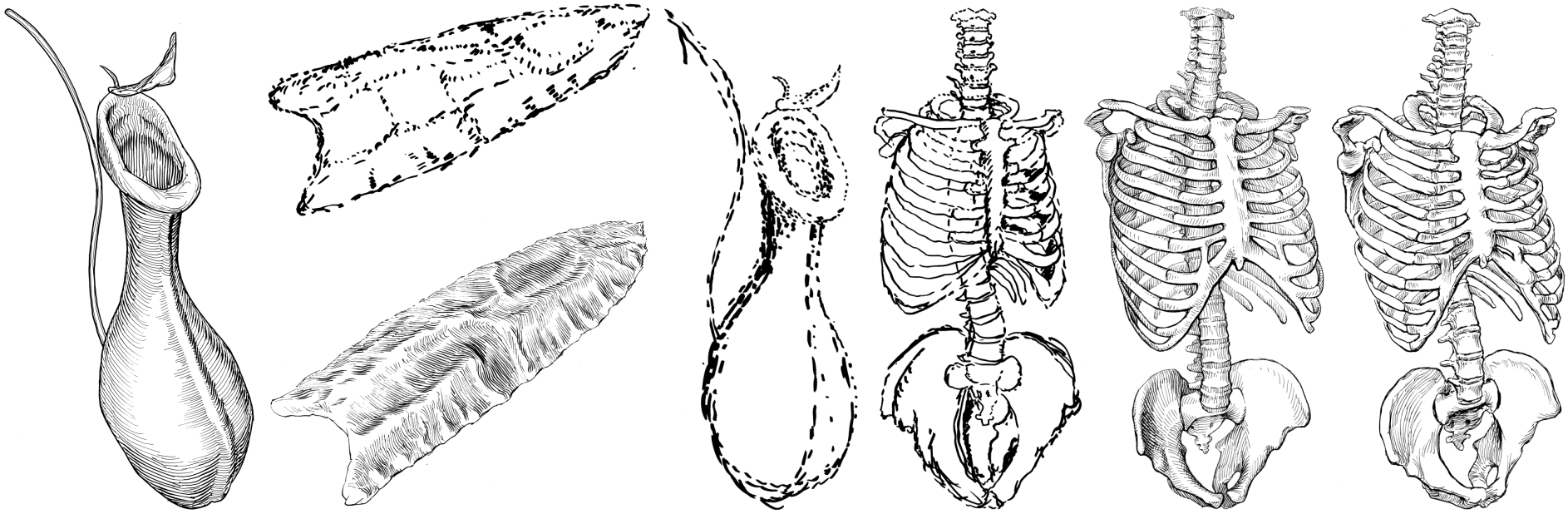
Image liking and appeal

- no clear favorites
- least favorites (named by $\geq 58\%$, all others $\leq 25\%$):
- context is essential!



Images looking most CG or hand-drawn

- many hand-drawn images stood out as such—lines:

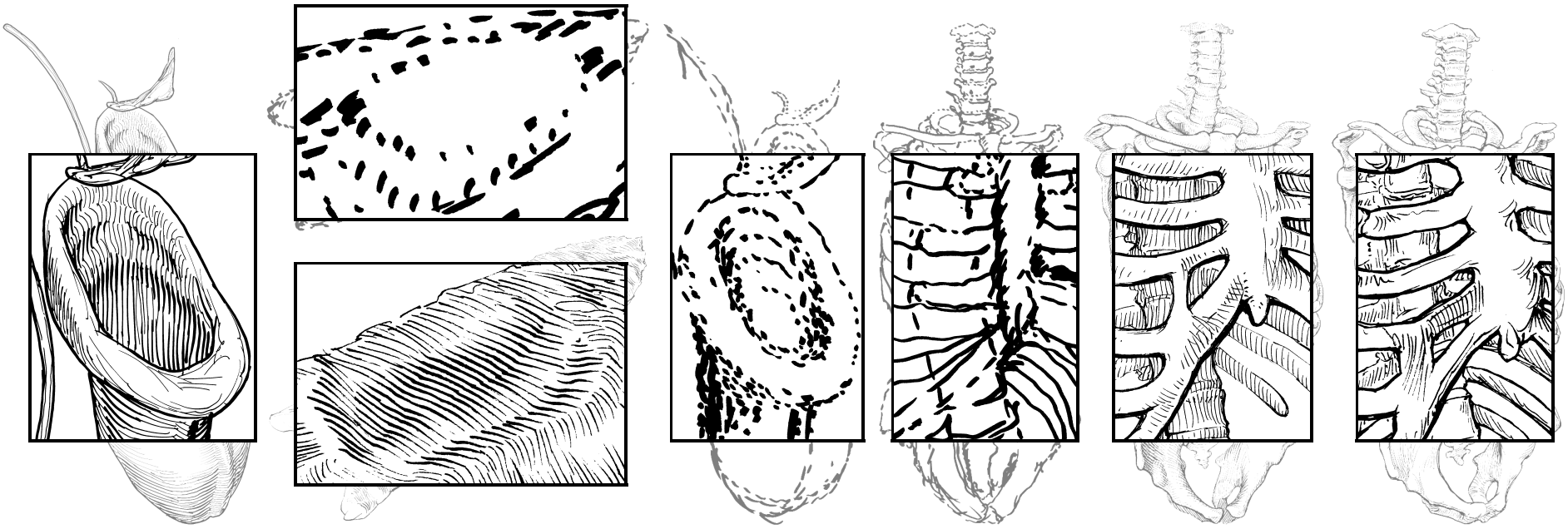


83% 83%/71% 79% 79% 67% 58%

- hand-drawn images less often named: stippling or mix of stippling with lines

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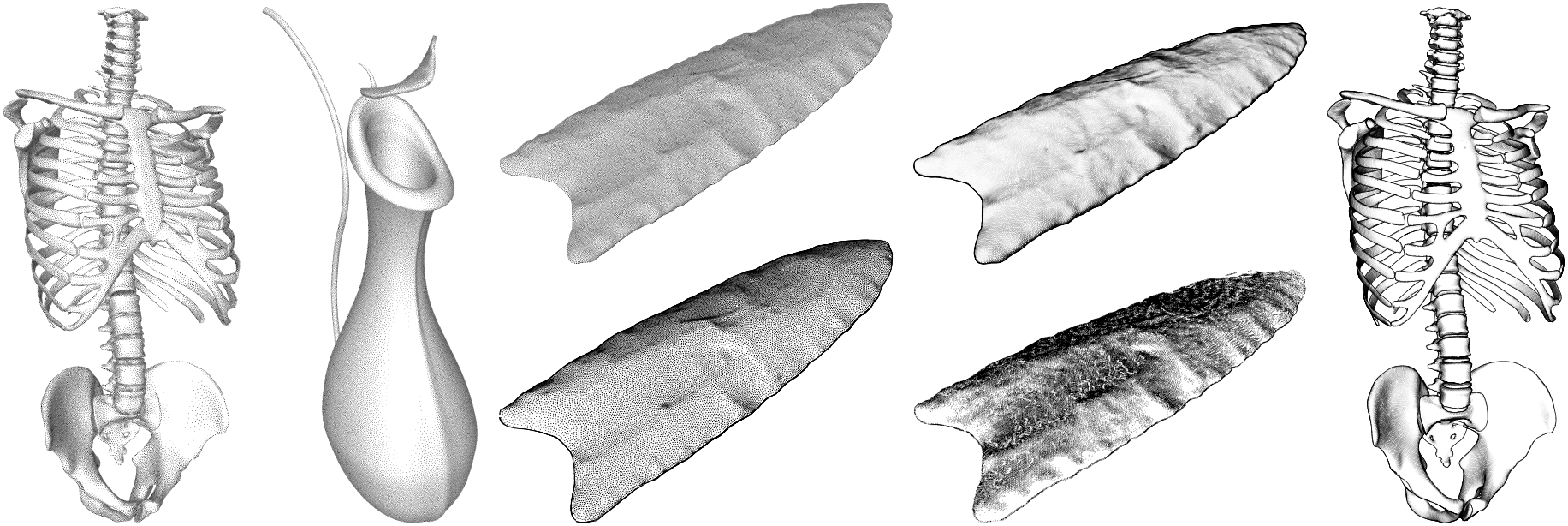


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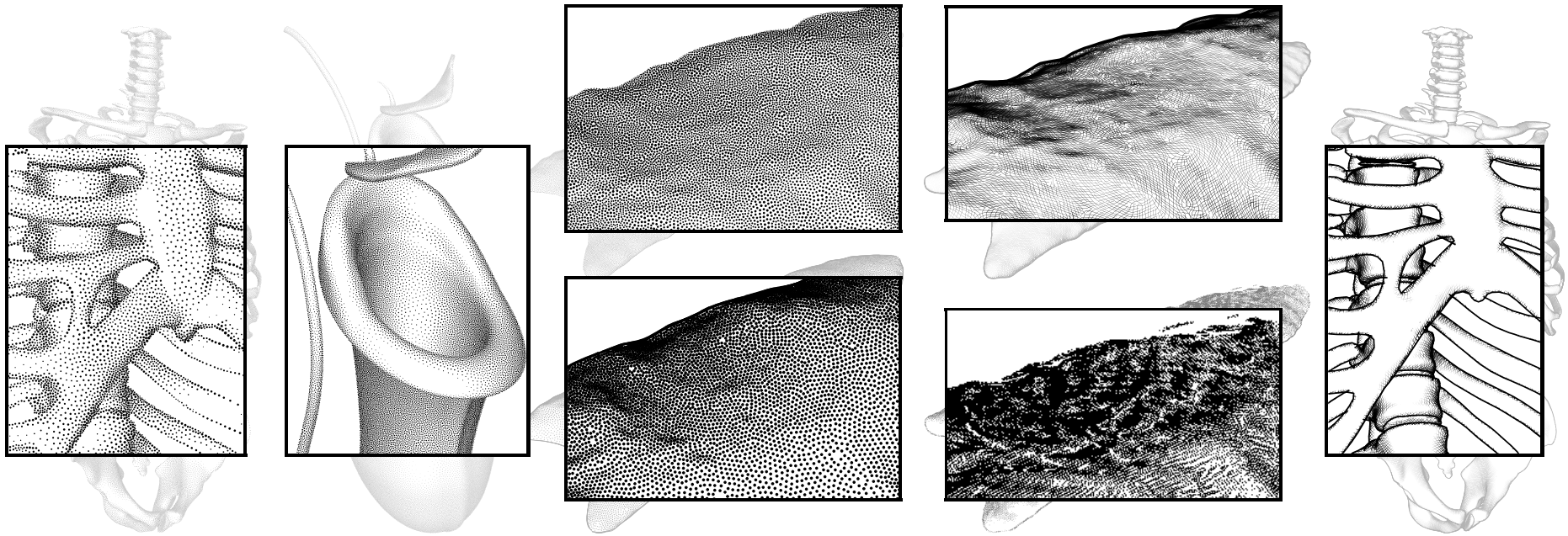
- cg images often named to stand out as such: stippling or high-resolution lines



88% 79% 79%/58% 54%/42% 46%

Images looking most CG or hand-drawn

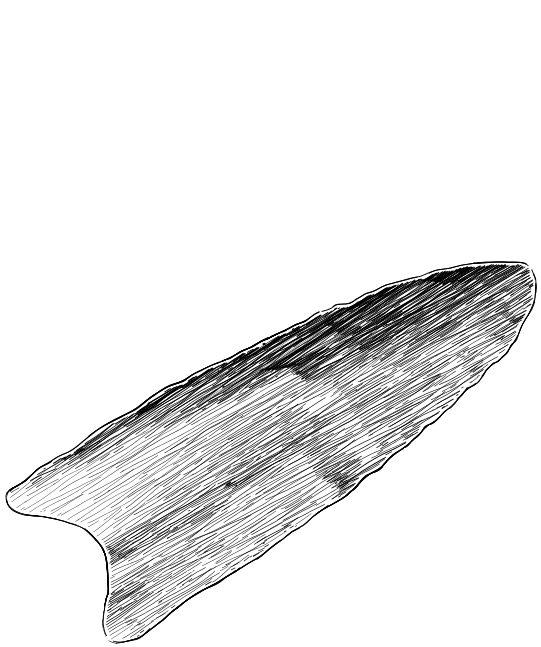
- cg images often named to stand out as such: stippling or high-resolution lines



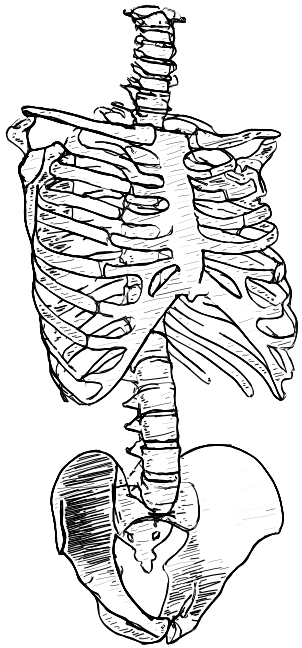
88% 79% 79%/58% 54%/42% 46%

Images looking most CG or hand-drawn

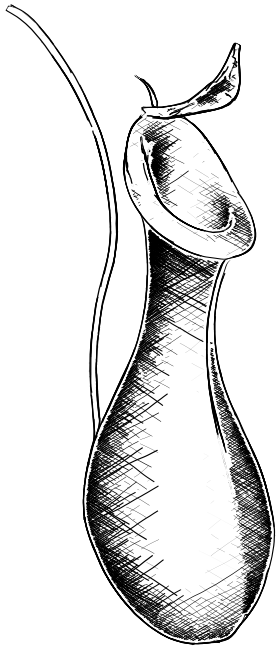
- hand-drawn images rarely named to stand out as cg ($\leq 13\%$)
- some cg images frequently thought to be hand-drawn:



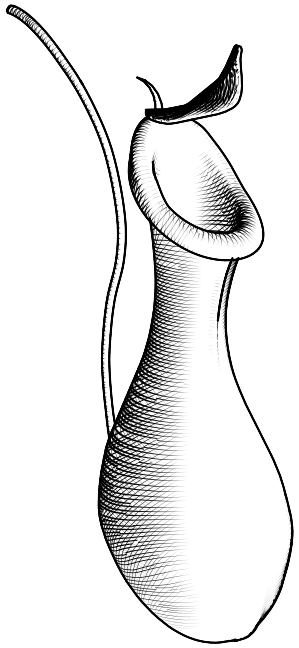
67%



63%



46%

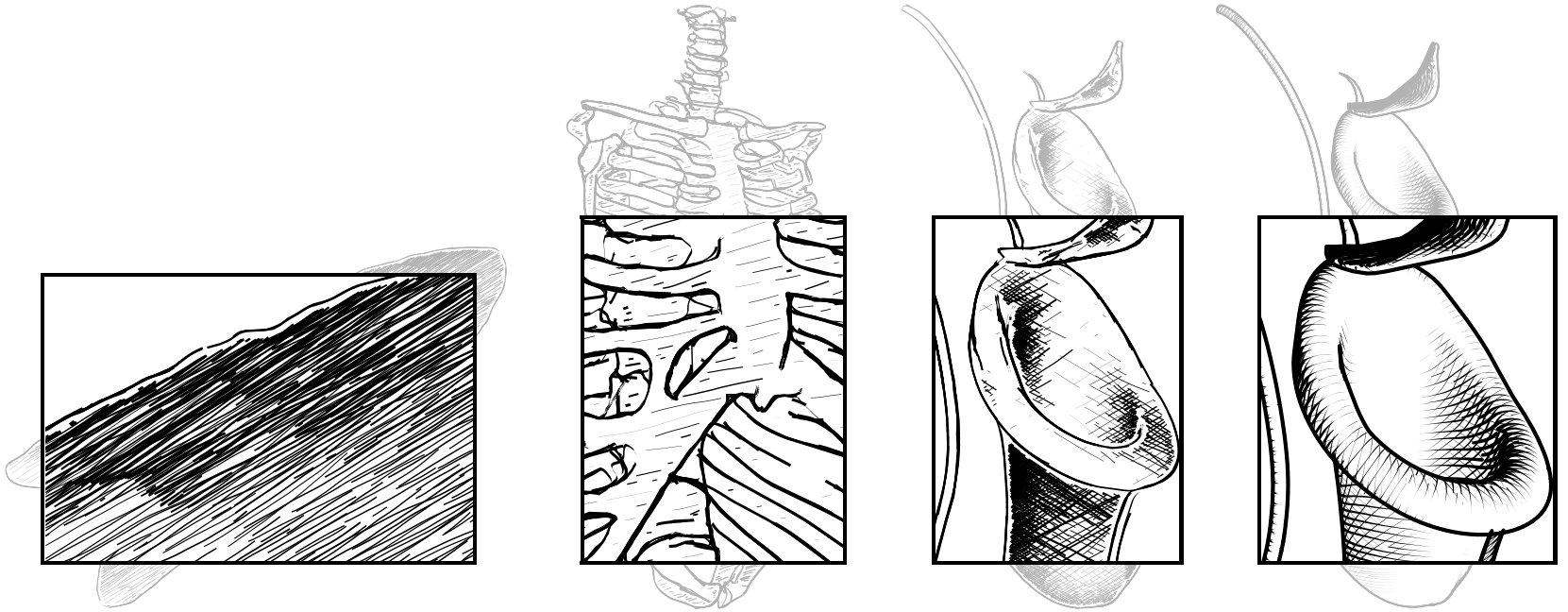


29%

- randomness, longer and less dense lines, lower detail

Images looking most CG or hand-drawn

- hand-drawn images rarely named to stand out as cg ($\leq 13\%$)
- some cg images frequently thought to be hand-drawn:



67% 63% 46% 29%

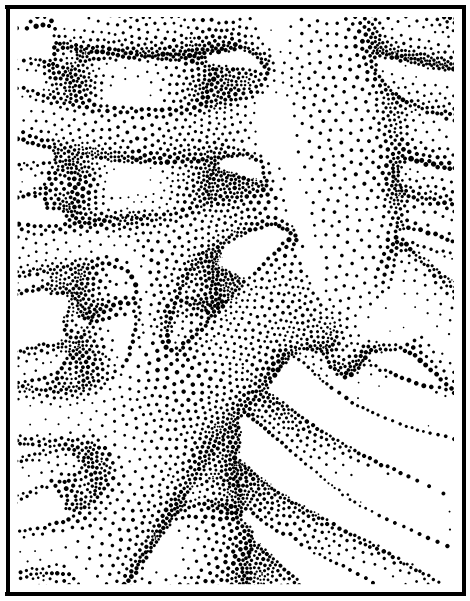
- randomness, longer and less dense lines, lower detail

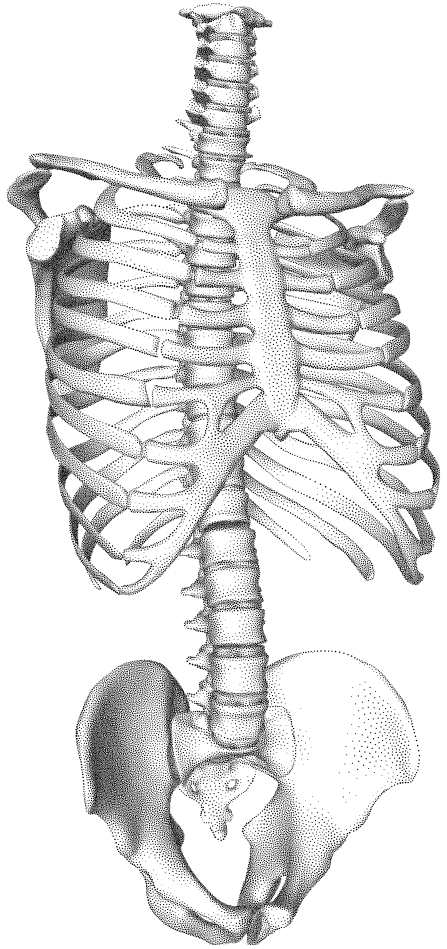
Discussion

- NPR-Turing test not passed, CG images recognized as such (named standing out as hand-drawn by $\leq 29\%$)
- some almost always recognized as CG:
  detail, 3D shading, exactness
- depending on algorithm AND parameters
- one major exception:
  RenderBots hatching
  "sketchy", *"simplified"*,
  "not show shape well"

Discussion

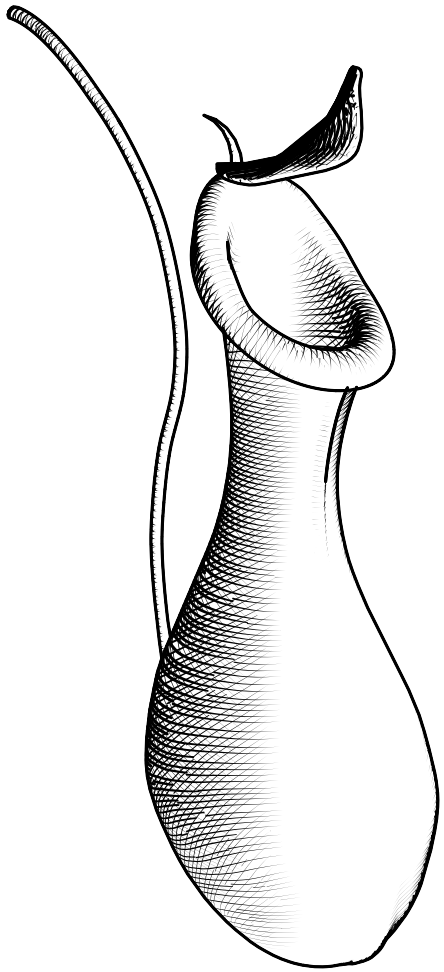
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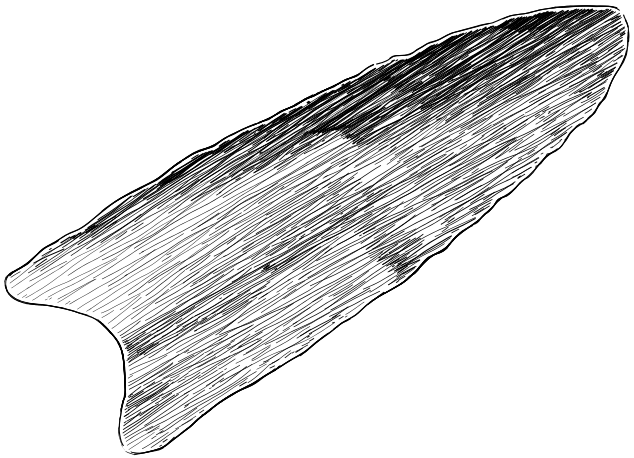
Discussion

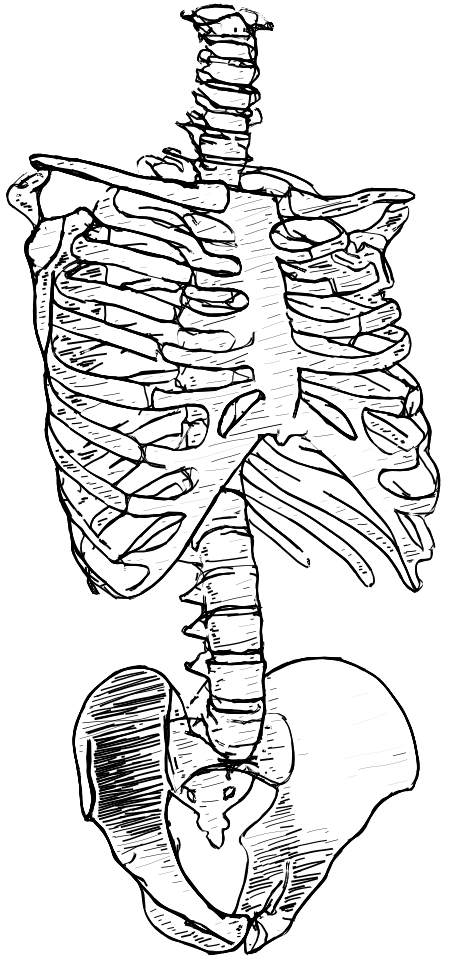
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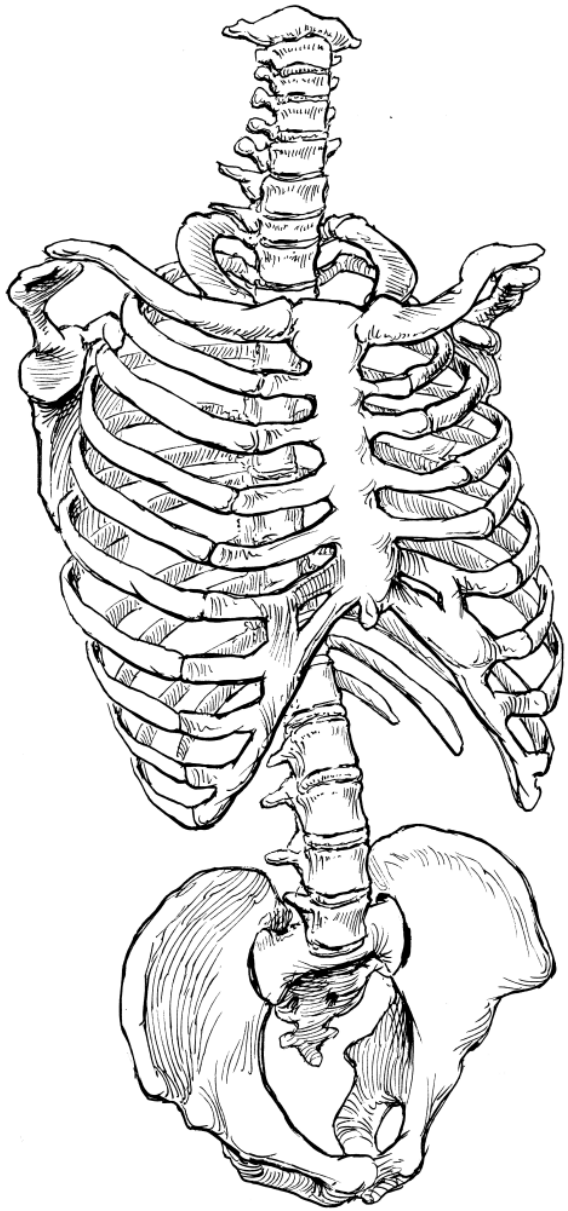
Discussion

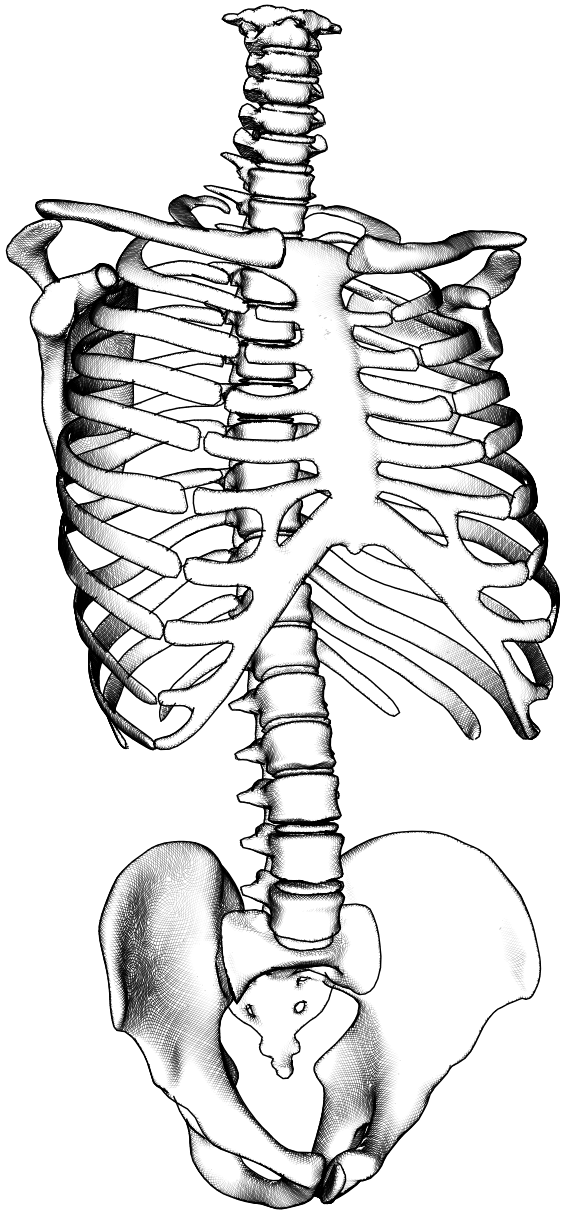
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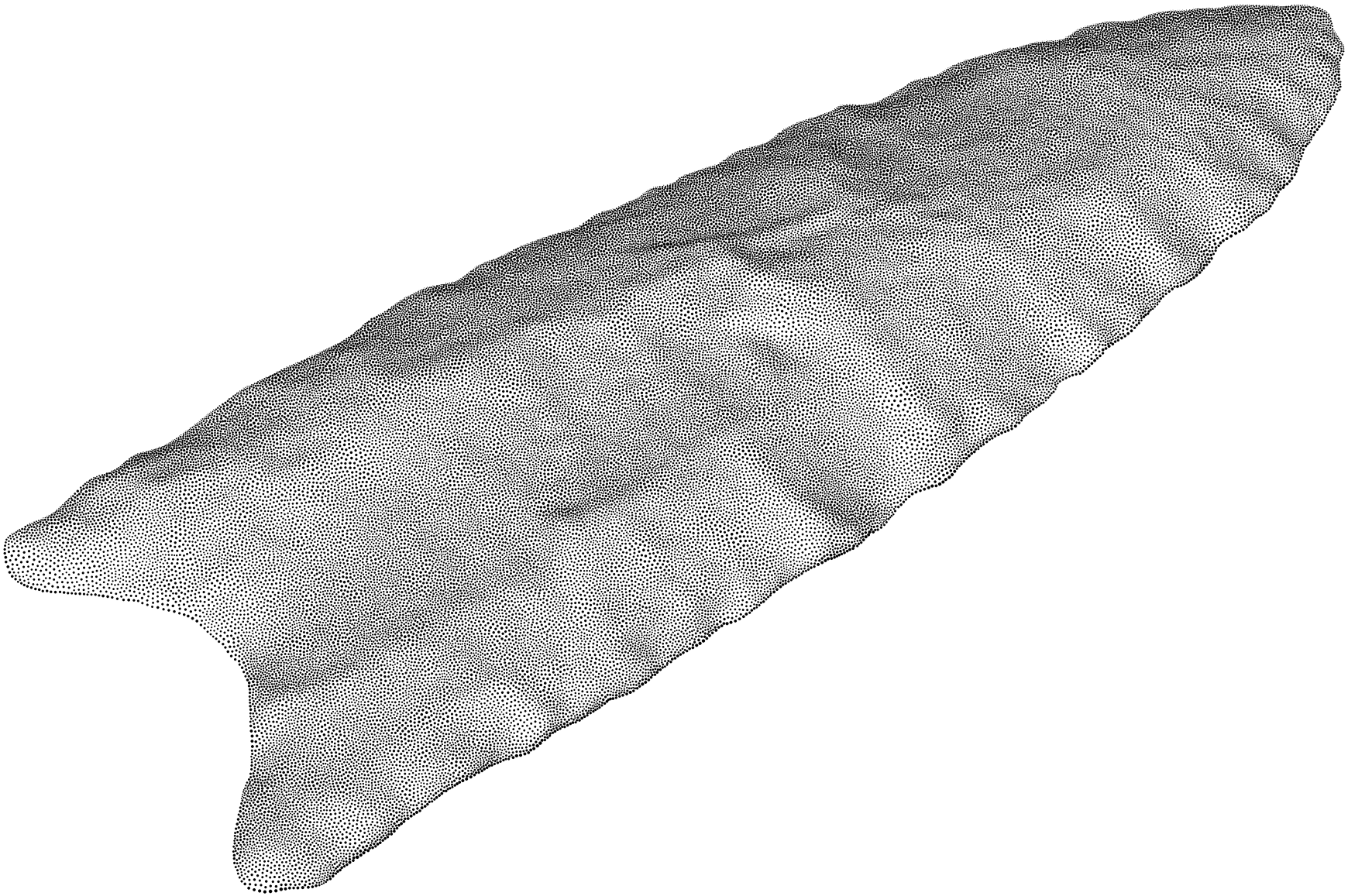


Impact for NPR Research: Know your goal & audience



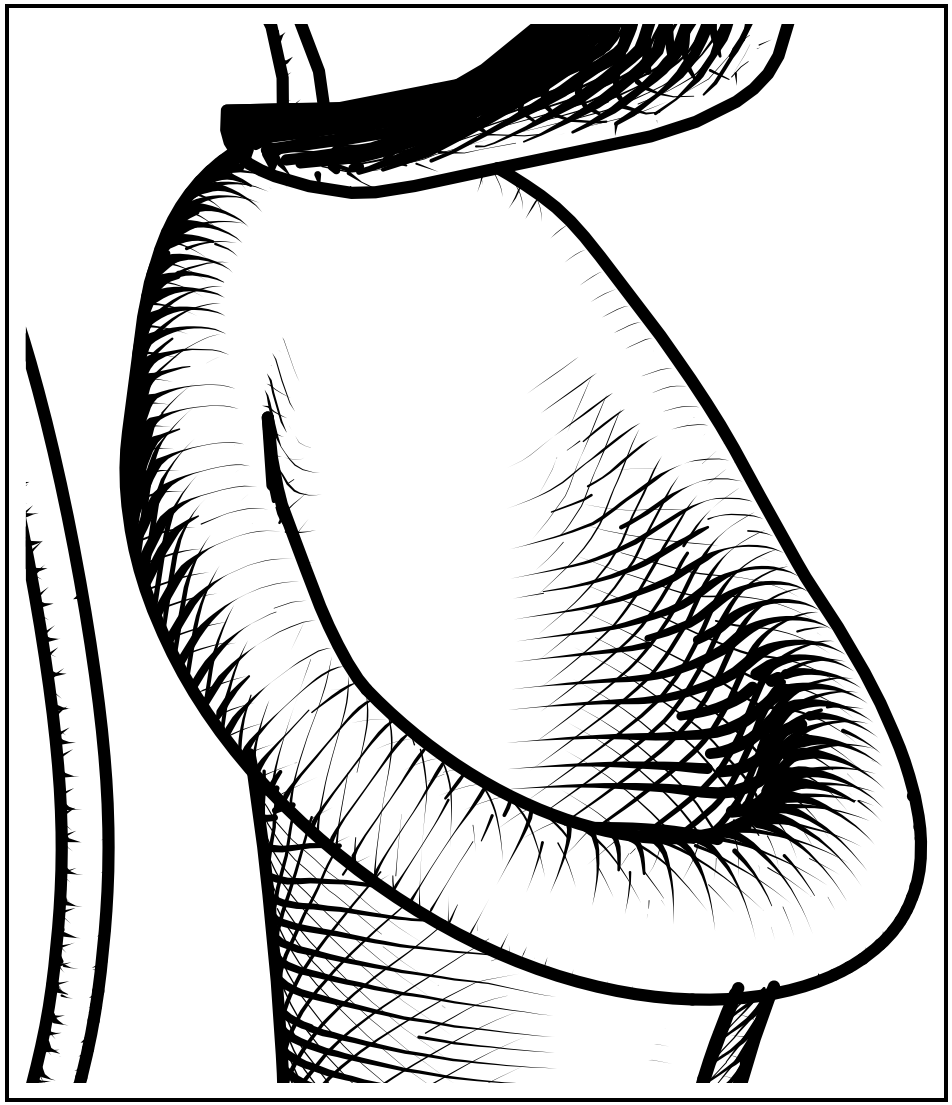


Impact for NPR Research: Portray materials

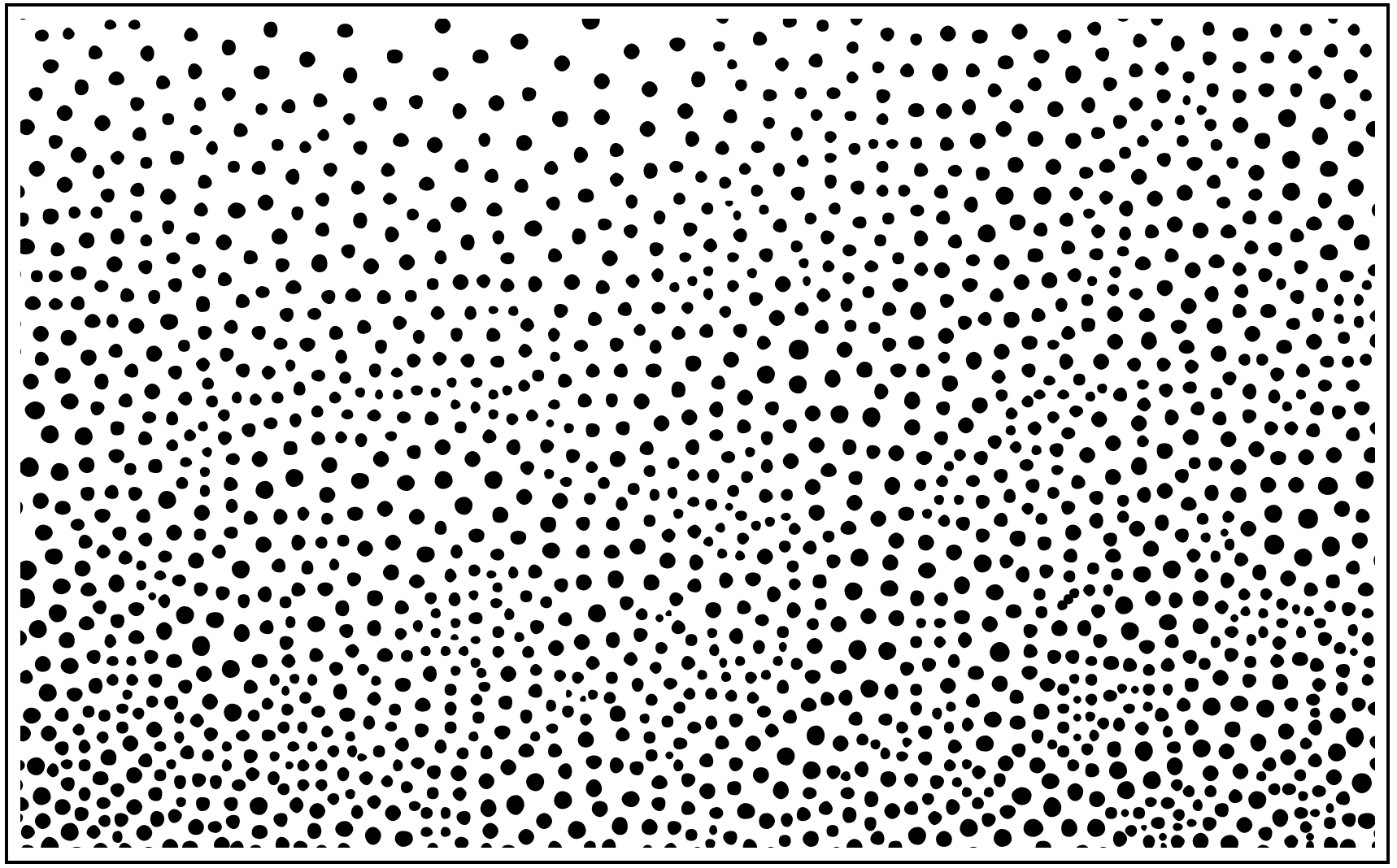


Impact for NPR Research: Work with models

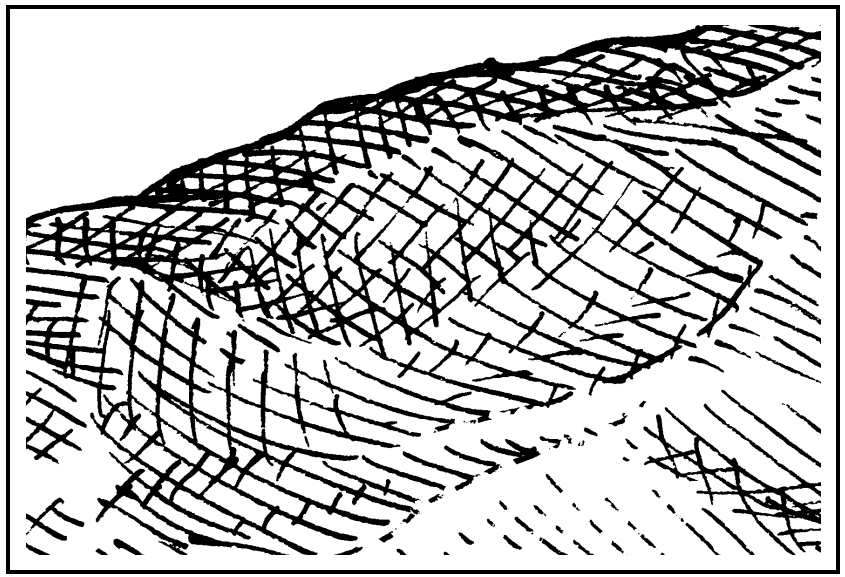


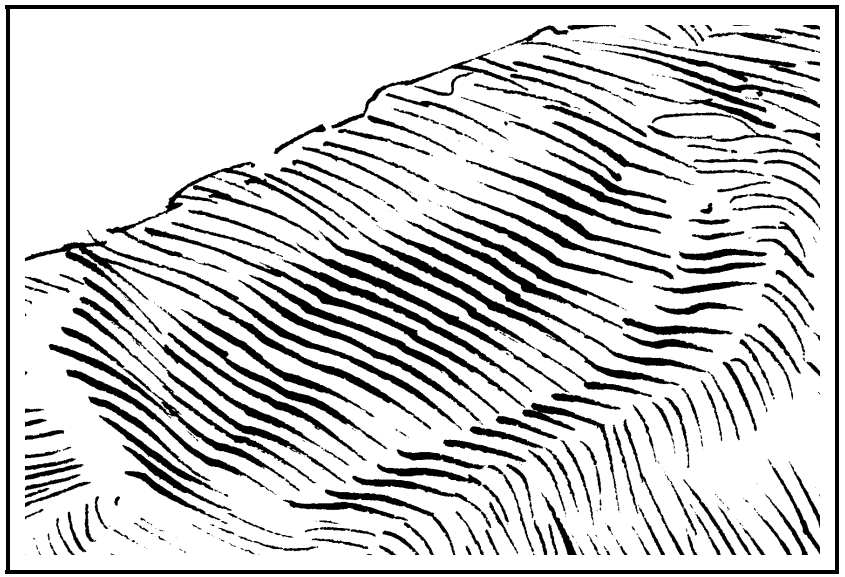


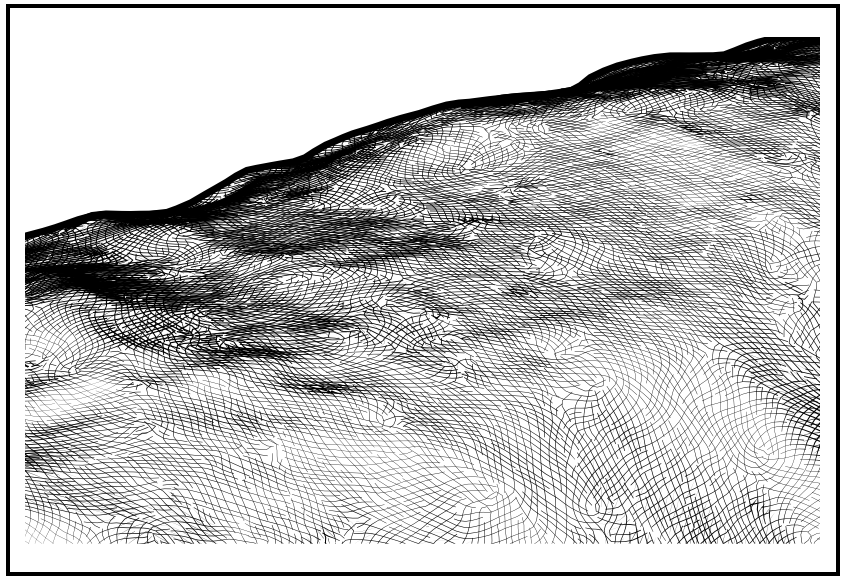
Impact for NPR Research: Avoid regularities

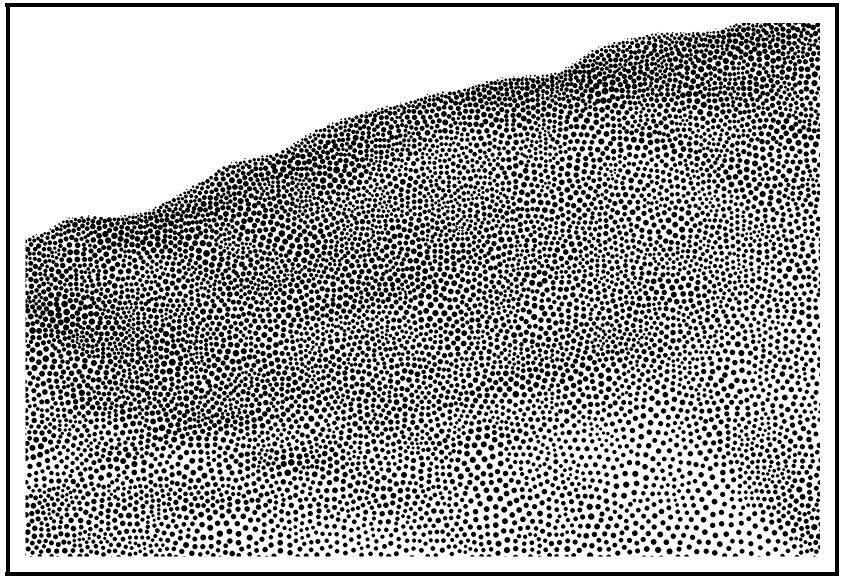


Impact for NPR Research: Pay attention to marks

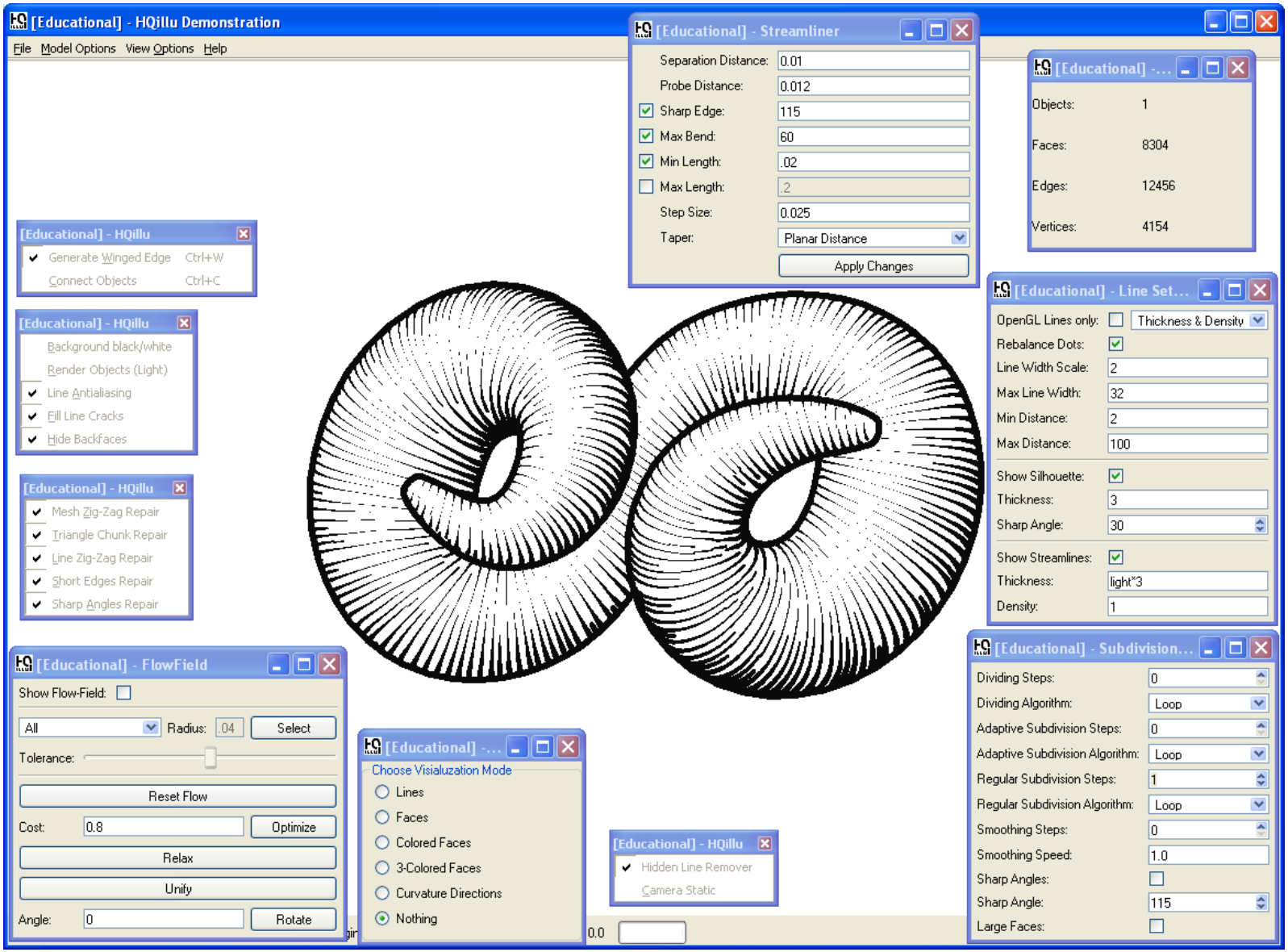








Impact for NPR Research: Pay attention to tools



Main Message:

We can **learn much about scientific illustration** by observing **how people look at illustrations** and asking them what they see. The **insights gained from evaluating NPR** can help to improve our non-photorealistic techniques.

Thanks for your attention!

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