DGP READING GROUP

Algorithmic Perception of Vertices in Sketched Drawings of Polyhedral Shapes

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ACM TAP 2019

X530
T 1200-1300
ubc-dgp.github.io

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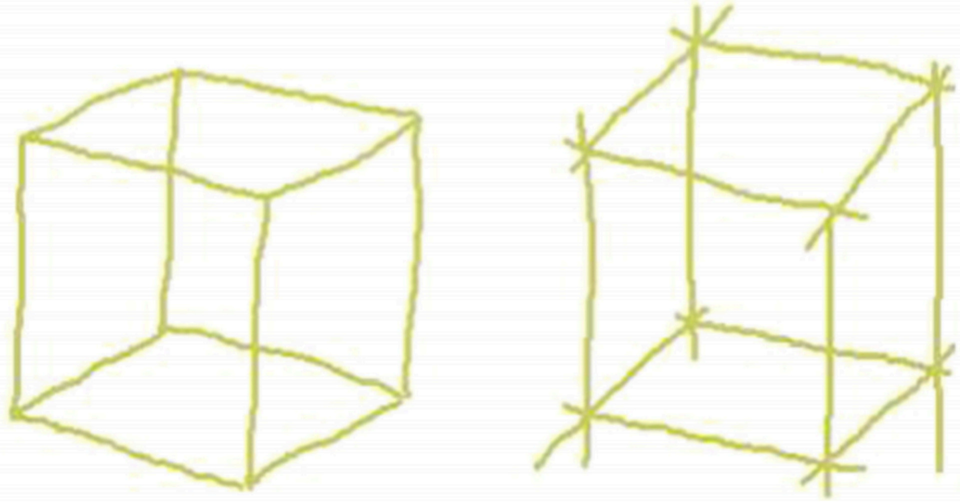
Contributions

- “Artificial Perception Model… for detecting junctions in line drawings”
  - 2D hand-drawn sketches
  - **Careful** vs *Casual* sketches

Terminology

- *Strokes*: lines defined by “pen-down” and “pen-up” movements
- *Dangling Tips*: portion of stroke that extends past *junction*
- *Junction*: point where strokes meet
- *Careful* and *Casual* sketches

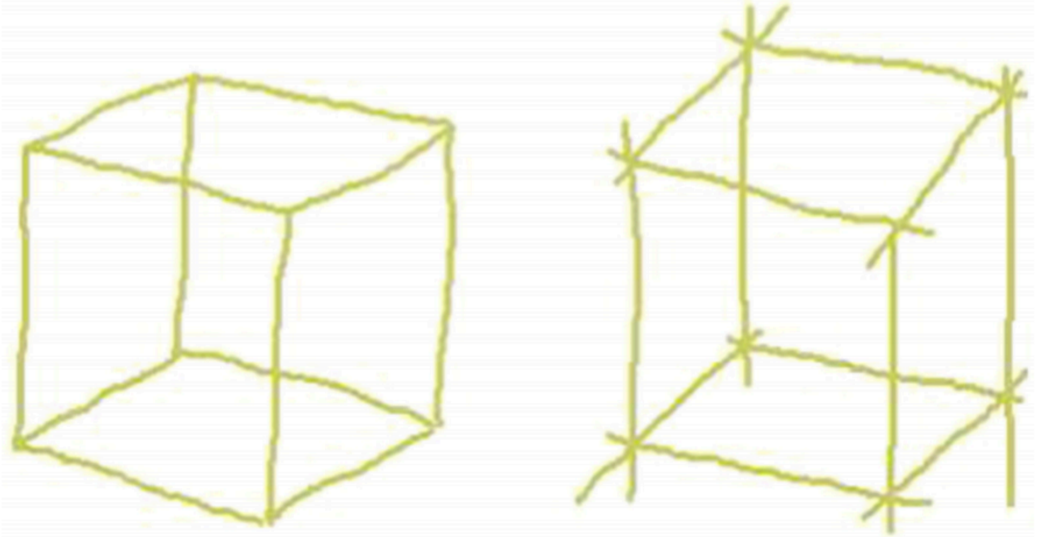
Dangling tips and Junction



Careful (left), Casual (right)

Assumptions

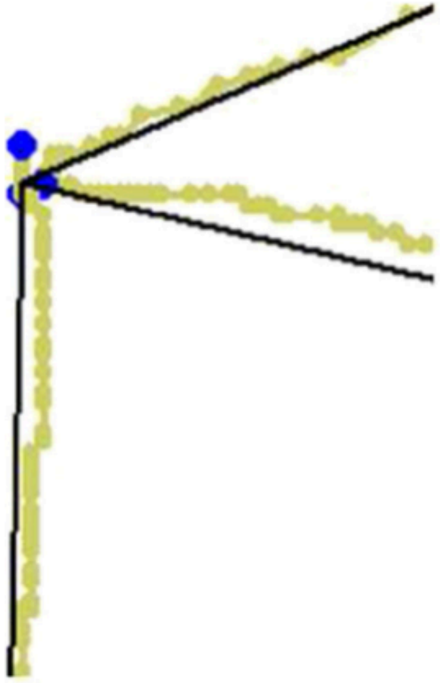
- Junction detection is **geometrical** and **perceptual**
- Sketches depict orthographic representation of flat figure or pictorial representation of polyhedral shape



Junction Detection

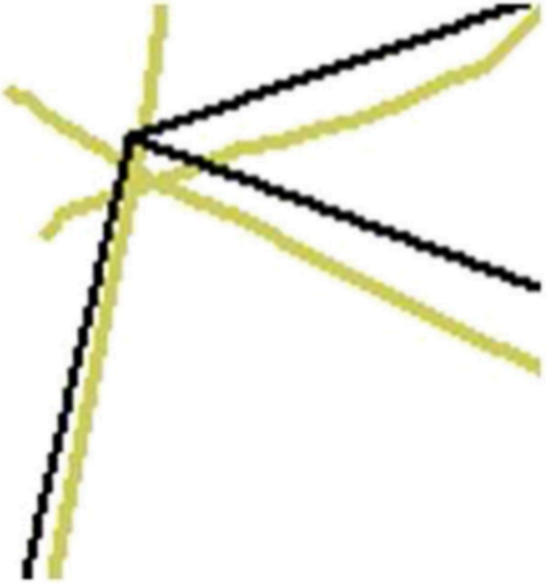
Careful

- Proximity
- Tips



Casual

- Closure
- Intersections

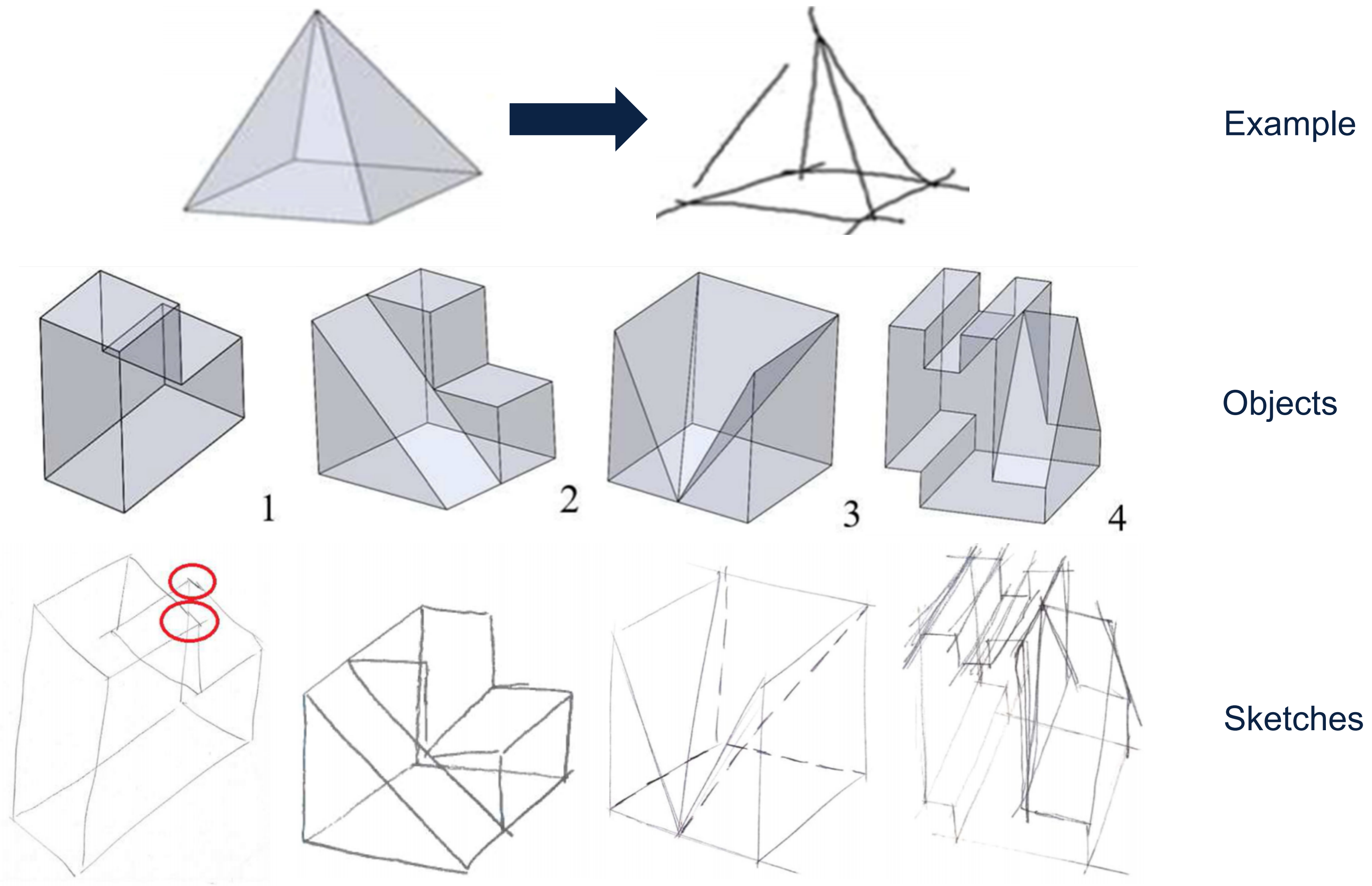


Experiment #0

There is no significant difference between test sketches and sketches collected from other subjects

Methods

- 91 subjects
- **Casually** sketch set of objects
- Single stroke / edge
- Include hidden edges
- 228 sketches of 4 models

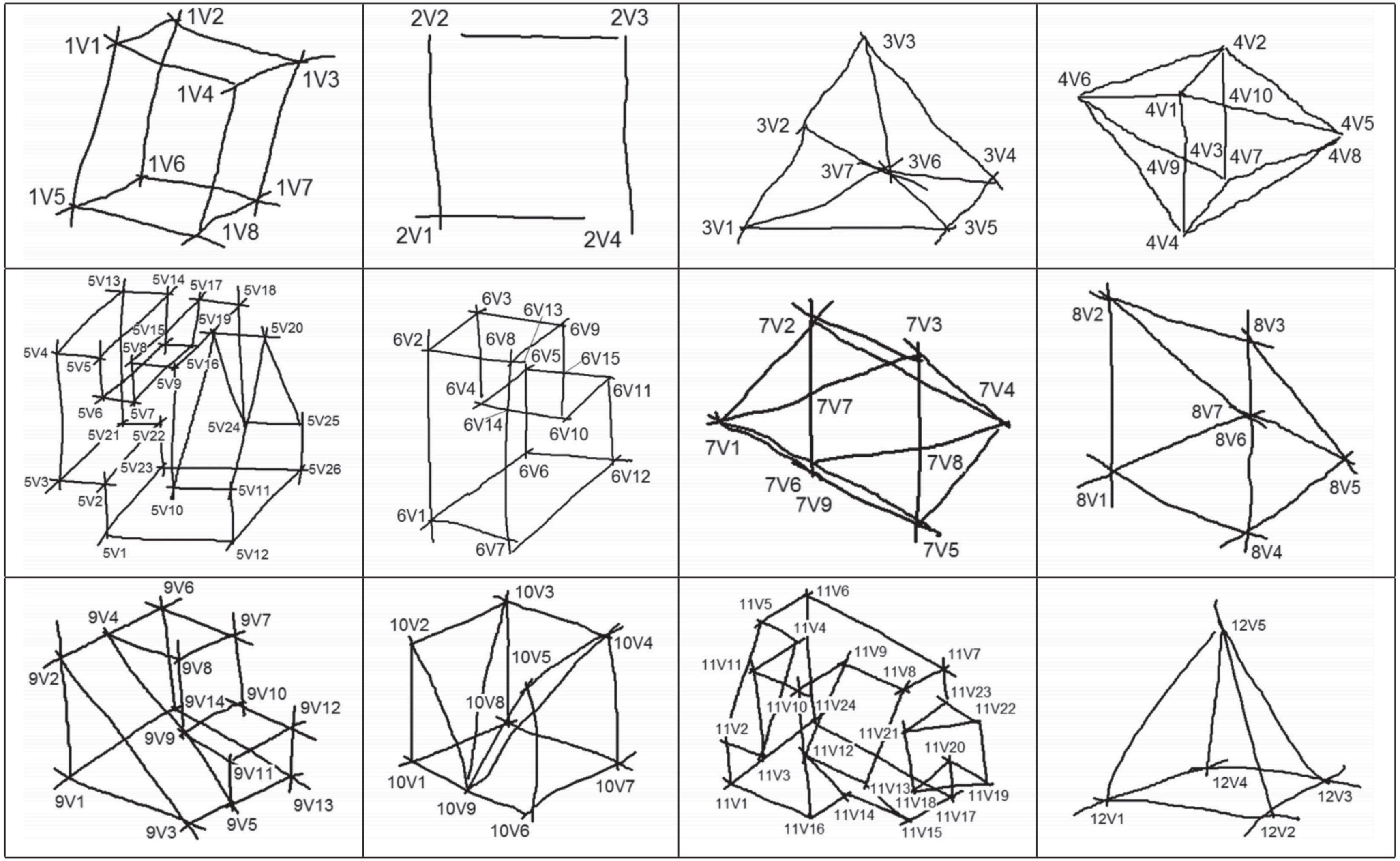


Experiment #1

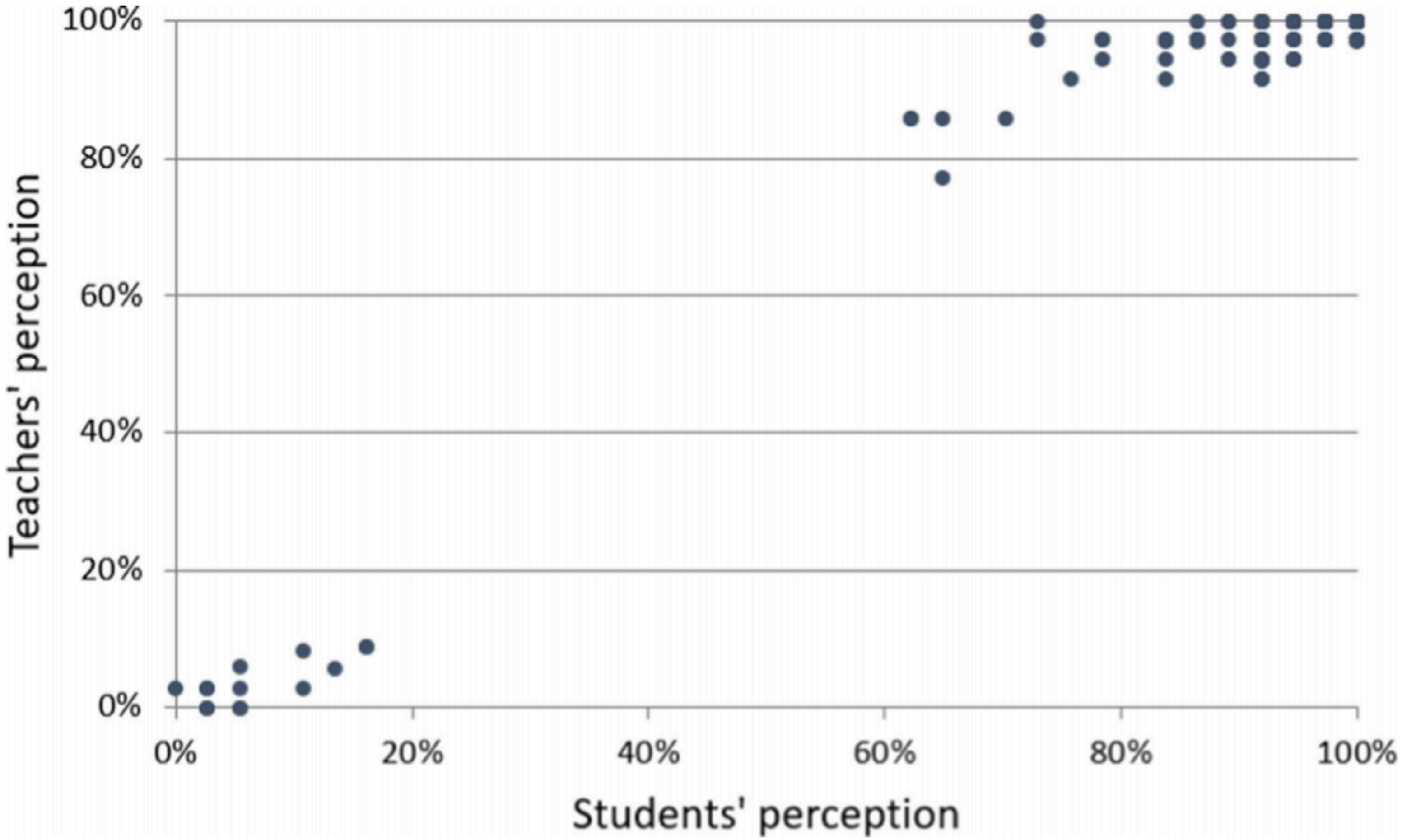
Subjects generally perceive the same junctions in casual sketches, regardless of experience in technical drawing

Methods

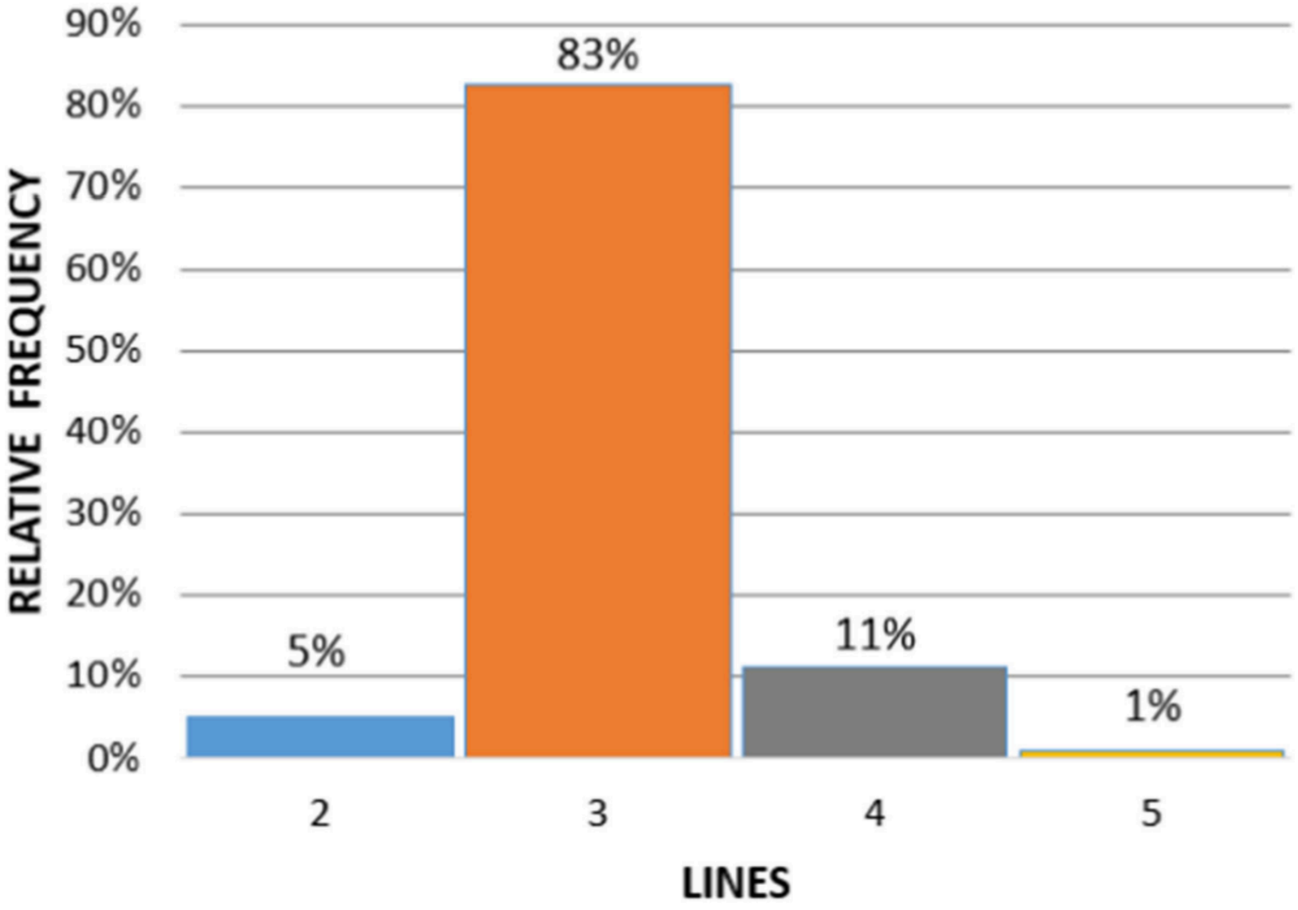
- 12 **casual** sketches
- Two groups (students / teachers)
  - 38 questionnaires / group
- Number and highlight junctions



Results (1)


100%
80%
60%
40%
20%
0%
Teachers' perception
0%
20%
40%
60%
80%
100%
Students' perception

Results (2)



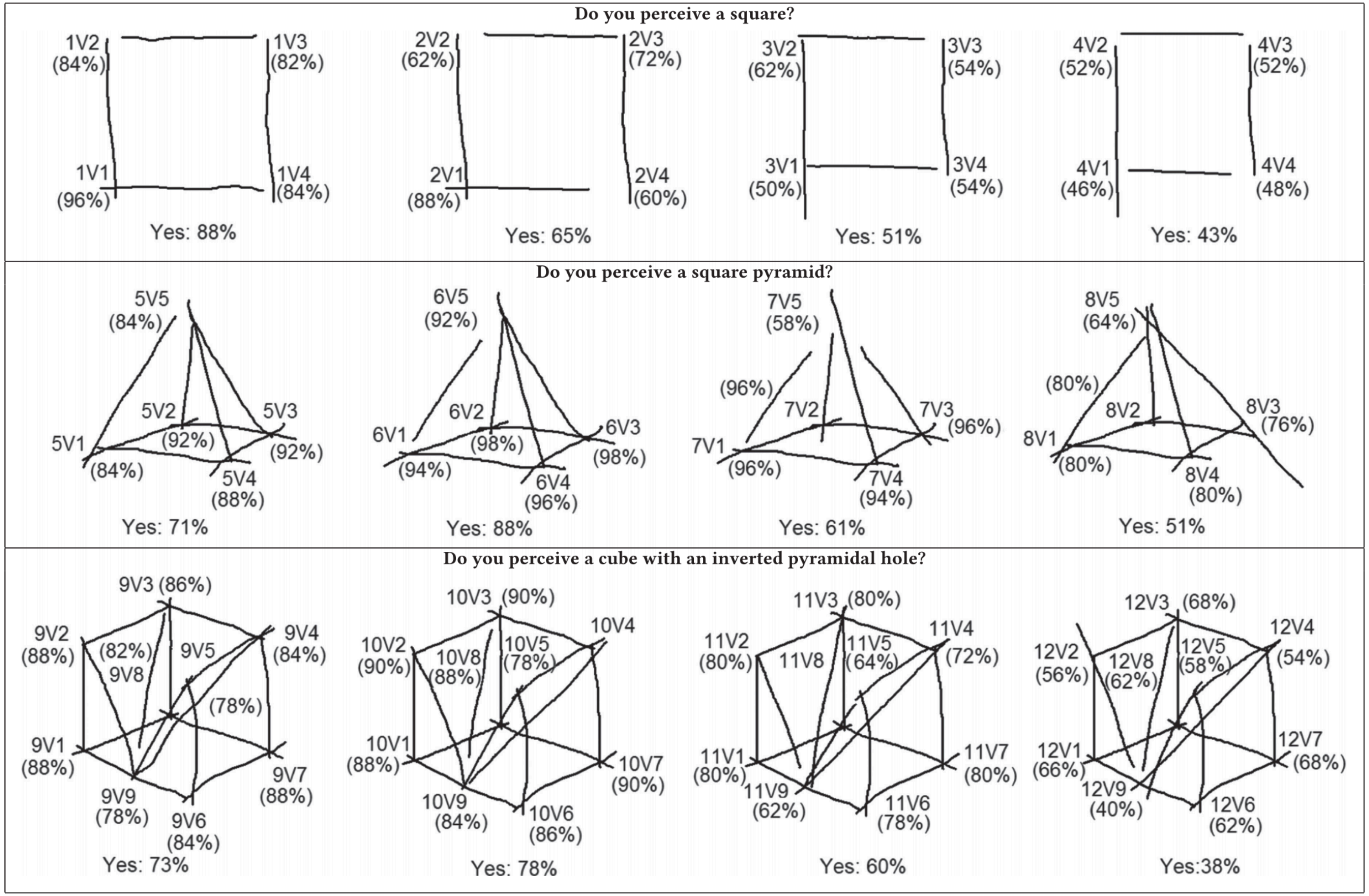
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
RELATIVE FREQUENCY
83%
5%
11%
1%
2
3
4
5
LINES

Experiment #2

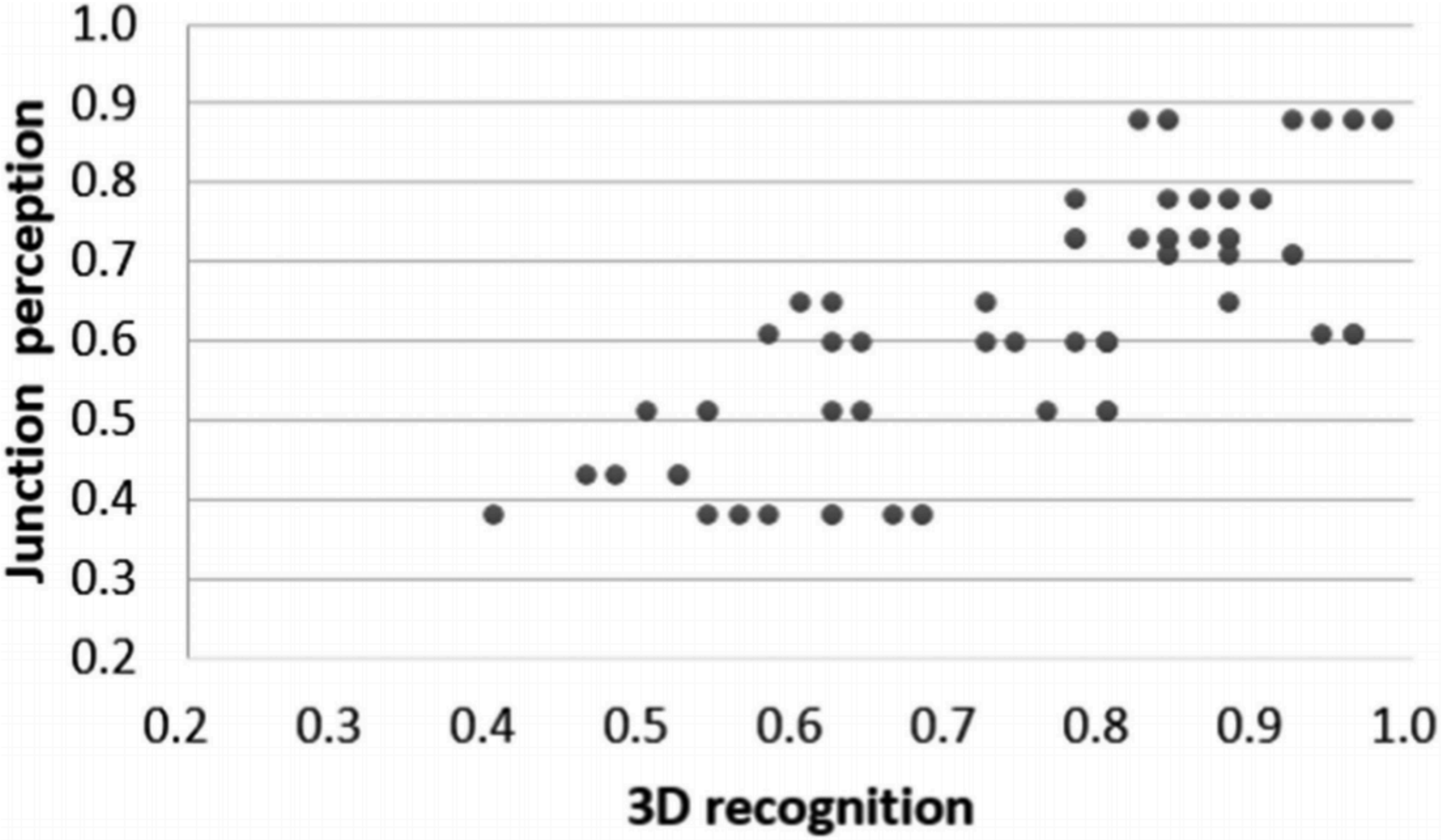
People are more tolerant of imprecise vertices if they are perceived as part of a recognizable figure

Methods

- 12 sketches
- Asked what objects were perceived
- Asked to number and highlight junctions
- 50 responses



Results



Junction perception
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
3D recognition

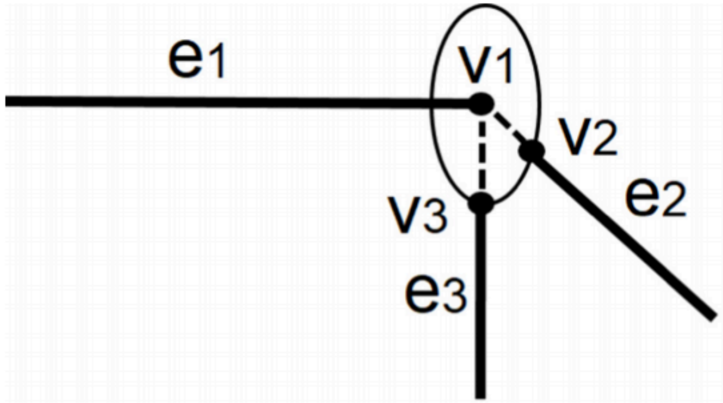
Results

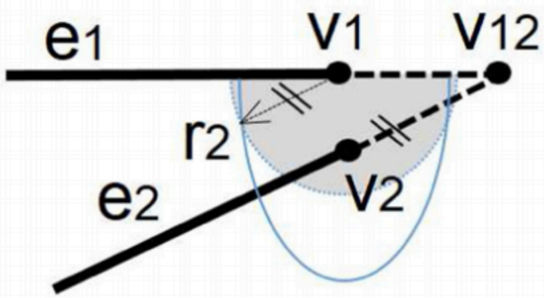
- Relative distance
  - Distance from intersection to most distant tip : max line length in junction
- Careful
  - Relative distance < 11%
- Casual
  - 11% < Relative distance < 25%
- Poor
  - 25% < Relative distance

Algorithm

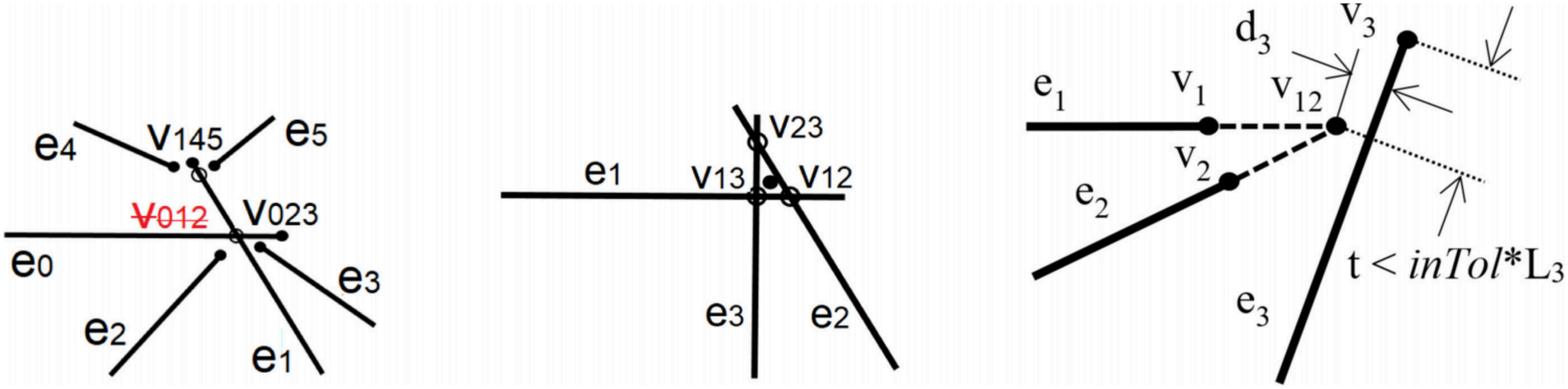
Perceptual Principles

1. Longer lines first
2. Distance threshold ~ line length
3. Right angles prioritized

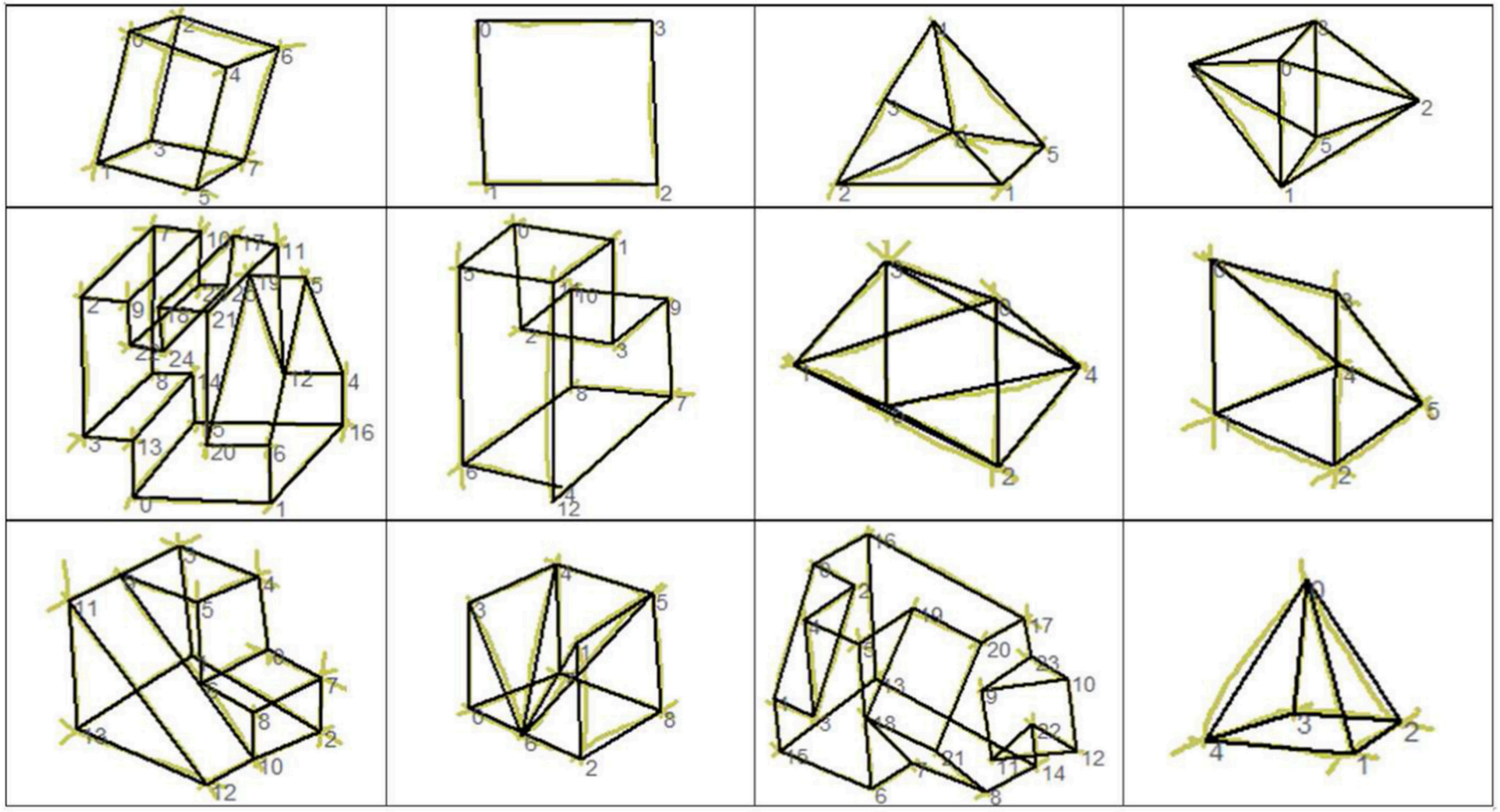




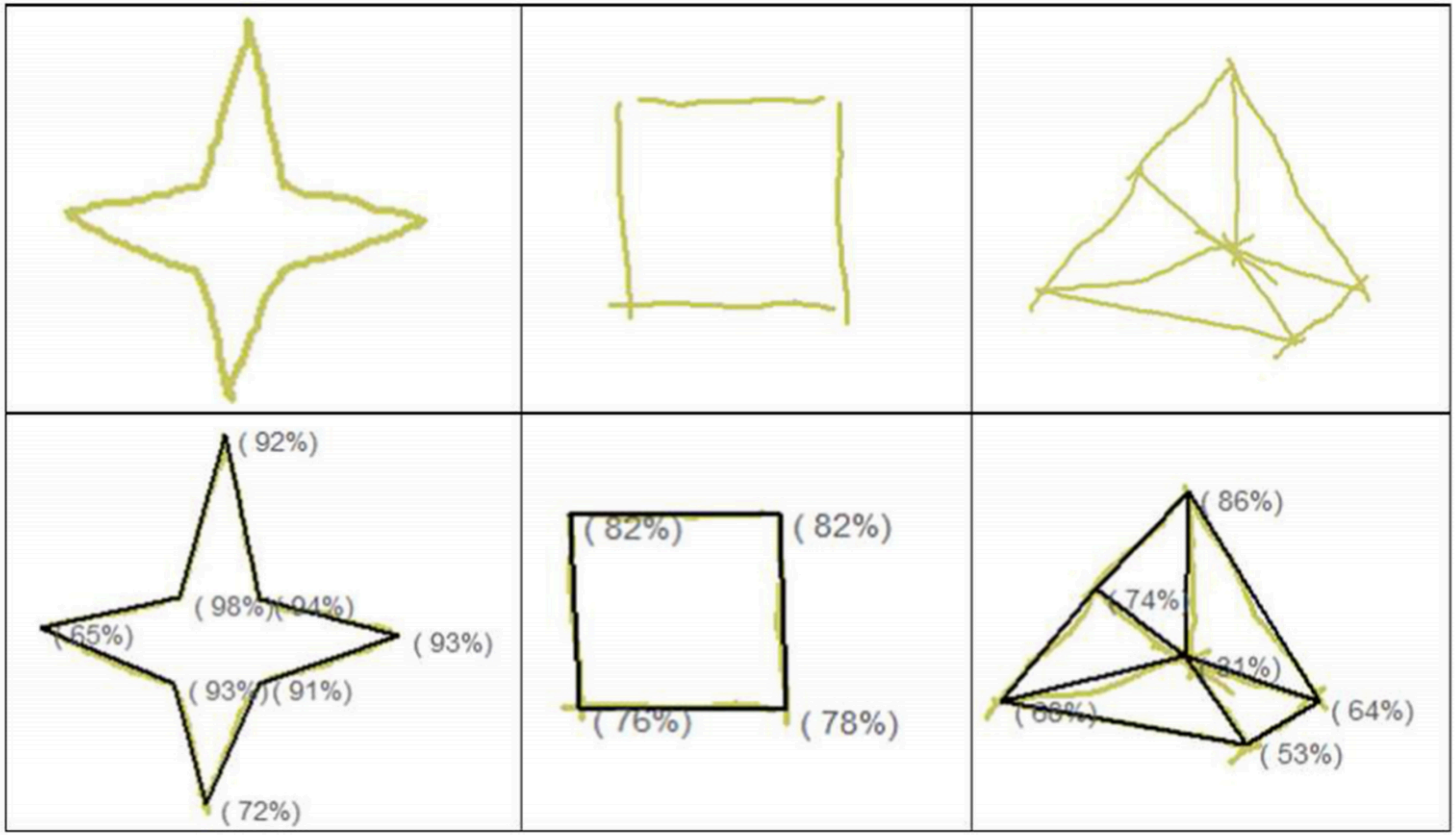
Merging Triplets



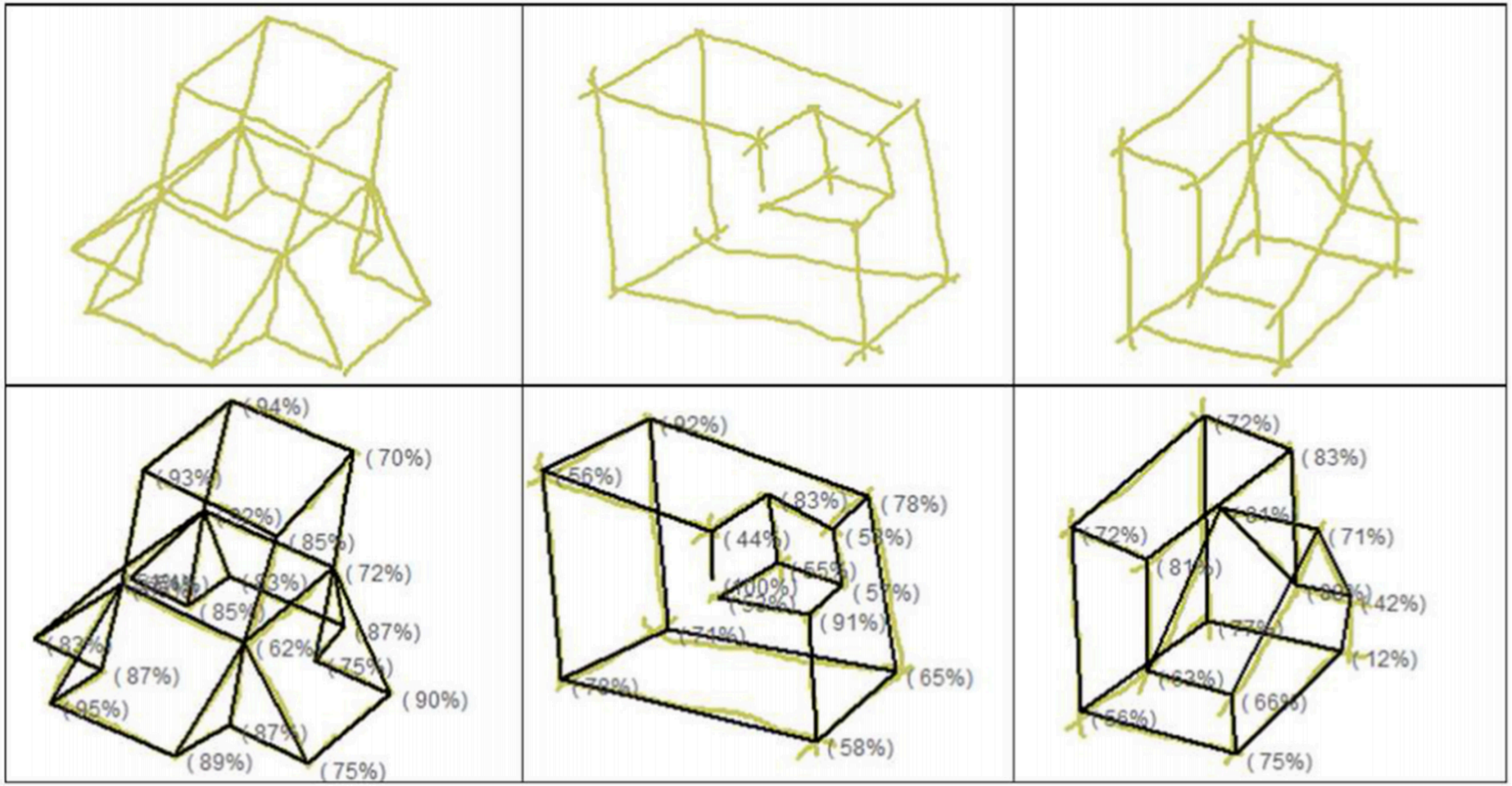
Results (1)



Results (2)



Results (3)



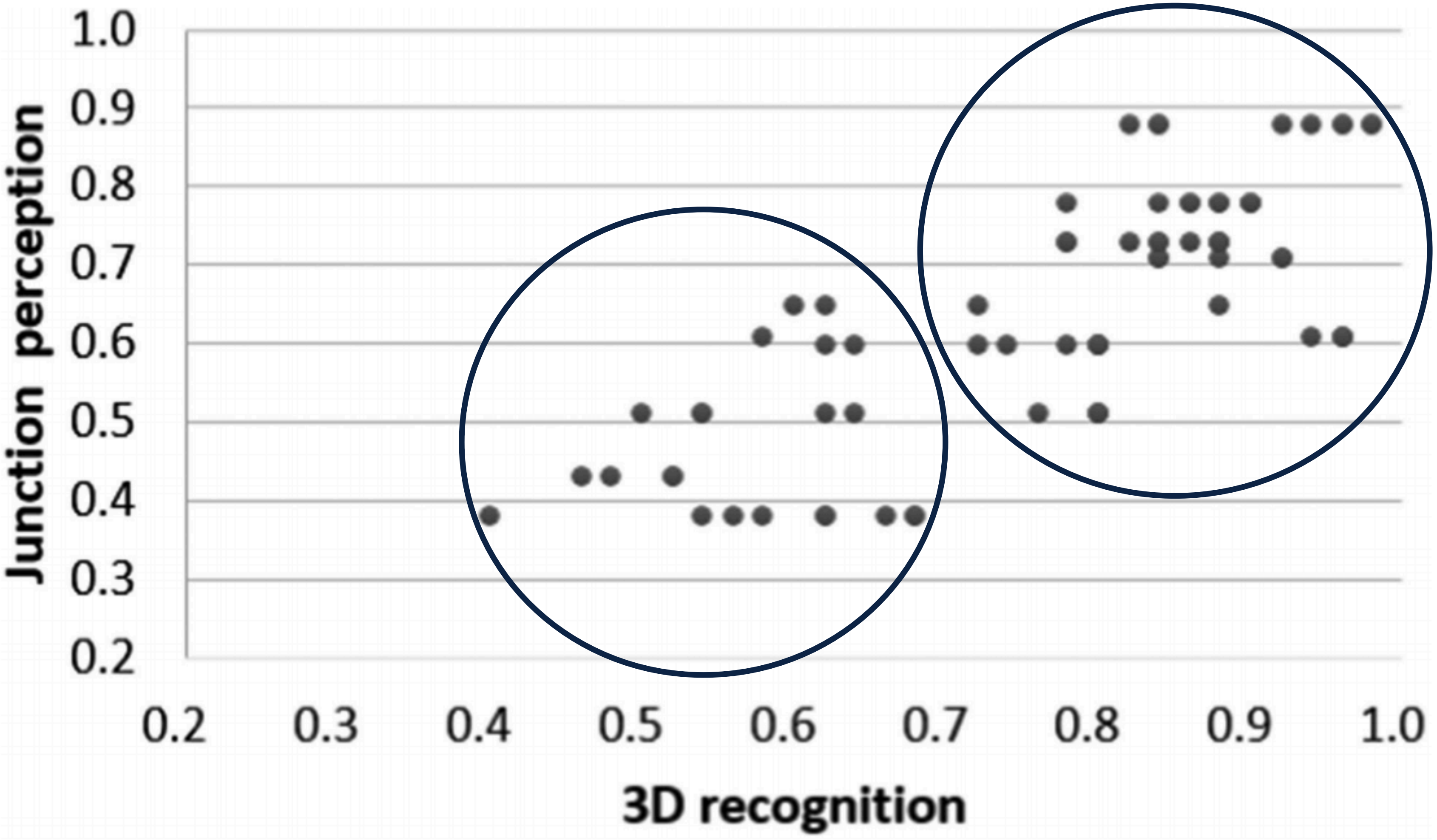
Discussion

Thanks!

Appendix: Table from Experiment#1

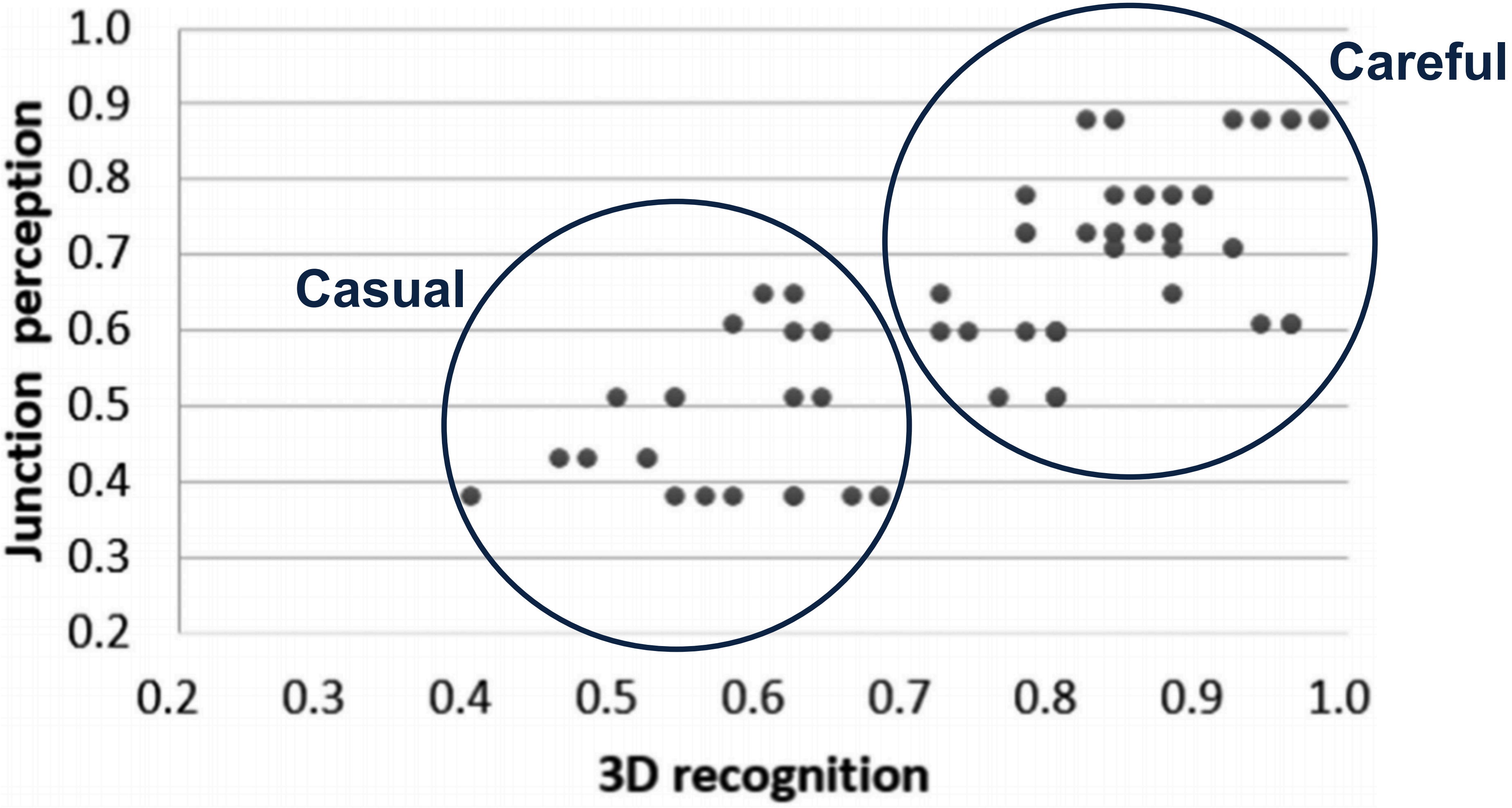
Example	Qty junctions	% observed	% less junct.	% more junct.
1	8	93.6%	6.4%	0%
2	4	75.6%	24.4%	0%
3	6	78.2%	12.8%	9%
4	6	84.6%	3.8%	11.5%
5	26	62.8%	36.2%	1%
6	12	89.7%	6.4%	3.8%
7	6	72.4%	10.5%	17.1%
8	6	96.1%	2.6%	1.3%
9	14	84.6%	15.4%	0%
10	9	90.9%	9.1%	0%
11	24	64.1%	32.1%	3.8%
12	5	93.5%	6.5%	0%

Results



Junction perception
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
3D recognition

Results



Careful
Casual
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
Junction perception
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
3D recognition

Appendix: Equations(1)

$$maxDist = 0.08 * lineLength$$

$$allowance = 2 - \cos(e_i, e_j)$$

$$allowedDist = maxDist * allowance$$

$$maxRot = 10°$$

Appendix: Equations(2)

$$maxDistTriplets = 0.1 * maxLineLength$$

$$maxDistDangling = 0.1 * lineLength$$

$$inTol = 0.5 * meanLineLength$$

$$outTol = 0.25 * meanLineLength$$

Appendix: Equations(3)

$$RM, ETM = 0.5$$

$$RD = RR = (1 - RM)/2$$

$$etm = 0.5 * (1 - \frac{distCentroid}{maxDistTriplets})$$

Appendix: Default Parameters

Parameter	Careful	% Balanced	% Casual
maxDist	12%	8%	4%
maxRot	5°	10°	10°
RM	.2	.5	.8
Valid range: inTol	25%	50%	50%
Valid range: outTol	12.5%	25%	25%
maxDistTriplets	5%	10%	15%
ETM	.2	.5	.8
maxDistDangling	5%	10%	15%

Appendix: Failure Cases