Supplementary Materials for

When Newton beats Euclid: intuitive physics underlies sensitivity to geometry

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Materials and Methods

Other Supplementary Materials for this manuscript include the following:

Demo videos of the different online questionnaires

Print versions of the online studies

Stimuli used in the online studies

Data and analysis script

Materials and Methods

Testing the new theory

Stimuli

We used the same geometrical L-shaped figures in all three experiments. Stimuli were created using the vector graphics editing software Inkscape (https://inkscape.org/).

The original stimulus consisted of three parts: a longer part of 88.9 mm length and 7.4 mm width with rounded tips, a shorter part of 44.45mm (i.e., half the length of the longer part), and 7.4 mm width with rounded tips, and a circle of 14.8 mm diameter. All three parts were black and opaque. The circle was place on top of the longer part and centered with it, while the shorter part was attached to the circle at a 135° angle with the longer part (see Fig. S1).

The Y-Symmetry stimulus was a horizontal symmetry of the original stimulus (i.e., a 180° rotation around the Y-axis). The Y-Translation stimulus was a translation of the original stimulus of 63.5 mm upwards in a vertical line. The Size stimulus was 1.5 times bigger than the original stimulus. The 180°-Rotation stimulus was a 180° rotation around the Z-axis of the original stimulus. The 90°-Rotation stimulus was a 90° rotation around the Z-axis of the original stimulus. The X-Symmetry stimulus was a vertical symmetry of the original stimulus (i.e., a 180° rotation around the X-axis). The Shape stimulus was a 90° angle deformation between the

two longer parts of the original stimulus. The X-Translation stimulus was a translation of the original stimulus of 63.5 mm to the right in a horizontal line.

Center of mass

To find the x-coordinates of the center of masses of our objects in Inkscape, we calculated the sum of the x-coordinate of the center of mass of each individual part of the objects weighed by their individual areas, divided by the total area of the objects. The same was done for the y-coordinates. The center of masses of the two oval parts of the objects are the intersection of the longer and the wider sections of the objects. The center of mass of the circles is the center of the circles.

Experiment 1a

In Exp. 1a, dark grey shades were added to each stimulus, which corresponded to a horizontal symmetry of the stimulus attached to its bottom part, and whose length was reduced to a third of its original height (see Fig. 3). A lilac flat plane was added to the environment, as well as two astronauts (i.e., the interstellar scientists) standing on each side of the stimuli. The shades of the astronauts were of the same color than those of the L-shaped figures, and were also reduced to a third of the height of the astronauts.

In the first picture that was shown to participants, the original figure stood in the middle of the picture, and both astronauts stood at both extremities (see Fig. S3). In the second picture, both transformed objects stood 115.5 mm either on the left or on the right of were the first object stood in the first picture, except for the X-Translation stimulus that stood, as mentioned above, 63.5 mm further to the right. Both astronauts stood at exactly the same position as in the first

picture. All stimuli stood at the same level on the ground, except for the Y-Translation stimulus that stood 63.5 mm upwards from the others.

Experiment 1b

The only difference between Exp. 1a and Exp. 1b, is that in the first picture of Exp. 1b, there were two instances of the first object that both stood 115.5 mm either to the left or to the right of where the first object had stood in the first picture of Exp. 1a.

Experiment 2

The only difference between Exp. 1a and Exp. 2 is that the astronauts are no longer there. Instead, a robot arm holds the object that lies above the ground. There are also no shadows.

Experiment 3

In Exp. 2, the background was transformed. The lilac plane and the astronauts were replaced by a dark grey background. In the middle was displayed the contours of a black rectangle with rounded corners of 277.9 mm height and 188.3 mm width. The first object was centered within the rectangle in the first picture that was shown to participants. In the second picture that was shown to participants, instead of one rectangle there were now two and each contained a different object. All figures in the second picture were centered in the width of the rectangle, except for the X-Translation stimulus that was shifted 63.5 mm to the right of the center. All figures stood at the same level than the first object in the first picture, except for the Y-Translation stimulus that was shifted 63.5 mm upwards.