



How can we change a bicycle frame to make it easier to ride?

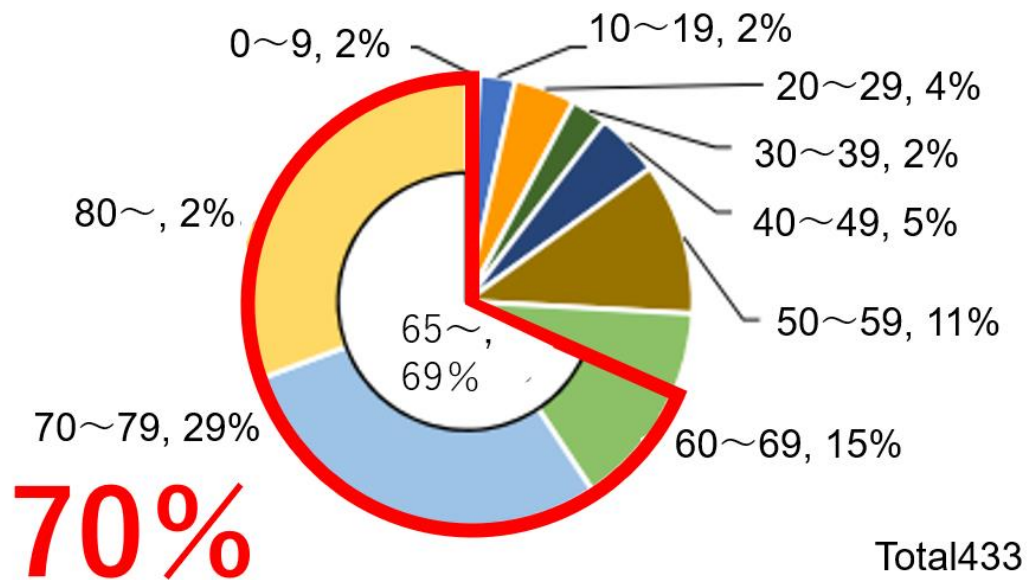
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Science & Math Course Science Research Group 4

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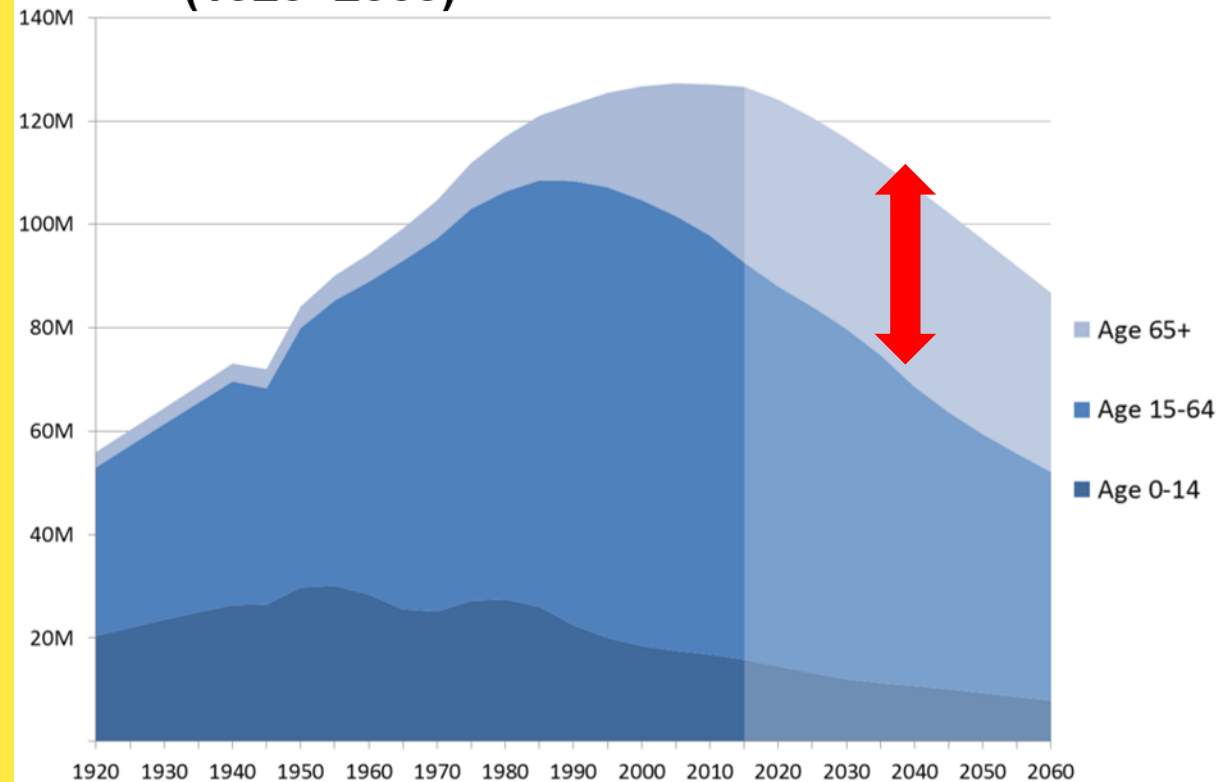
1. Purpose

The death toll from bicycle accidents by age
(The first year of Reiwa)



(the National Police Agency)

How Japanese society is aging
(1920~2060)



(Statistics Bureau, Ministry of Internal Affairs and Communications)

1. Purpose

4

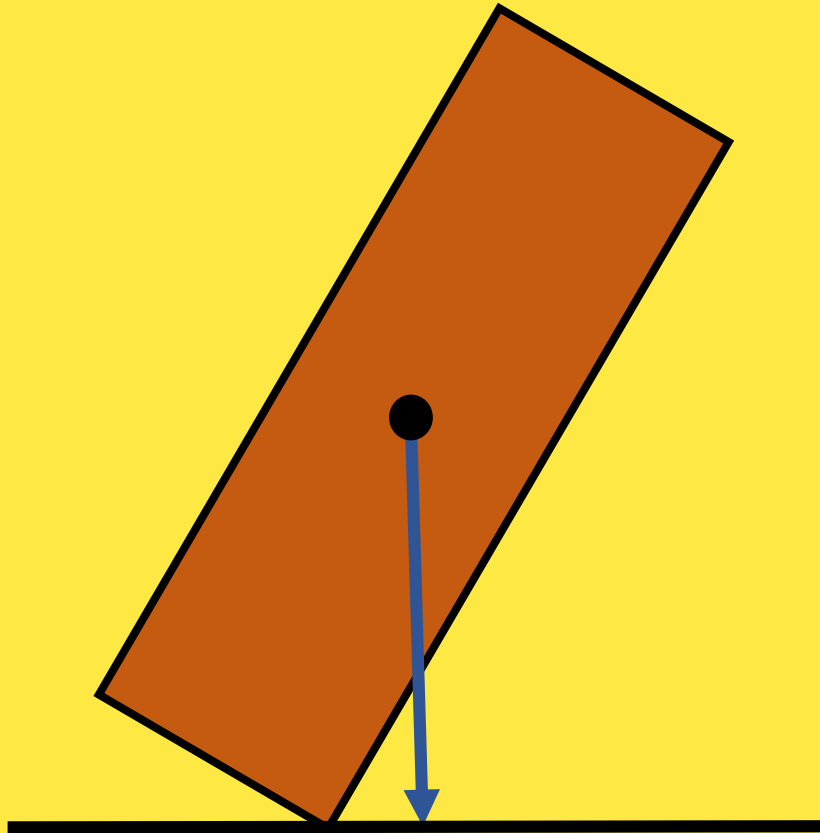
How can we decrease
the number of accidents?



Create a more stable bicycle

2. Hypothesis

Known fact ①

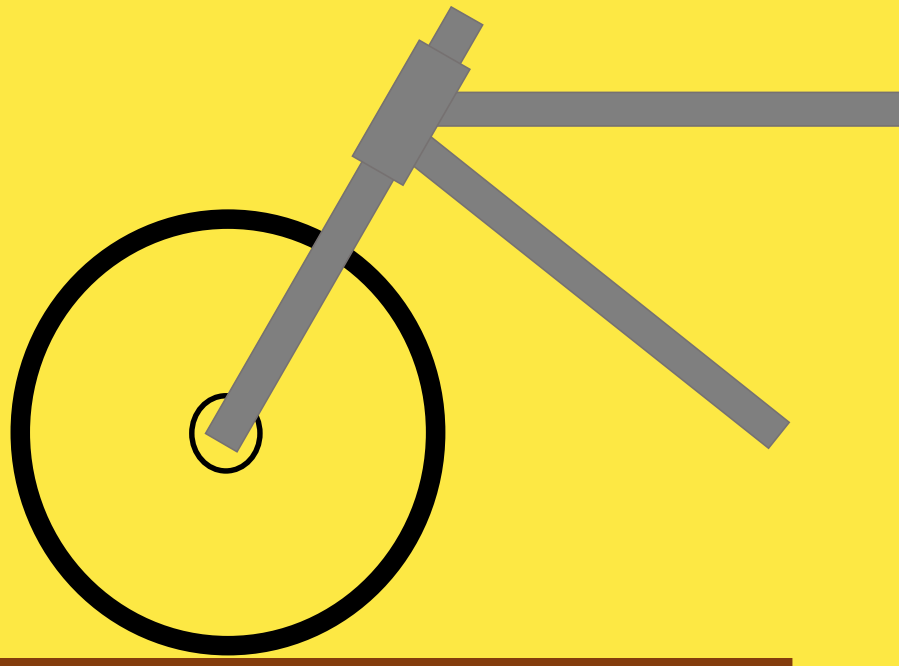


position of
the center of gravity

lower → more stable

2. Hypothesis

Known fact ②

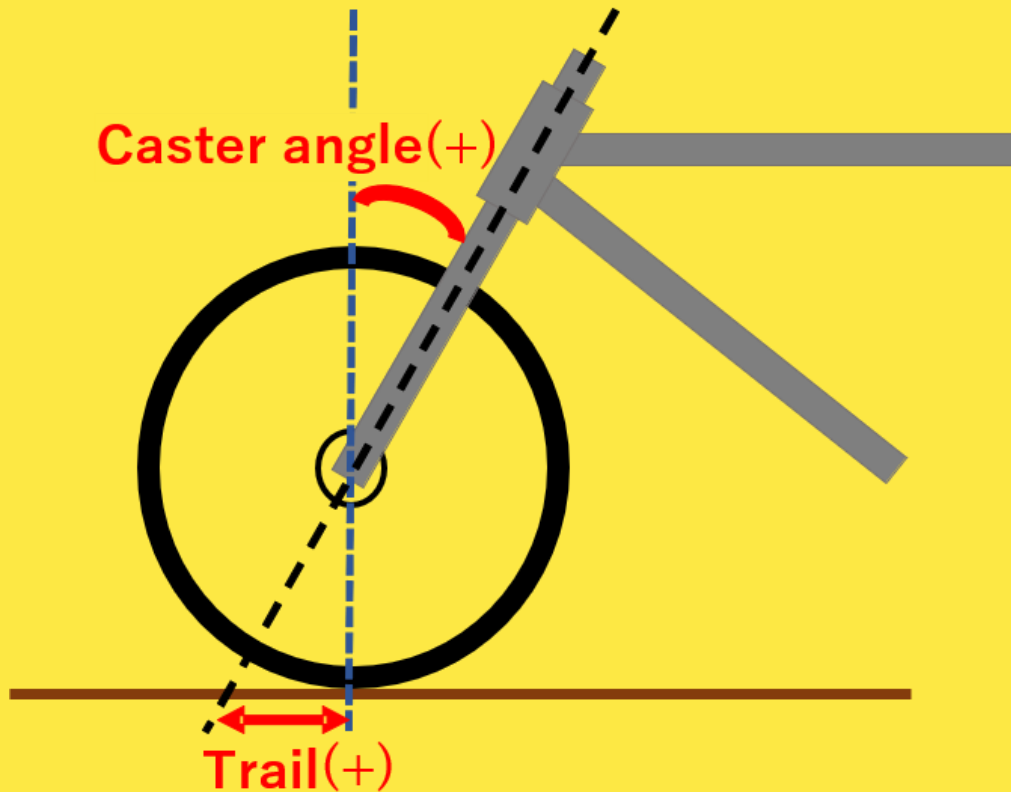


size of wheels

bigger → more stable

2. Hypothesis

Known fact ③

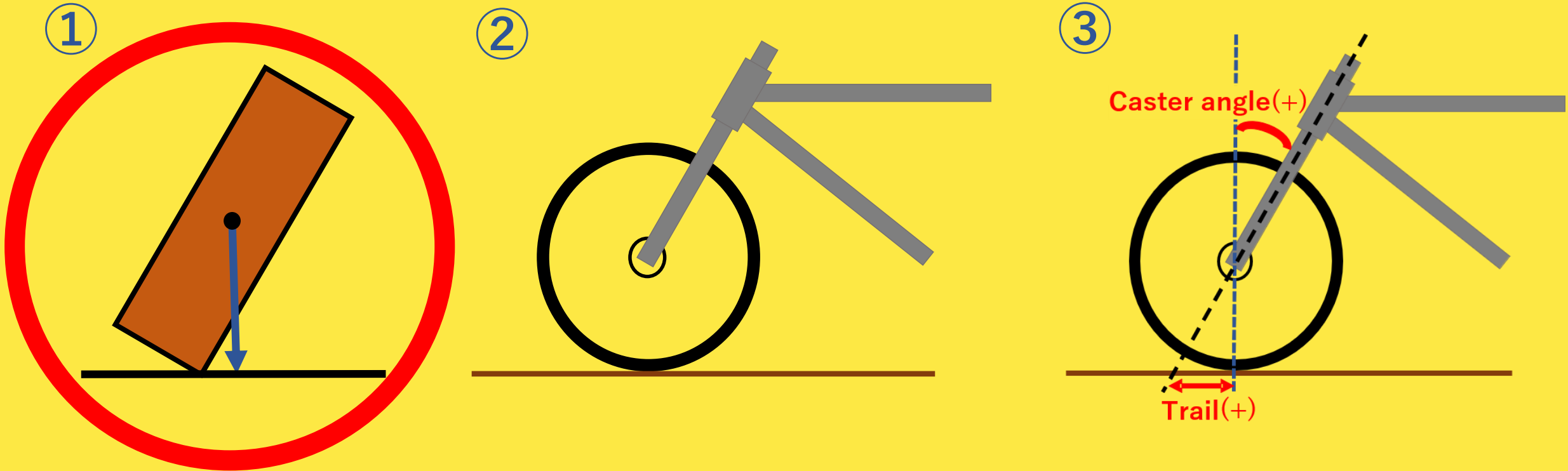


Caster angle and Trail

bigger and longer

➔ more stable

2. Hypothesis



By changing these three factors together, we could create an ideal bicycle.

3. Methods

Experimental set-up



Model bicycle

frame: resin (3D printer)
wheel: wood (Laser cutter)

rubber band

3. Methods

Experimental set-up

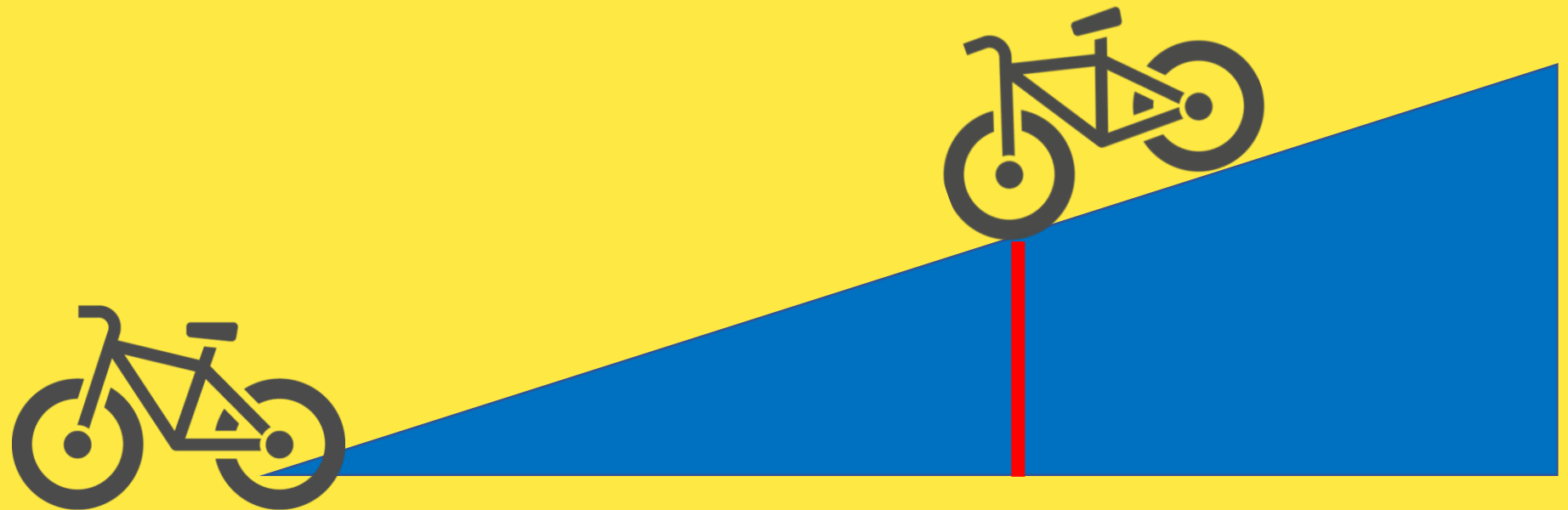
Taped ground →

Ramp and Rail →



3. Methods

Experimental set-up

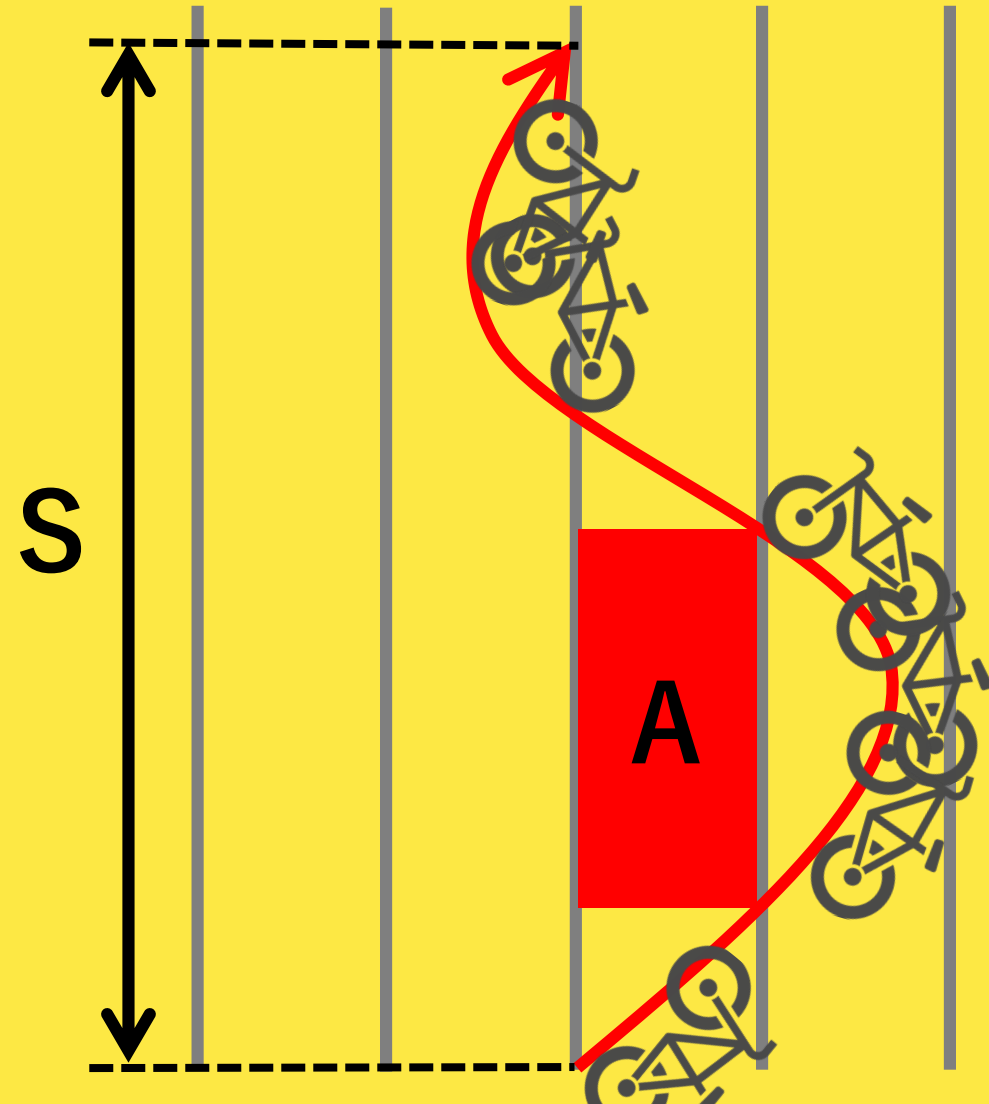


3. Methods

Equation

- Straight Distance=S
- Area=A
- Stability=X

$$X = \frac{S^2}{A}$$



3. Methods



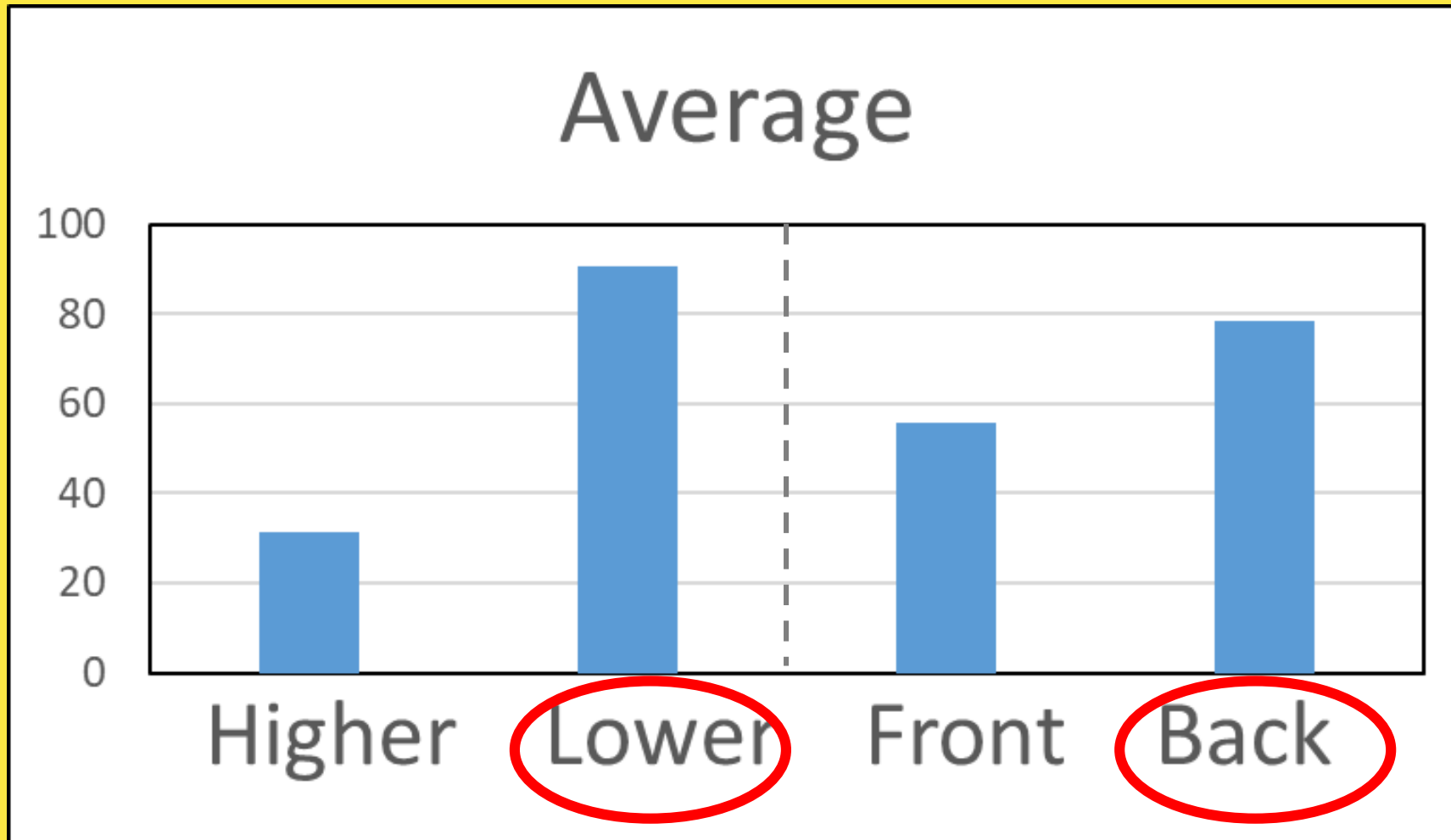
4. Result

Experimental data of X

Test run	Higher	Lower	Front	Back
1	92	18	49	96
2	15	47	34	63
3	63	30	72	52
4	25	100	35	137
5	17	60	45	84
6	17	145	68	24
7	15	91	29	69
8	18	157	56	33
9	12	75	128	44
10	39	182	42	193



4. Result



Conclusion

Having the center of gravity lower and towards the back is better.

5. Prospects

- Do experiments testing other conditions (size of wheels, caster angle and trail)
- Improve the rail to support the bicycle running on the ramp more steadily
- Conduct experiments changing a combination of these three conditions

6. References

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- 2) Statistics Bureau, Ministry of Internal Affairs and Communications : Elderly population (in Japanese)
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- 3) Hiroshi Miki, Toshiyuki Murakami ; Journal of the Institute of Electrical Engineers of Japan (Industrial application magazine) handle125 vol.(2005) number8, p 779~ p 785 : A consideration on stabilizing the running of electric bicycles by controlling the hundle(in Japanese)
- 4) Tomohiro Nakagawa, Shoichiro Takehara, Suda Yoshihiro: Bicycle motion analysis and running experiment ,Effect of wheel diameter(Mechanical mechanics, measurement, Automatic control) (2009) (in Japanese)
- 5) BiA cycle Can Be Self-Stable Without Gyroscopic or Caster Effects
J. D. G. Kooijman, J. P. Meijaard et al. ; Science, 332, 6027,339 (2011)

Thank you for listening!