# Kansei Evaluation of Subjective Sense of Object Weight Produced by Shape Property Using Three-dimensional Images


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## 1. INTRODUCTION

In recent years, with the increase in portable electronic devices (e.g., tablet terminals and mobile phones), "weight" has become a very important factor when a consumer chooses a product. Therefore, more companies are conducting research on ways to reduce the weight of a product.

This weight is determined by the materials employed and the volume. However, an object can be considered heavier or lighter than another with the same weight based on differences in their shapes, sizes, or colors. Moreover, even for the same design, different people can have different feelings. This is because even if two objects have the same physical characteristics, their perceived weights can be different because of different surface features (shape, size, or color).

Therefore, we focused on shape as a factor affecting the perceived weight. In other words, by assessing the influence of shape on the perception of weight, this study aimed to explore the subjective sense of an object's weight due to the surface features of its shape. In particular, by performing experiments with the three-dimensional shapes that form the basis of product design, the relationship between shape and the subjective sense of an object's weight could be clarified.

## 2. OVERVIEW OF RESEARCH

Objects were constructed using basic shapes: cuboids, spheres, cylinders, cones, and pyramids. Three aspect ratios were used, 1:1, 1:1.6, and 1.6:1, referred to as the golden ratio, for a total of 15 different models. The dimensions of each shape were selected to produce a cubic volume of 100 $mm^3$, with a margin of error of 1%. The models were constructed using three-dimensional computer aided design (3DCAD) software (AUTODESK®: INVENTOR).

To measure the unconscious intuitive perceived weight, experiments were conducted using the pair comparison method. The pair comparison method uses one-to-one object comparisons. The procedures are simple, and it has high reliability and validity. With this evaluation method, two shapes were displayed side by side on a large monitor, and subjects were asked to select the shape that looked lighter using a clicker, which was shaped like a TV remote control. They could answer by pressing the Select button. Thus, by using this clicker, the subject could answer without moving their line of sight on the screen. Each model was displayed for 6 s, and then a break time of 4 s was provided to eliminate the influence of the previous model.

The subjects answered 45 questions presented randomly. This laboratory study employed 32 subjects (26 male and 6 female) recruited from local university students, with an average age of 21.75 (±1.17) years.

## 3. RESULTS AND ANALYSES

Because the subjects were asked to select the shape that appeared to be lighter, a high ranking meant the shape looked lighter, and a low ranking meant the shape looked heavier.

Table 1 lists the evaluation values and rankings for the basic shapes. For the sphere and rectangle, it was found that the horizontal type appeared to be the lightest, followed by the vertical type. For the cone and cylinder, the vertical type was perceived to be the lightest, and the horizontal type was perceived to be the heaviest. For the square pyramid, the order was the vertical type, horizontal type, and normal type. From the above results, we found that different ratios were perceived as the lightest, based on the shape.

Table 2 lists the results of the analyses using the pair comparison method. As can be seen, the shape rankings for the vertical and normal types match. However, the ranking for the horizontal type is different from those of the vertical and normal types. Thus, regardless of the aspect ratio used for the basic shapes, the sphere was perceived to be the lightest, whereas the rectangle was perceived to be the heaviest.

In addition, when considered in conjunction with the analysis of the shape characteristics, the order of the vertical and normal types is consistent with the order of the curved surface rate, in descending order of the rate curve and ascending order of the number of sides. And the objects that appeared to be circular from the top looked lighter, and the objects that appeared to be square were perceived as heavier.

For the horizontal type, no regularity was observed in relation to the curve factor, surface ratio, or sides. However, the shape of the front view of the horizontal type had the order of a circle, triangle, and square.

## 4. DISCUSSIONS AND CONCLUSION

The purpose of this study was to clarify the influence of the shape property on the perception of weight by using three-dimensional images with different basic shapes and aspect ratios. As a result, this study showed quantitatively that shapes with curved surfaces are perceived to be lighter, whereas rectilinear shapes appear to be heavier. Regardless of the aspect ratio, the same results were found for all the models.

In addition, we found that for each shape, the aspect ratio had an influence on the perception of weight. Further, based on a comparison of the cone shapes, there is a possibility that the viewing angle has an effect on the subjective sense of weight. Thus, it will be necessary to clarify the effect of the viewing angle by further analyses.


REFERENCES

[1] De Camp, J. E. (1917). The influence of color on apparent weight. A preliminary study. Journal of Experimental Psychology, Vol 2(5), Oct 1917, 347-370.

[2] Engineering Centre ECAR (2010). A380 weight saving project. Retrieved March 3, 2014, from http://en.ecar-airbus.ru/projects/a380-weight-saving-project/

[3] Yusuke S., Lee M., Yoshihiro N. (2014). Study on Shapes and Subjective Weight of Object-Kansei Engineering Approach Using 3D Image. Proceedings of spring Conference 9th of JSKE [CD ROM]. 3B-05. Sapporo, Japan.



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< Table 1 > Result for each object

| Object | First | Second | Third |
|---|---|---|---|
| Box | | | |
| Evaluation value | 1.27 | -0.18 | -1.09 |
| Ball | | | |
| Evaluation value | 0.24 | -0.08 | -0.16 |
| Column | | | |
| Evaluation value | 0.40 | 0.2 | -0.60 |
| Cone | | | |
| Evaluation value | 0.28 | 0.13 | -0.40 |
| Square pyramid | | | |
| Evaluation value | 0.12 | 0 | -0.18 |

< Table 2 > Results based on type

| Type | First | Second | Third | Fourth | Fifth |
|---|---|---|---|---|---|
| Normal Type | | | | | |
| Evaluation value | 1.01 | 0.89 | -0.00 | -0.26 | -1.62 |
| Vertical Type | | | | | |
| Evaluation value | 0.94 | 0.64 | -0.13 | -0.24 | -1.21 |
| Horizontal Type | | | | | |
| Evaluation value | 0.62 | 0.07 | -0.08 | -0.23 | -0.38 |