

# Chopsticks!

A few researchers set out to determine the optimal length of chopsticks for children and adults. They came up with a measure of how effective a pair of chopsticks performed, called the "Food Pinching Performance." The "Food Pinching Performance" was determined by counting the number of peanuts picked and placed in a cup (PPPC).

## An investigation for determining the optimum length of chopsticks.

[Link to Abstract and Paper](#)

*the abstract below was adapted from the link*

Chopsticks are one of the most simple and popular hand tools ever invented by humans, but have not previously been investigated by [ergonomists](#). Two laboratory studies were conducted in this research, using a [randomised complete block design](#), to evaluate the effects of the length of the chopsticks on the food-serving performance of adults and children. Thirty-one male junior college students and 21 primary school pupils served as subjects for the experiment to test chopsticks lengths of 180, 210, 240, 270, 300, and 330 mm. The results showed that the food-pinching performance was significantly affected by the length of the chopsticks, and that chopsticks of about 240 and 180 mm long were optimal for adults and pupils, respectively. Based on these findings, the researchers suggested that families with children should provide both 240 and 180 mm long chopsticks. In addition, restaurants could provide 210 mm long chopsticks, considering the trade-offs between ergonomics and cost.

**For the rest of this project, answer all questions based only on the part of the experiment analyzing the thirty-one adult male college students.**

Download the [data set for the adults](#), then answer the following questions based on the abstract and the data set.

**If you double click on this cell**, you will see the text change so that all of the formatting is removed. This allows you to edit this block of text. This block of text is written using [Markdown](#), which is a way to format text using headers, links, italics, and many other options. You will learn more about Markdown later in the Nanodegree Program. Hit shift + enter or shift + return to show the formatted text.

### **1. What is the independent variable in the experiment?**

You can either double click on this cell to add your answer in this cell, or use the plus sign in the toolbar (Insert cell below) to add your answer in a new cell.

```
In [3]: "Chopstick Length"
```

```
Out[3]: 'Chopstick Length'
```

### **2. What is the dependent variable in the experiment?**

```
In [4]: "Food Pinching Efficiency"
```

```
Out[4]: 'Food Pinching Efficiency'
```

### 3. How is the dependent variable operationally defined?

In [10]: "The operational definition for dependent variable defined as number of peanuts picked and placed in a cup-PPPC"

Out[10]: 'The operational definition for dependent variable defined as number of peanuts picked and placed in a cup-PPPC'

### 4. Based on the description of the experiment and the data set, list at least two variables that you know were controlled.

Think about the participants who generated the data and what they have in common. You don't need to guess any variables or read the full paper to determine these variables. (For example, it seems plausible that the material of the chopsticks was held constant, but this is not stated in the abstract or data description. Because of this, chopstick length should not be cited as a controlled variable.)

In [13]: "There can be more than two variables -\  
1. The size of the peanuts(practically it's not possible to get identical but consider of similar size)\  
2. The size of the cup\  
3. Time given to perform activity"

Out[13]: "There can be more than two variables - 1. The size of the peanuts(practically it's not possible to get identical but consider of similar size) 2. The size of the cup 3. Time given to perform activity"

One great advantage of ipython notebooks is that you can document your data analysis using code, add comments to the code, or even add blocks of text using Markdown. These notebooks allow you to collaborate with others and share your work. For now, let's see some code for doing

statistics.

In [5]: `import pandas as pd`

```
# pandas is a software library for data manipulation and analysis  
# We commonly use shorter nicknames for certain packages. Pandas is often abbreviated to pd.  
# hit shift + enter to run this cell or block of code
```

In [6]: `path = r'~/Downloads/chopstick-effectiveness.csv'`

```
# Change the path to the location where the chopstick-effectiveness.csv file is located on your computer.  
# If you get an error when running this block of code, be sure the chopstick-effectiveness.csv is located at the path on your computer.
```

```
dataFrame = pd.read_csv(path)  
dataFrame
```

Out[6]:

|    | Food.Pinching.Efficiency | Individual | Chopstick.Length |
|----|--------------------------|------------|------------------|
| 0  | 19.55                    | 1          | 180              |
| 1  | 27.24                    | 2          | 180              |
| 2  | 28.76                    | 3          | 180              |
| 3  | 31.19                    | 4          | 180              |
| 4  | 21.91                    | 5          | 180              |
| 5  | 27.62                    | 6          | 180              |
| 6  | 29.46                    | 7          | 180              |
| 7  | 26.35                    | 8          | 180              |
| 8  | 26.69                    | 9          | 180              |
| 9  | 30.22                    | 10         | 180              |
| 10 | 27.81                    | 11         | 180              |
| 11 | 23.46                    | 12         | 180              |
| 12 | 23.64                    | 13         | 180              |
| 13 | 27.85                    | 14         | 180              |
| 14 | 20.62                    | 15         | 180              |
| 15 | 25.35                    | 16         | 180              |
| 16 | 28.00                    | 17         | 180              |
| 17 | 23.49                    | 18         | 180              |

|            |       |     |     |
|------------|-------|-----|-----|
| <b>18</b>  | 27.77 | 19  | 180 |
| <b>19</b>  | 18.48 | 20  | 180 |
| <b>20</b>  | 23.01 | 21  | 180 |
| <b>21</b>  | 22.66 | 22  | 180 |
| <b>22</b>  | 23.24 | 23  | 180 |
| <b>23</b>  | 22.82 | 24  | 180 |
| <b>24</b>  | 17.94 | 25  | 180 |
| <b>25</b>  | 26.67 | 26  | 180 |
| <b>26</b>  | 28.98 | 27  | 180 |
| <b>27</b>  | 21.48 | 28  | 180 |
| <b>28</b>  | 14.47 | 29  | 180 |
| <b>29</b>  | 28.29 | 30  | 180 |
| ...        | ...   | ... | ... |
| <b>156</b> | 26.18 | 2   | 330 |
| <b>157</b> | 25.93 | 3   | 330 |
| <b>158</b> | 28.61 | 4   | 330 |
| <b>159</b> | 20.54 | 5   | 330 |
| <b>160</b> | 26.44 | 6   | 330 |
| <b>161</b> | 29.36 | 7   | 330 |
| <b>162</b> | 19.77 | 8   | 330 |

|            |       |    |     |
|------------|-------|----|-----|
| <b>163</b> | 31.69 | 9  | 330 |
| <b>164</b> | 24.64 | 10 | 330 |
| <b>165</b> | 22.09 | 11 | 330 |
| <b>166</b> | 23.42 | 12 | 330 |
| <b>167</b> | 28.63 | 13 | 330 |
| <b>168</b> | 26.30 | 14 | 330 |
| <b>169</b> | 22.89 | 15 | 330 |
| <b>170</b> | 22.68 | 16 | 330 |
| <b>171</b> | 30.92 | 17 | 330 |
| <b>172</b> | 20.74 | 18 | 330 |
| <b>173</b> | 27.24 | 19 | 330 |
| <b>174</b> | 17.12 | 20 | 330 |
| <b>175</b> | 23.63 | 21 | 330 |
| <b>176</b> | 20.91 | 22 | 330 |
| <b>177</b> | 23.49 | 23 | 330 |
| <b>178</b> | 24.86 | 24 | 330 |
| <b>179</b> | 16.28 | 25 | 330 |
| <b>180</b> | 21.52 | 26 | 330 |
| <b>181</b> | 27.22 | 27 | 330 |

|            |       |    |     |
|------------|-------|----|-----|
| <b>182</b> | 17.41 | 28 | 330 |
| <b>183</b> | 16.42 | 29 | 330 |
| <b>184</b> | 28.22 | 30 | 330 |
| <b>185</b> | 27.52 | 31 | 330 |

186 rows × 3 columns

Let's do a basic statistical calculation on the data using code! Run the block of code below to calculate the average "Food Pinching Efficiency" for all 31 participants and all chopstick lengths.

```
In [7]: dataframe['Food.Pinching.Efficiency'].mean()
```

```
Out[7]: 25.00559139784947
```

This number is helpful, but the number doesn't let us know which of the chopstick lengths performed best for the thirty-one male junior college students. Let's break down the data by chopstick length. The next block of code will generate the average "Food Pinching Efficiency" for each chopstick length. Run the block of code below.

```
In [8]: meansByChopstickLength = dataframe.groupby('Chopstick.Length')['Food.Pinching
.Efficiency'].mean().reset_index()
meansByChopstickLength
```

```
# reset_index() changes Chopstick.Length from an index to column. Instead of
the index being the length of the chopsticks, the index is the row numbers 0,
1, 2, 3, 4, 5.
```



Out[8]:

|   | Chopstick.Length | Food.Pinching.Efficiency |
|---|------------------|--------------------------|
| 0 | 180              | 24.935161                |
| 1 | 210              | 25.483871                |
| 2 | 240              | 26.322903                |
| 3 | 270              | 24.323871                |
| 4 | 300              | 24.968065                |
| 5 | 330              | 23.999677                |

**5. Which chopstick length performed the best for the group of thirty-one male junior college students?**

In [11]: "Chopstick Length about 240mm Long"

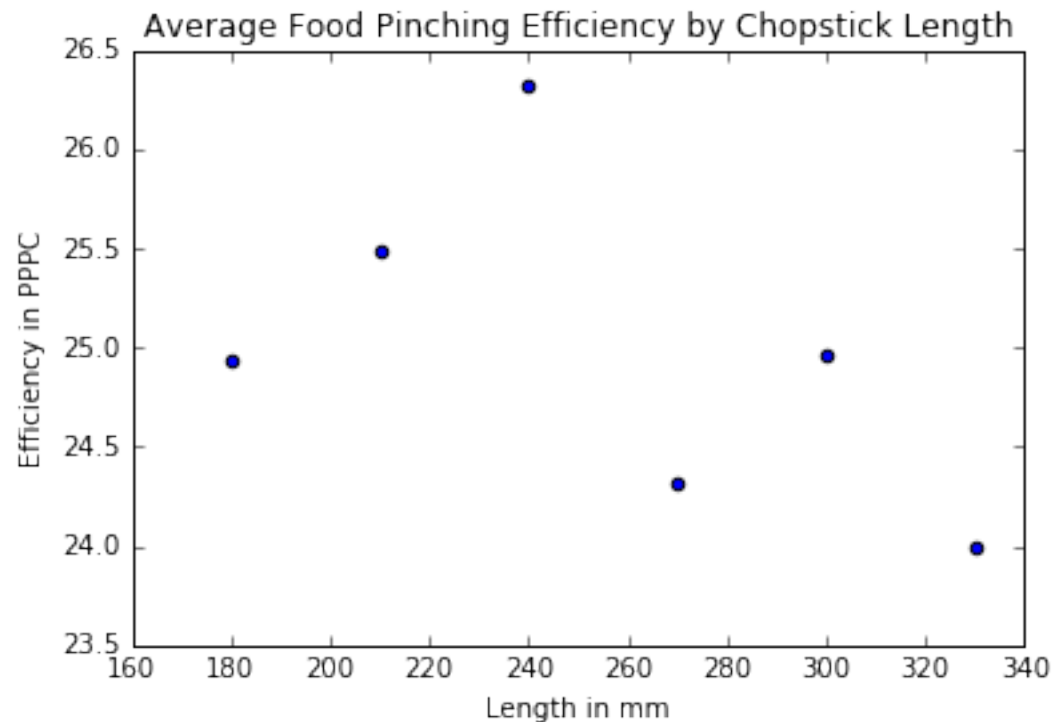
Out[11]: 'Chopstick Length about 240mm Long'

```
In [9]: # Causes plots to display within the notebook rather than in a new window
%pylab inline

import matplotlib.pyplot as plt

plt.scatter(x=meansByChopstickLength['Chopstick.Length'], y=meansByChopstickLength['Food.Pinching.Efficiency'])
           # title="")
plt.xlabel("Length in mm")
plt.ylabel("Efficiency in PPPC")
plt.title("Average Food Pinching Efficiency by Chopstick Length")
plt.show()
```

Populating the interactive namespace from numpy and matplotlib



6. Based on the scatterplot created from the code above, interpret the relationship you see. What do you notice?

**In the abstract the researchers stated that their results showed food-pinching performance was significantly affected by the length of the chopsticks, and that chopsticks of about 240 mm long were optimal for adults.**

7a. Based on the data you have analyzed, do you agree with the claim?

7b. Why?

```
In [ ]: "6. Based on the scatter plot we can interpret that the increase in length of
chopstick does not\
increase the efficiency in PPPC. As we can see the efficiency for chopstick l
ength 180 and 300 are almost same.\
But we can notice an increase in efficiency from 180 to 240"

"7a. Yes"
"7b. It is clearly evident from the Plot graph that the avg PPPC for chopstic
ks of about 240 length is high"

"Note: The comments are for this specific sample"
```