```
> install.packages("readr") #You choose "Korea for CRAN use."
> library(read)
> install.packages("car")
> library(car)
> library(carData)
> install.packages("lme4")
> library(lme4)
> library(Matrix)
> install.packages("lmerTest")
> library(lmerTest)
```

```
> file_path = file.choose() #You choose a csv file in the file directory on your
machine.
> dt = read_csv(file_path)
> str(dt)
> head(dt)
> tail (dt)
> summary(lm(LLy_constrictionDur ~ SpeechRate, data = dt)) #linear regression
model
```

e.g.,

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	17.3304 (intercept)	0.4993	34.711	< 2e-16 ***
SpeechRatefast	-4.3961(slope)	0.7077	-6.212	2.57e-09 ***

Recall linear equation (y = b + ax)

Ho: Constriction duration is the same across different speech rate (fast vs. comfortable).

Interpretation: "The constriction duration using the vertical movement of the lower lip varied with SpeechRate." This indicates that constriction duration is shorter for Fast speech rate by 4.3961. Be aware that it is a negative value.

1) Fixed effects: Factors we are interested in.

2) Random effects: Subjects and items are randomly sampled from population.

하지만, 이 수치들은 7명의 화자들의 발화를 측정한 결과이다. 따라서 다른 화자들을 측정 했을 때는 다른 수치를 나타낼 수 있기 때문에 화자는 전형적인 랜덤(non-repeatable)효과(random effects)의 예이다. (e.g., 반별, 아이템(예: 동사별))

Subjects and Items(예 동사 are randomly sampled from their population. Suppose we redo/repeat the same experiment. In this case, we design its experimental design same as

the previous one, implying different subjects and items.

e.g., (PP_SentInitial# According to the media) (ArgS# President Menem) (verb took) (ArgS# office) (PP_SentFinal# on July 8).

3) Mixed effects Model:
- A model contacting both fixed and random factors.
R packages: lmerTest
R function: lmer() (cf., Johnson(2008) uses different packages and functions)

> summary(lmer(LLy_Max ~ SpeechRate + (1|Subject), data = dt))

Random effects:

Groups	Name	Variance	Std.Dev.
Subject	(Intercept)	1.129	1.062
Residual		2.468	1.571

Number of obs: 223, groups: Subject, 7

Fixed effects:

	Estimate	Std. Error	df	t value	Pr(>|t|)	
(Intercept)	-15.3259	0.4281	6.7905	-35.800	5.45e-09	***
SpeechRatefast	-0.5371	0.2104	215.0064	-2.553	**0.0114**	* **(Slope에 관한 Estimates가 0과 다른 확률값을 본다)**

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1