Logistic Regression

Abby Fergus

Why logistic regression?

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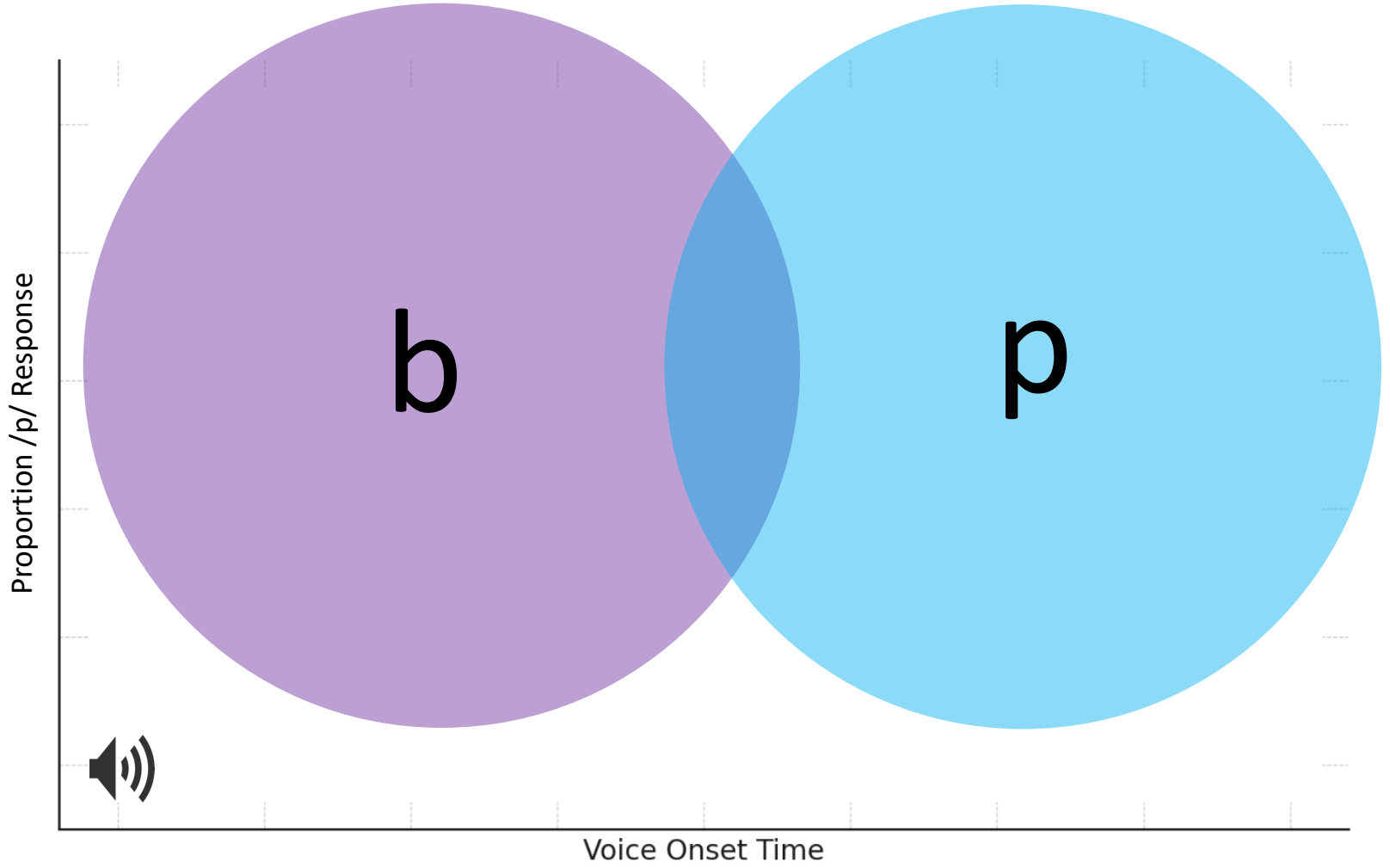

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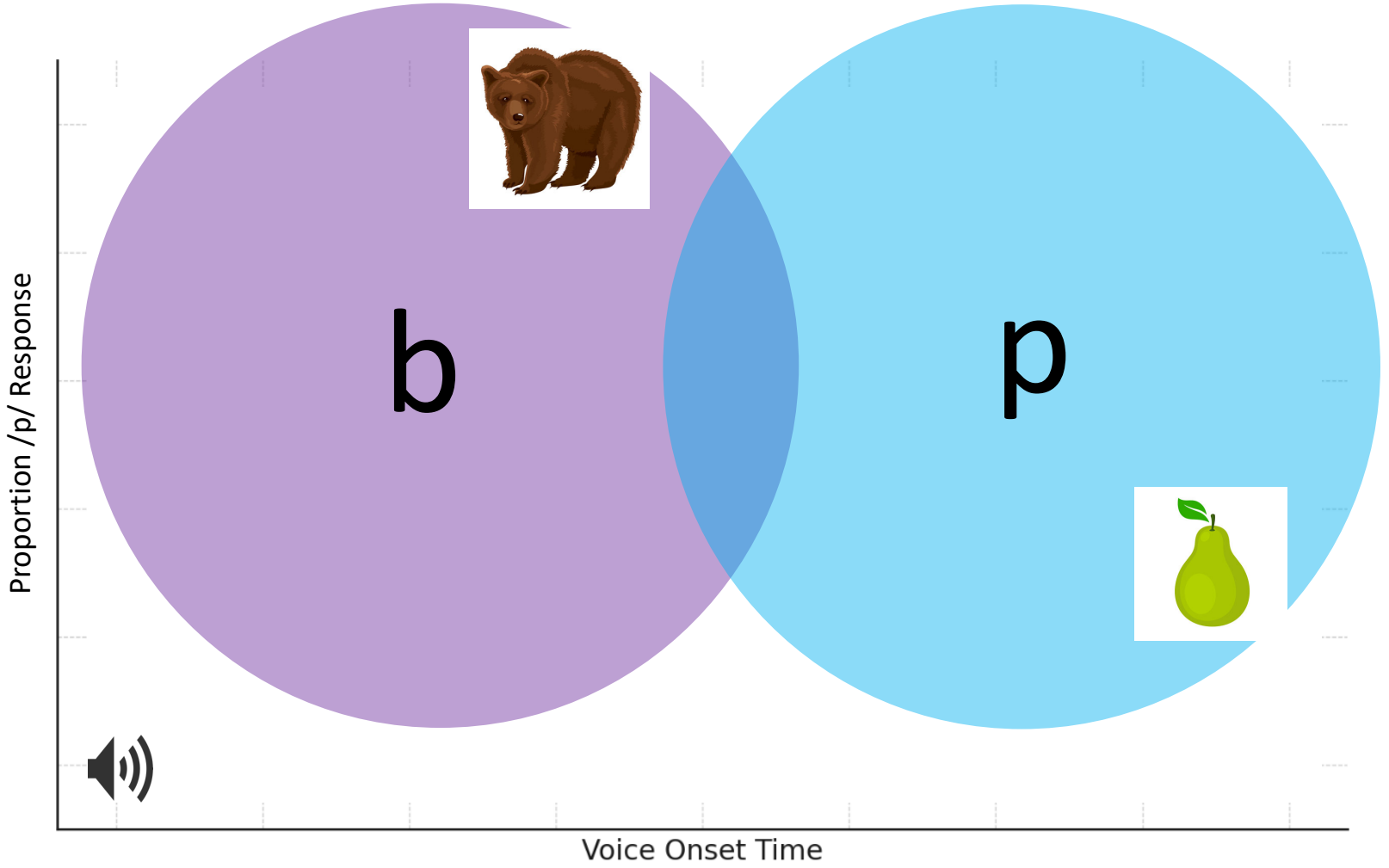

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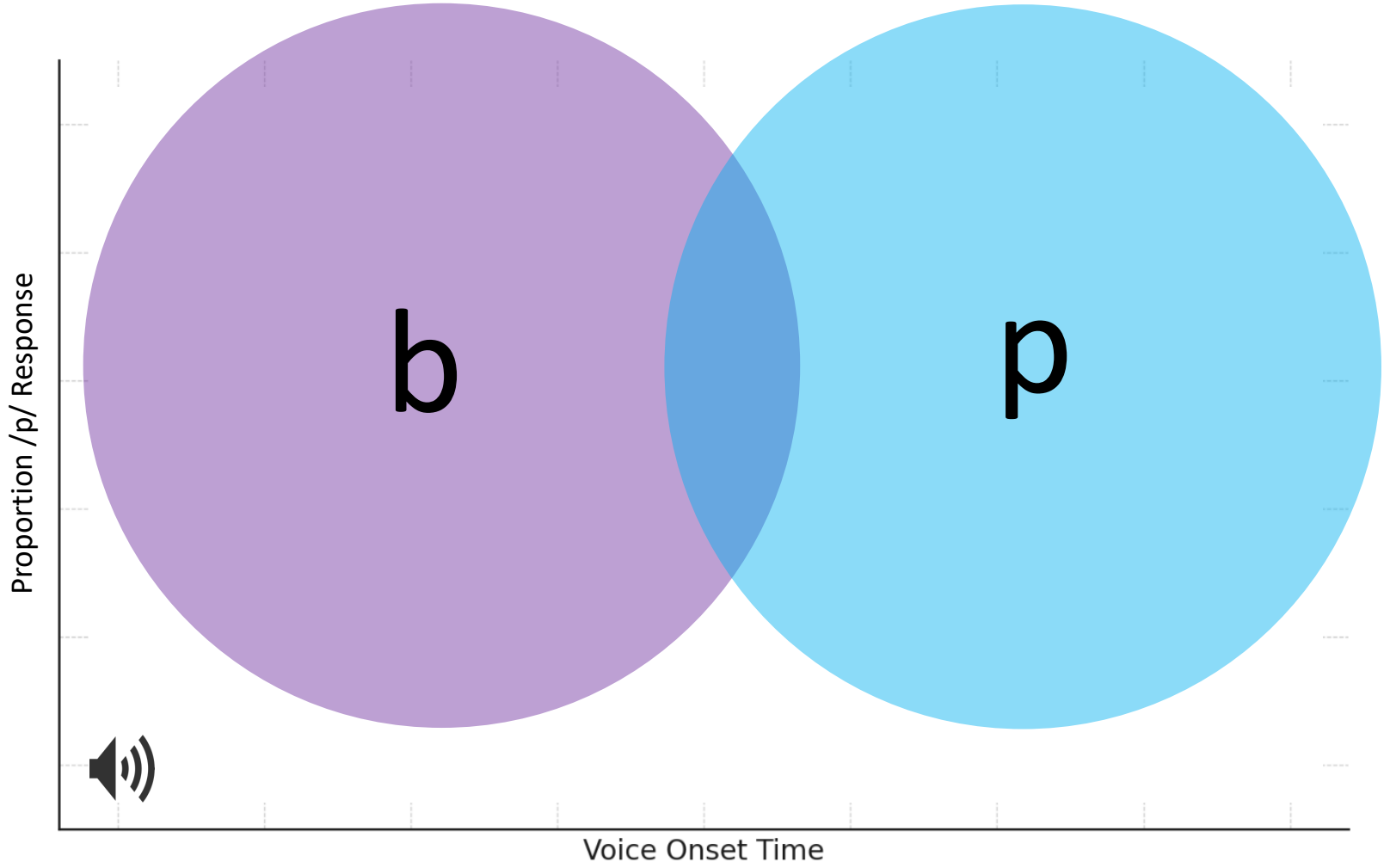

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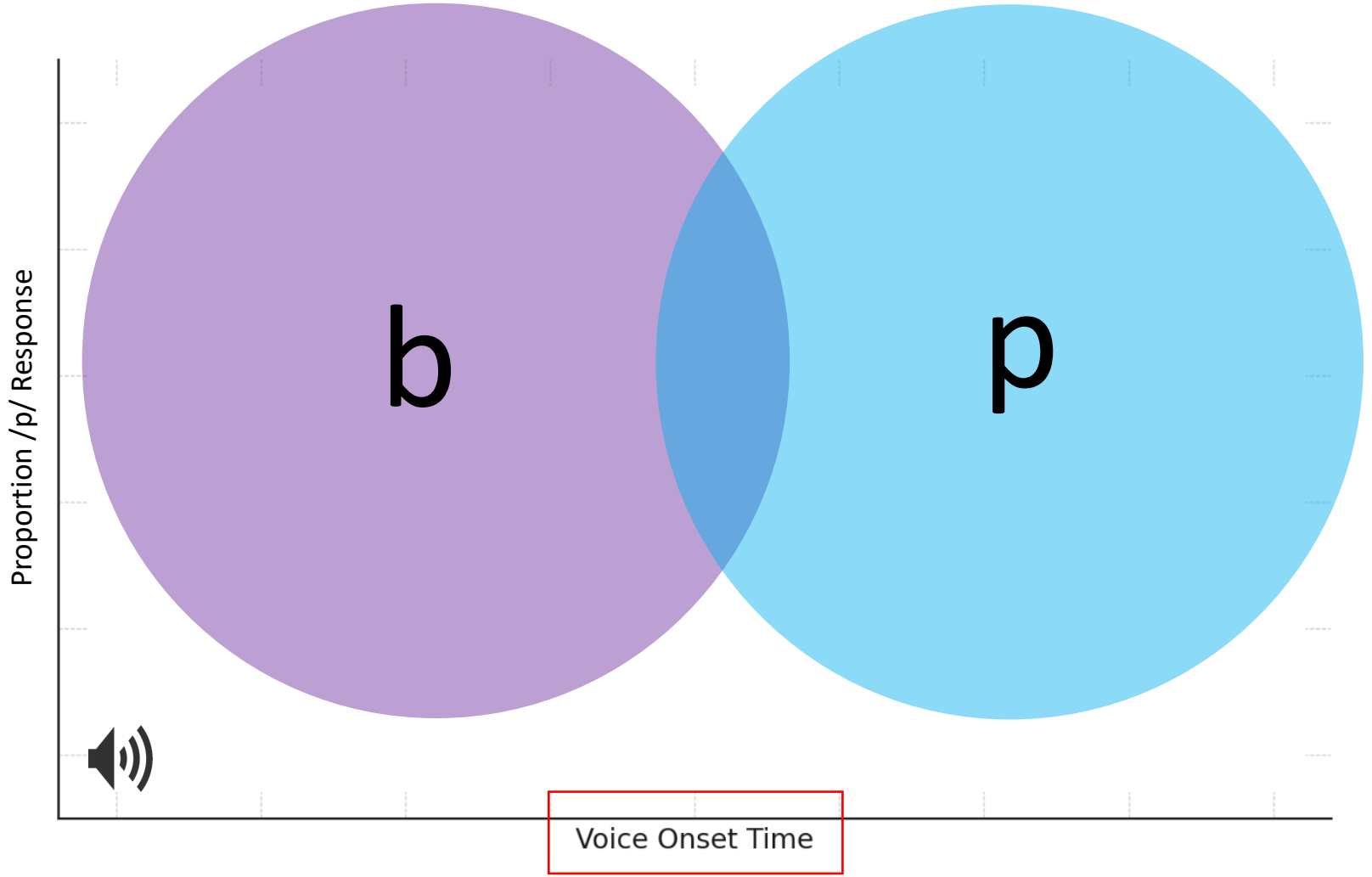

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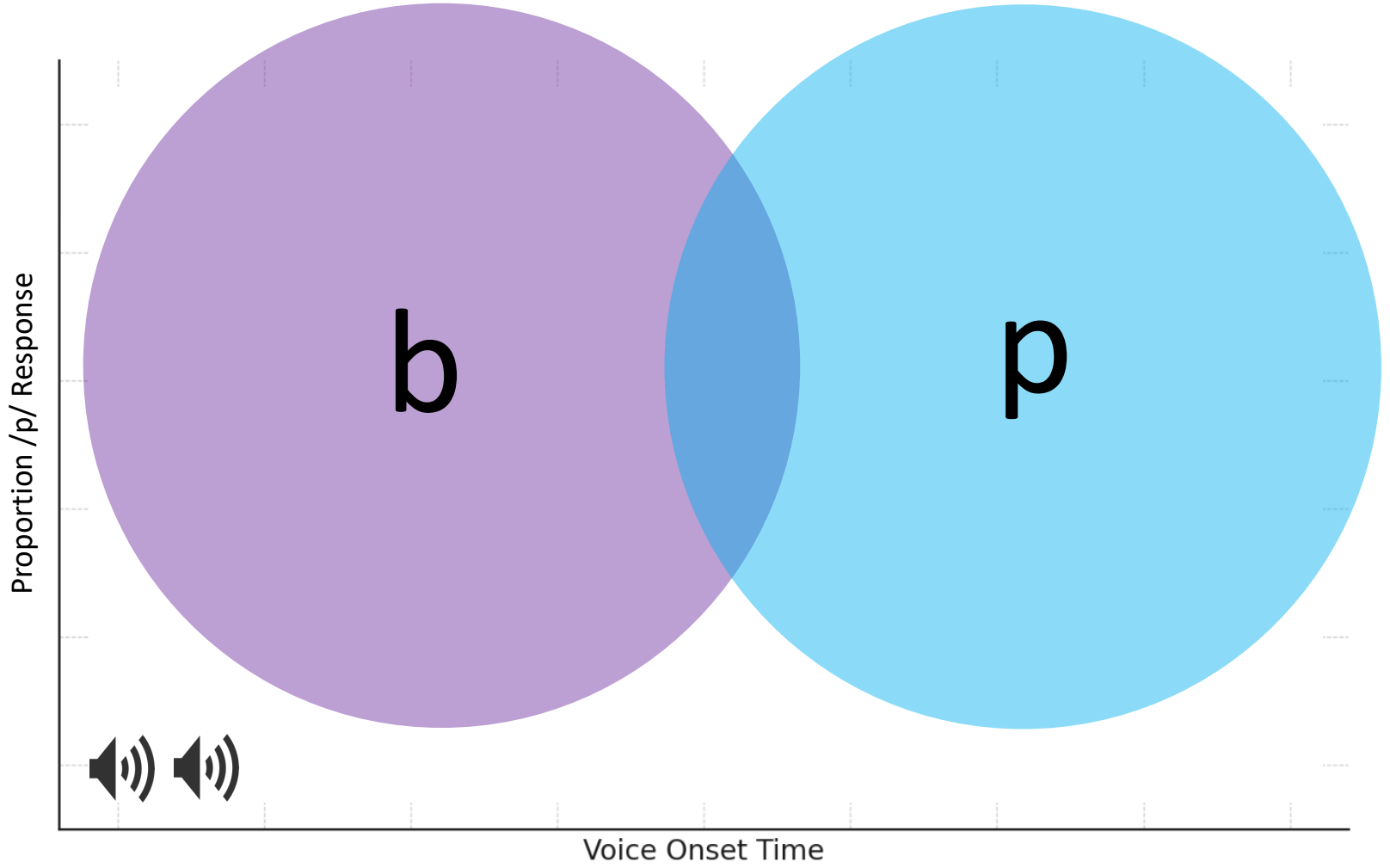

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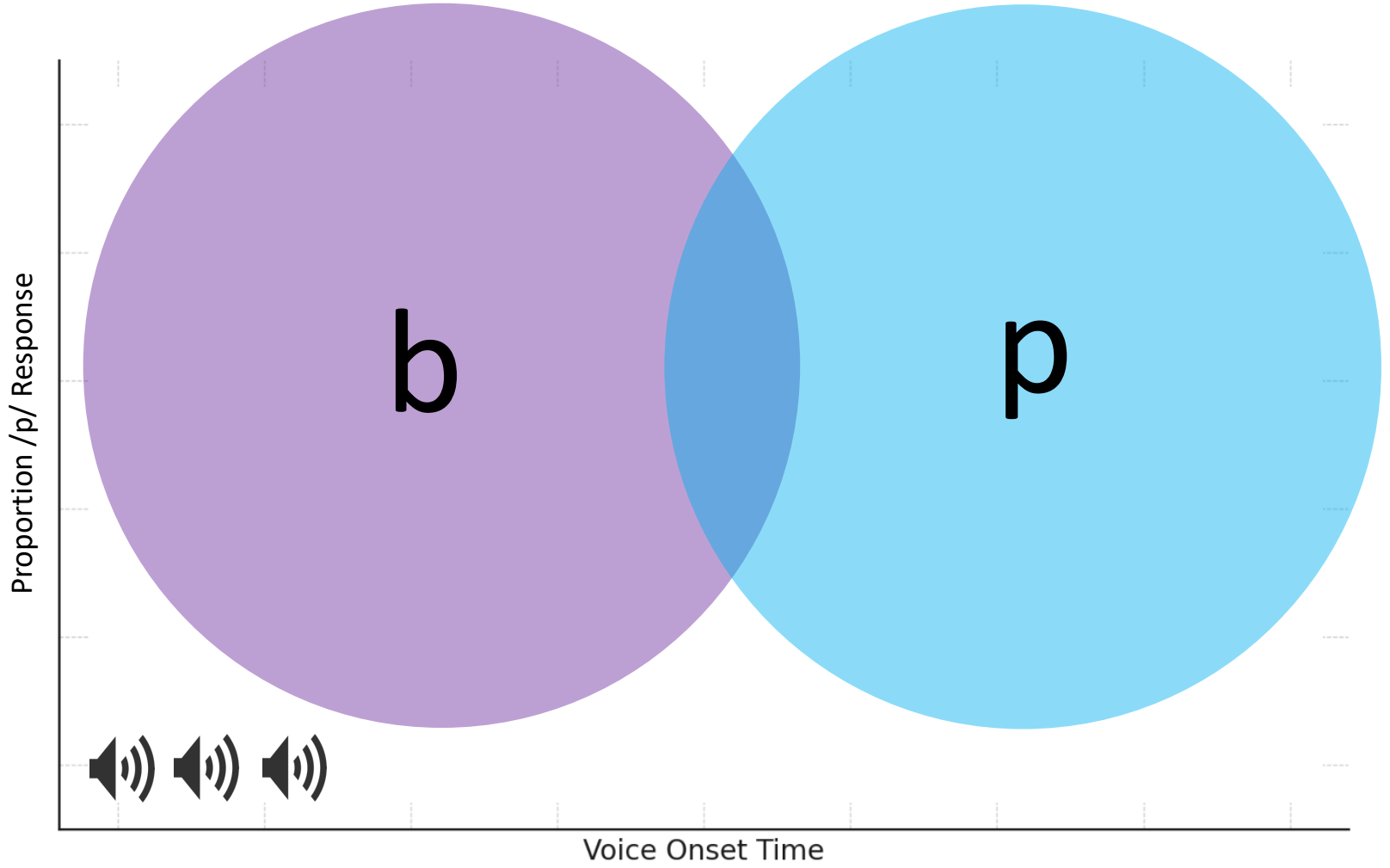

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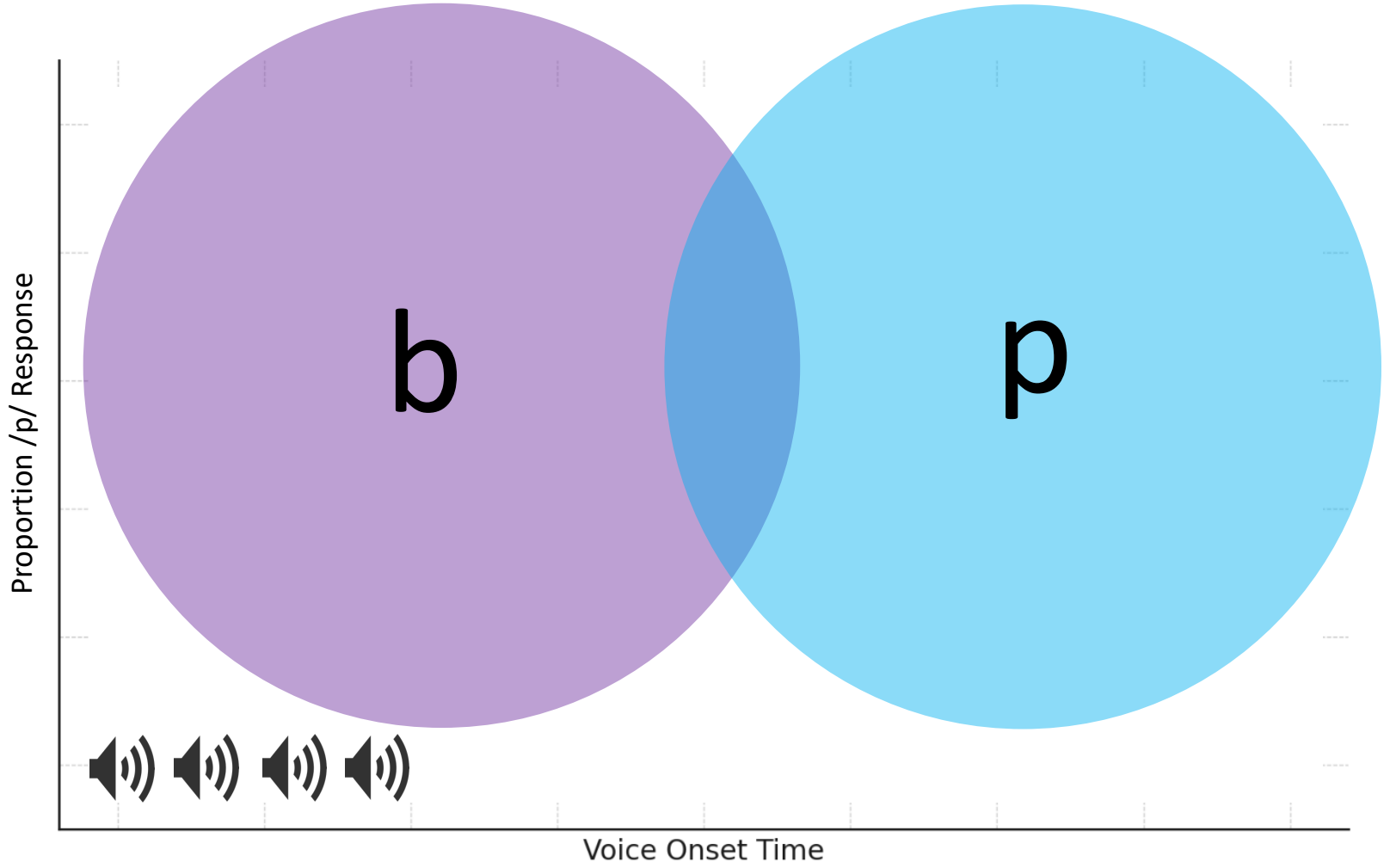

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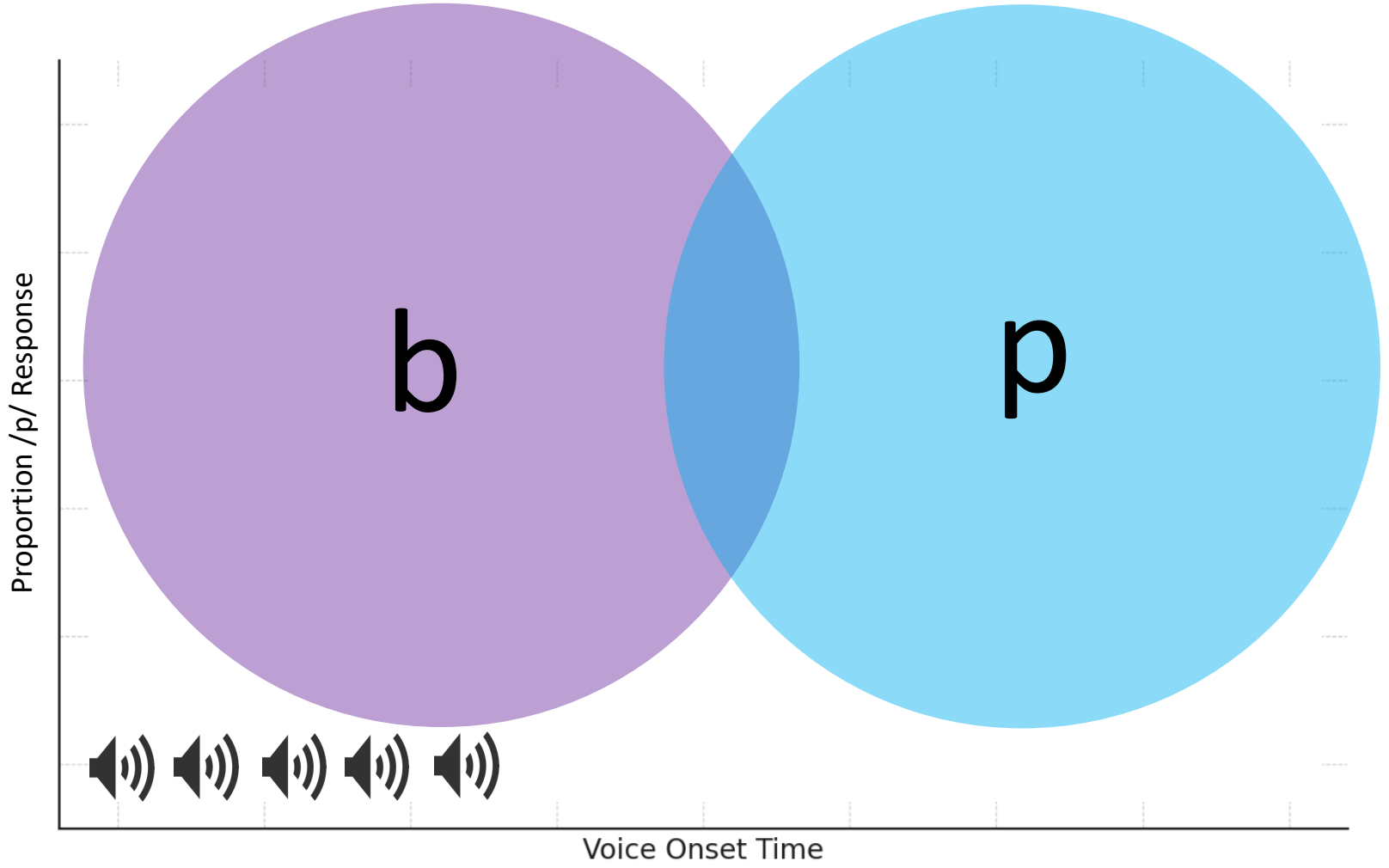

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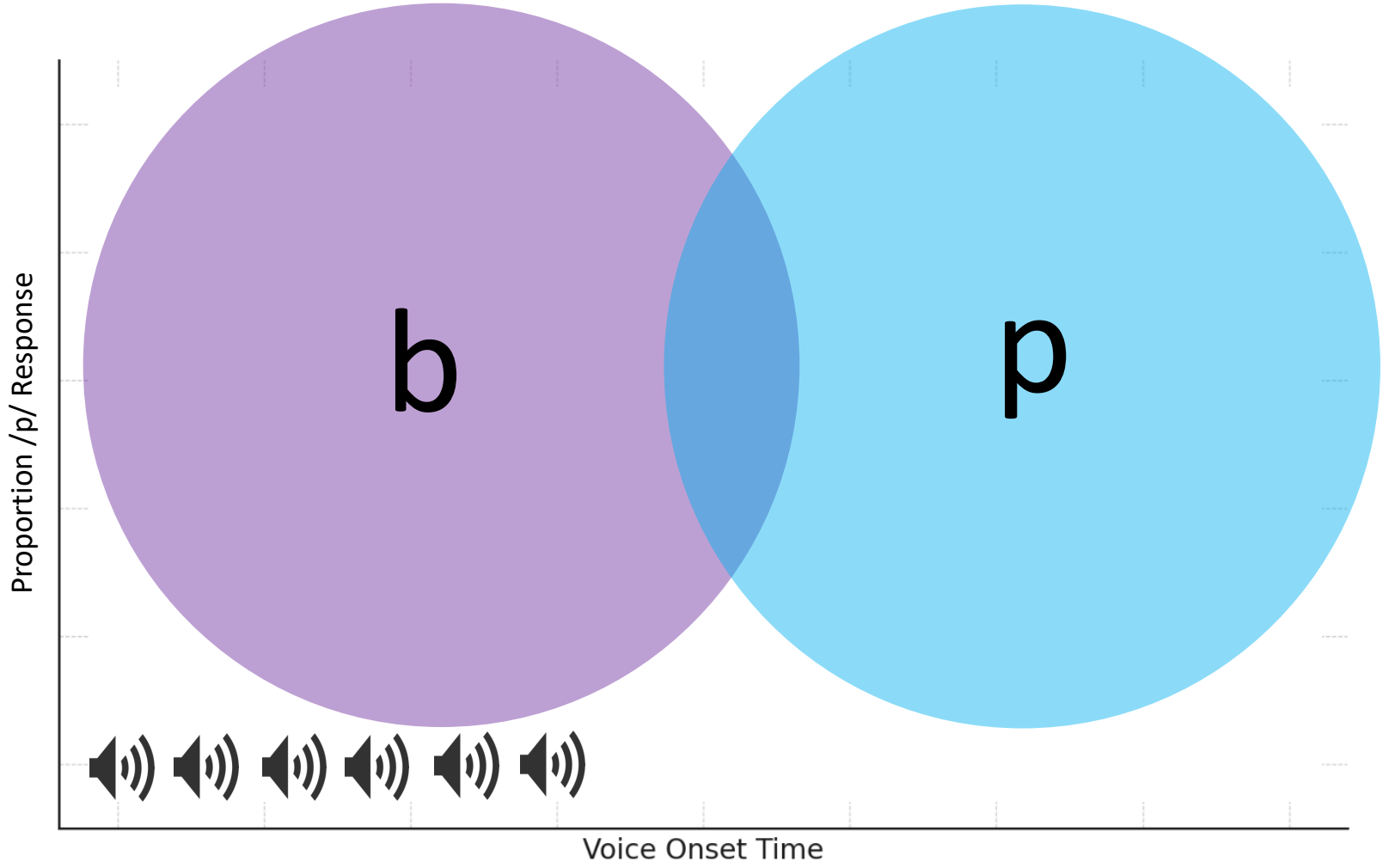

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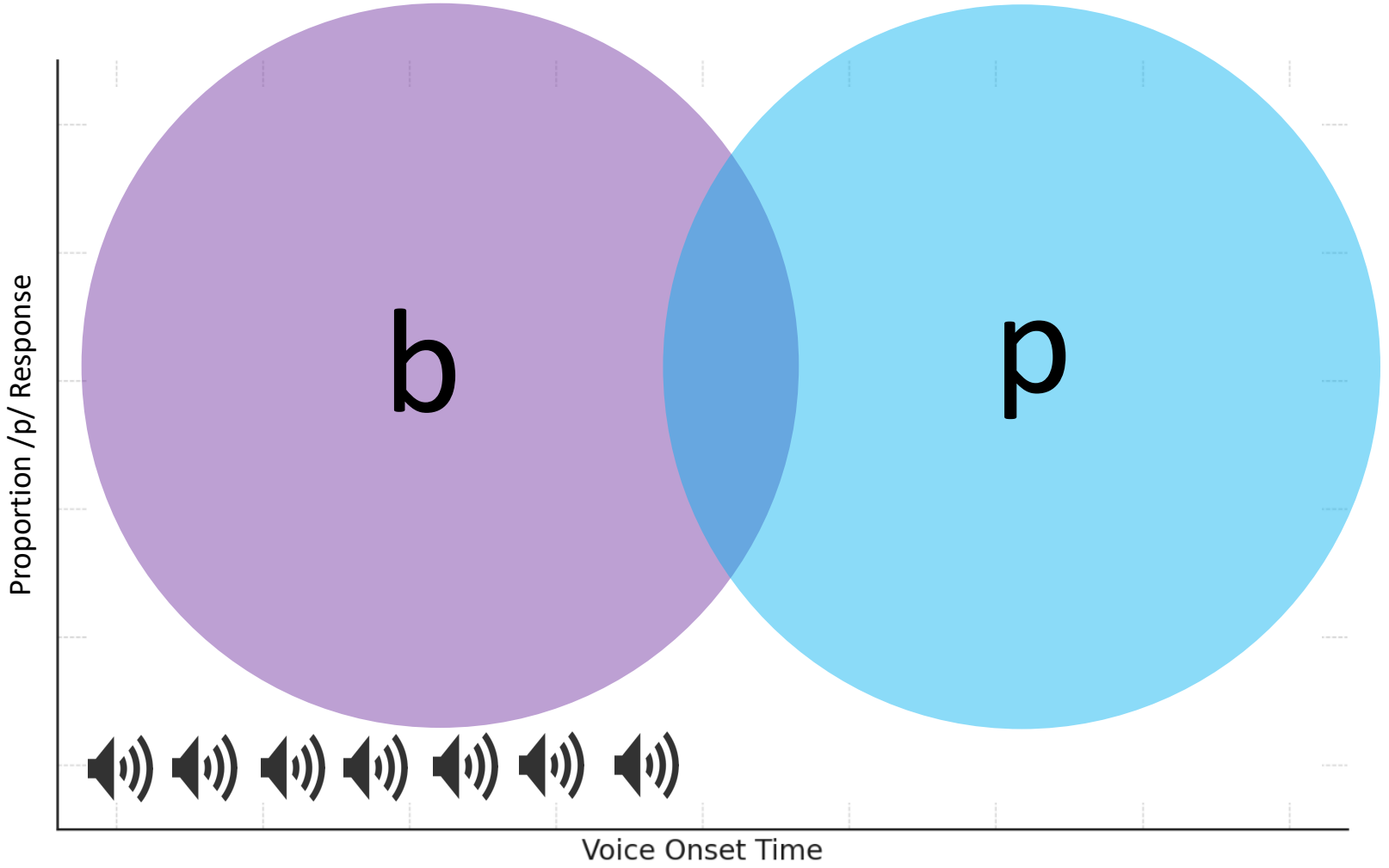

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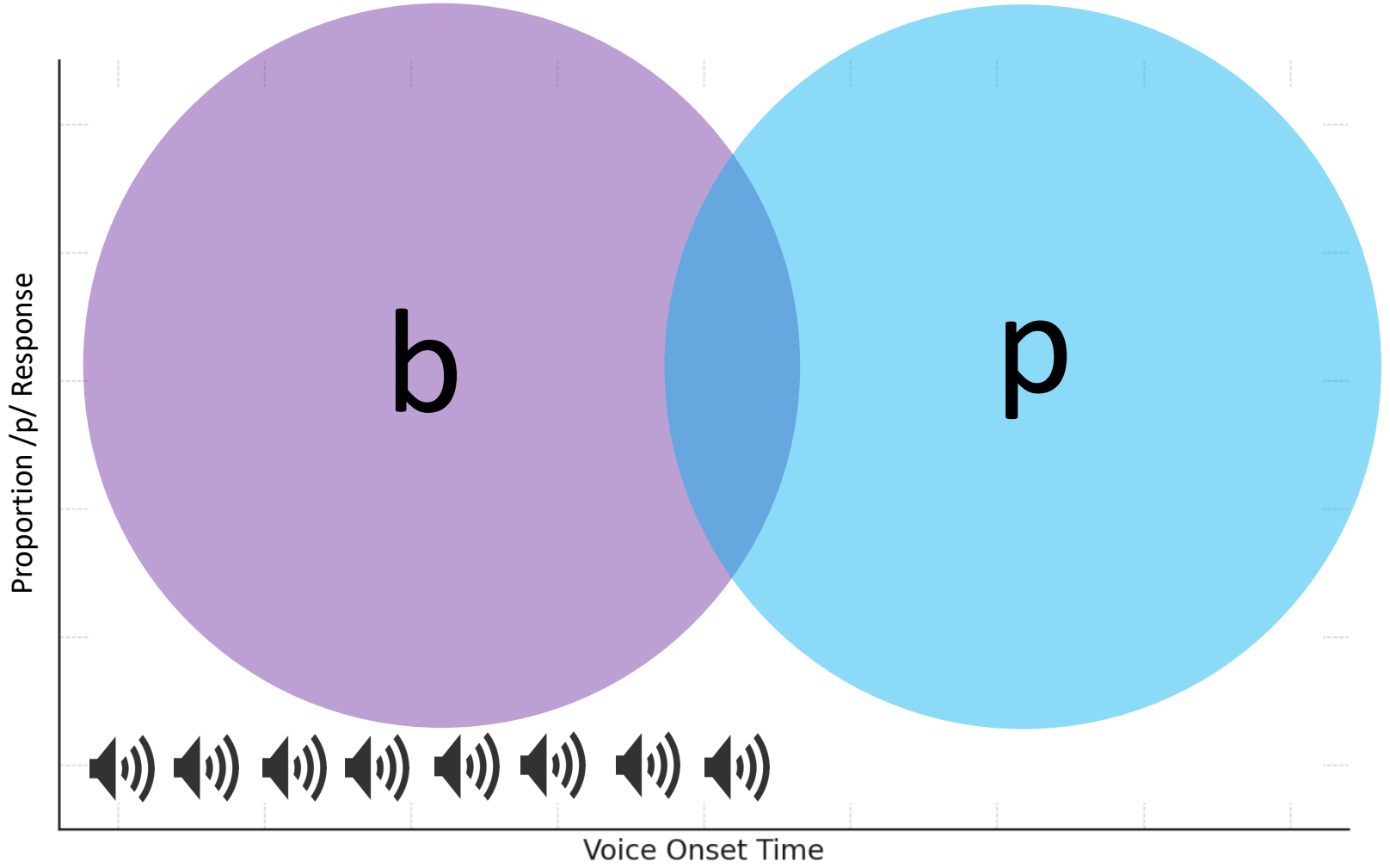

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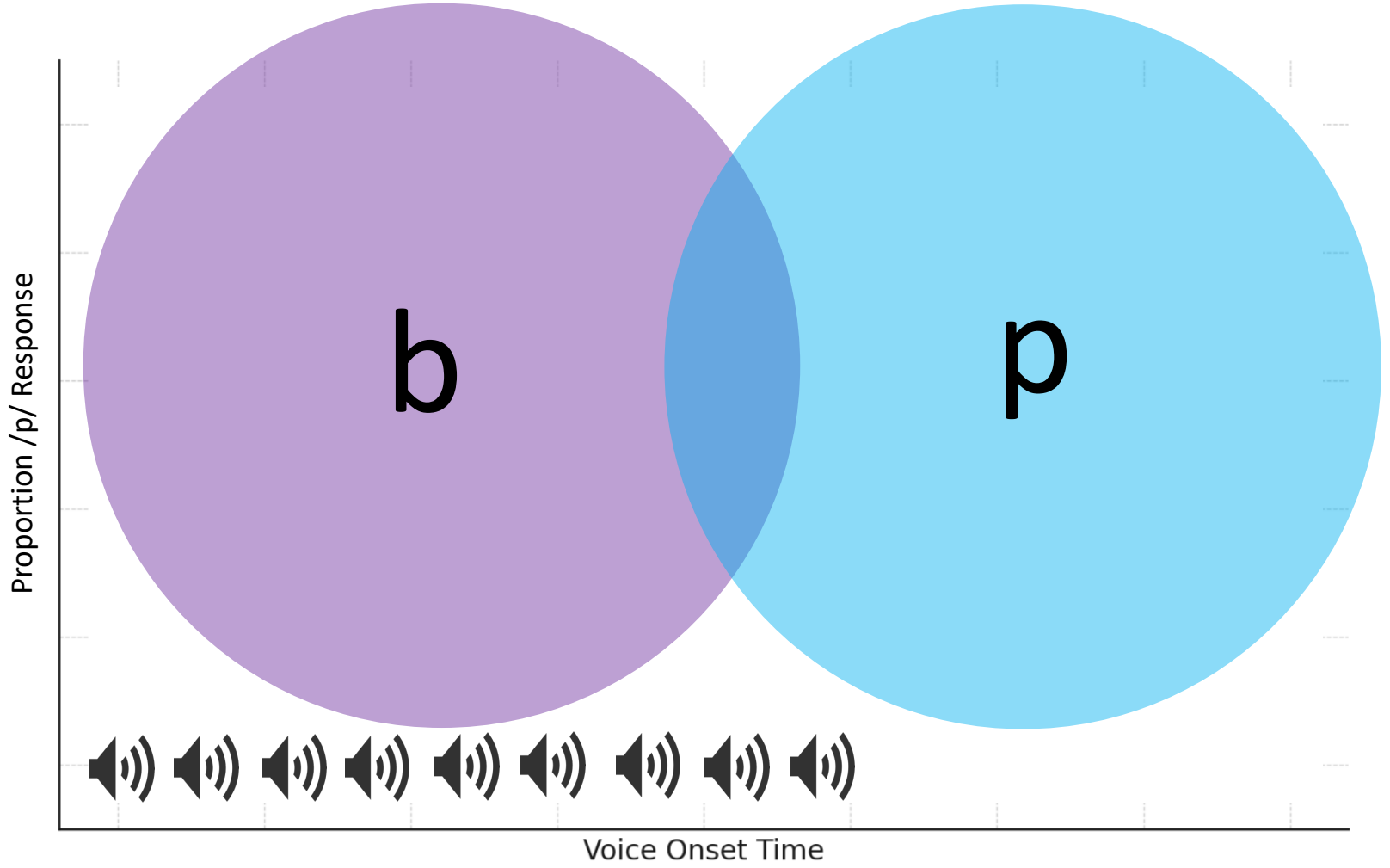

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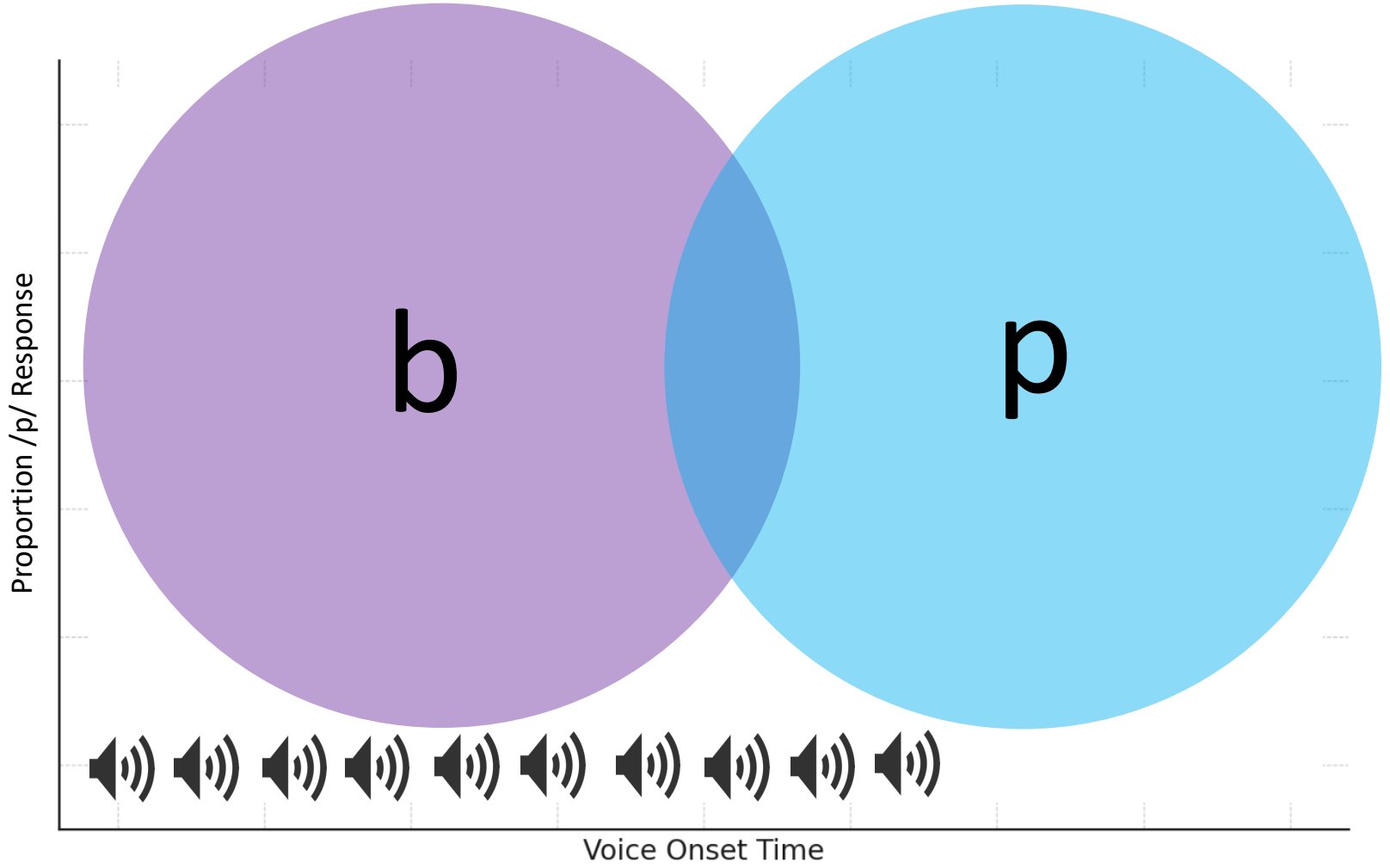

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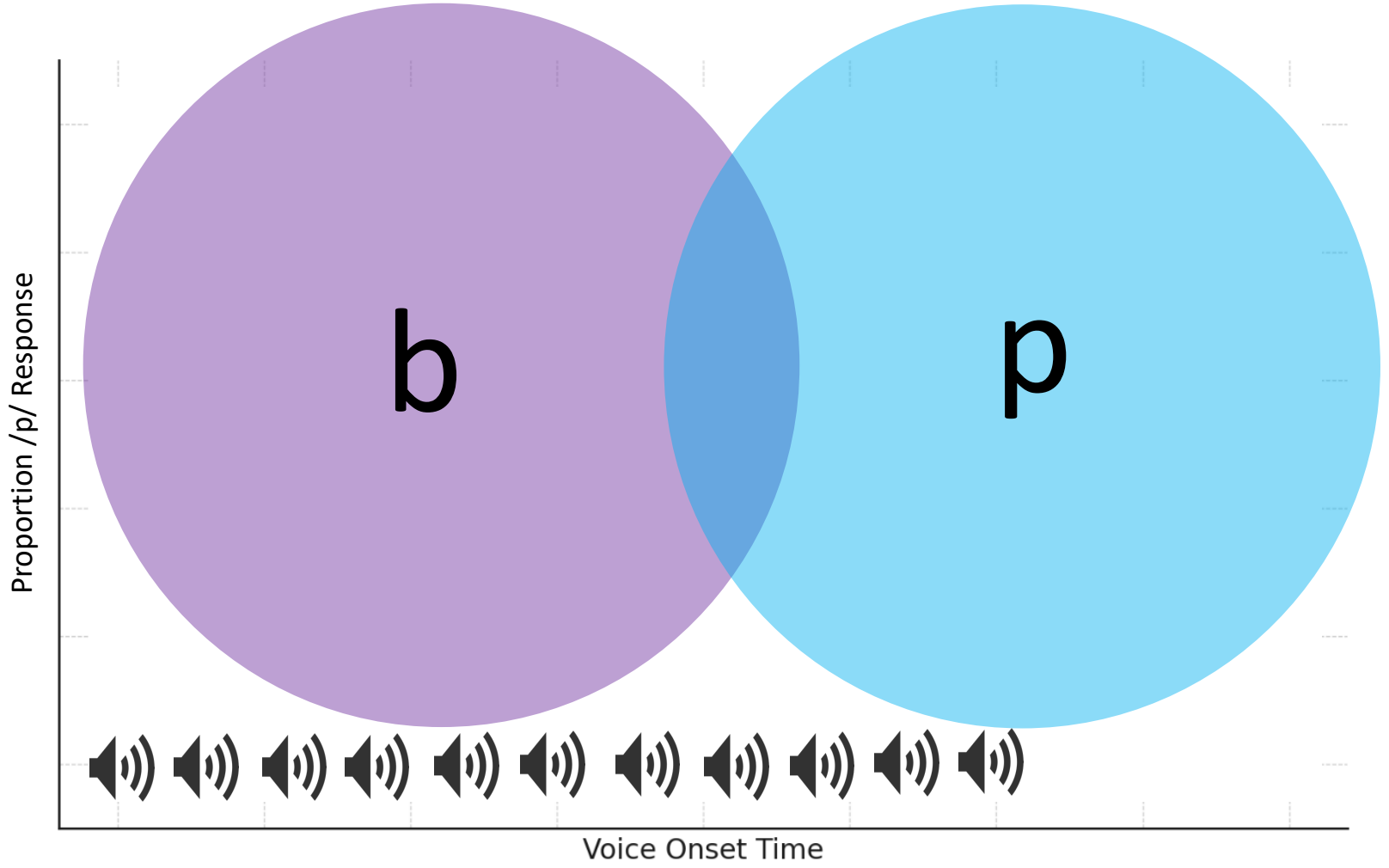

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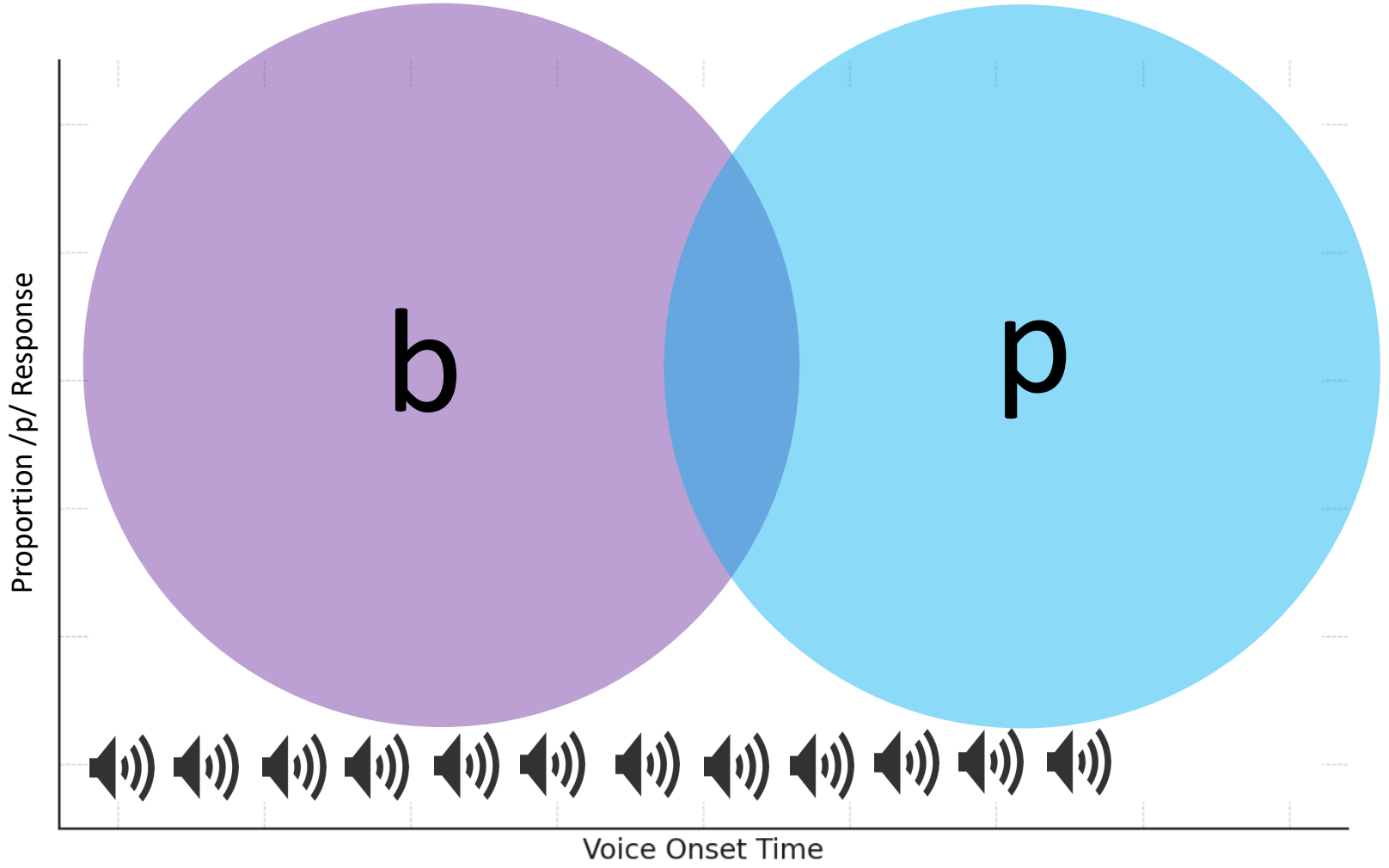

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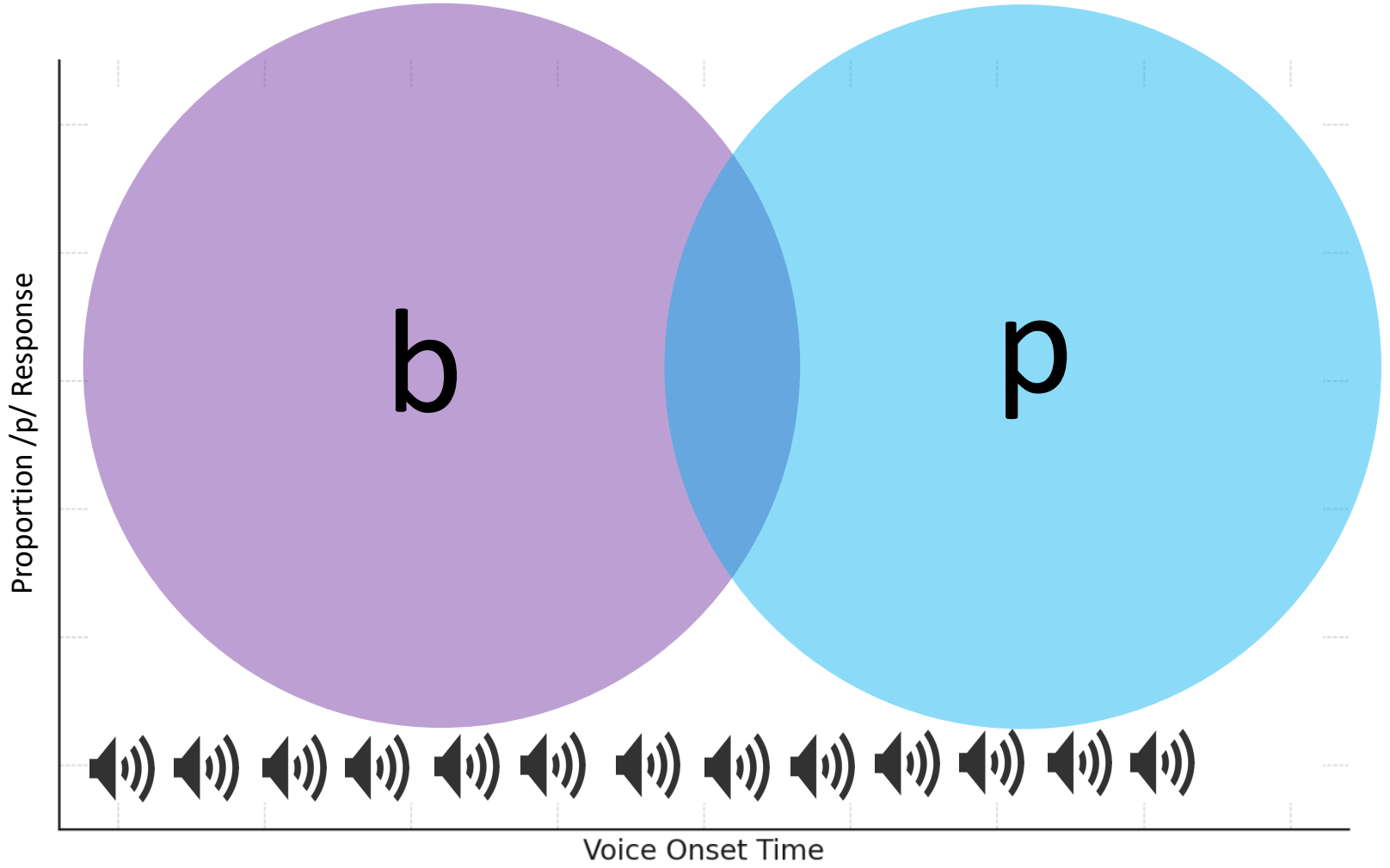

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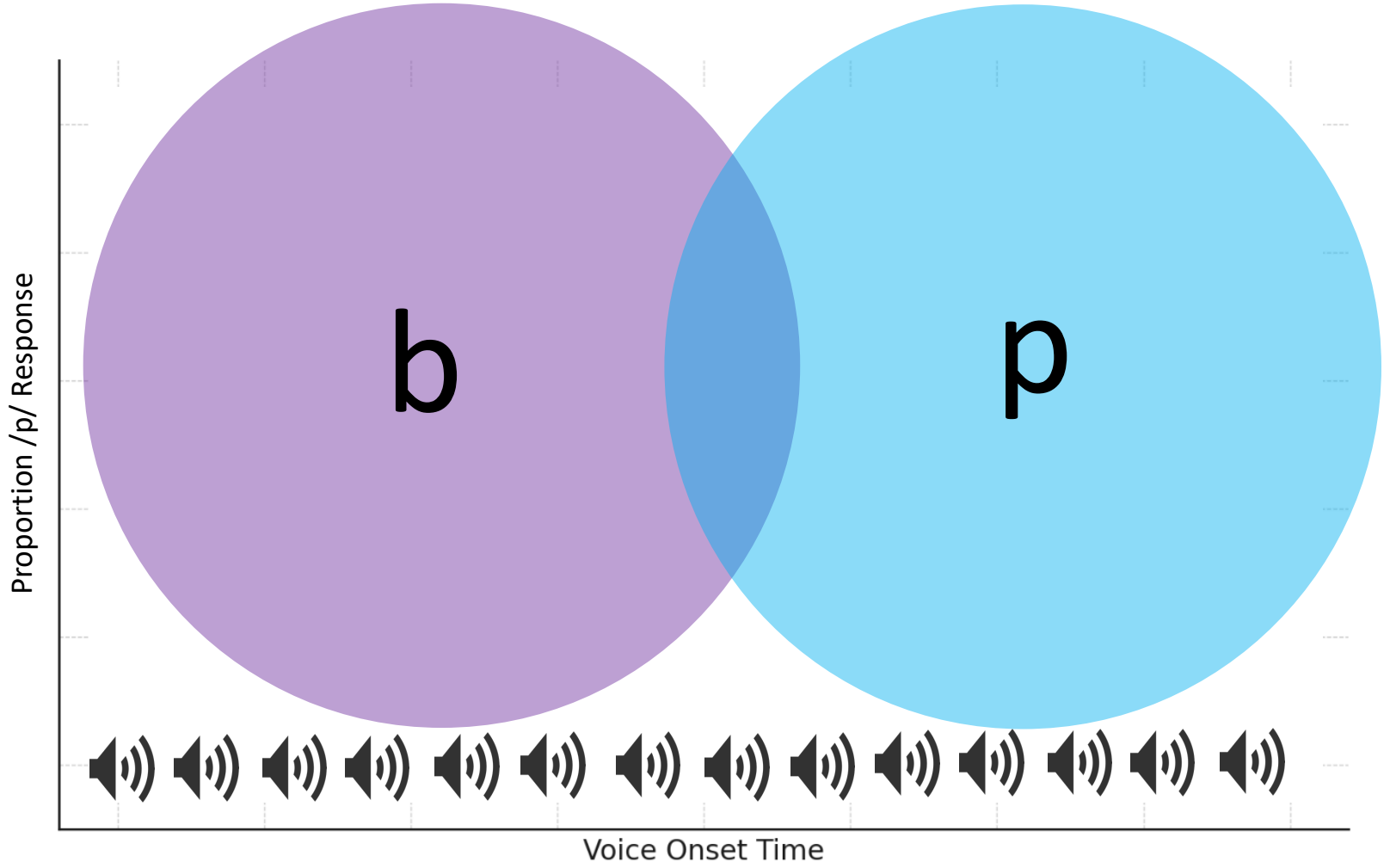

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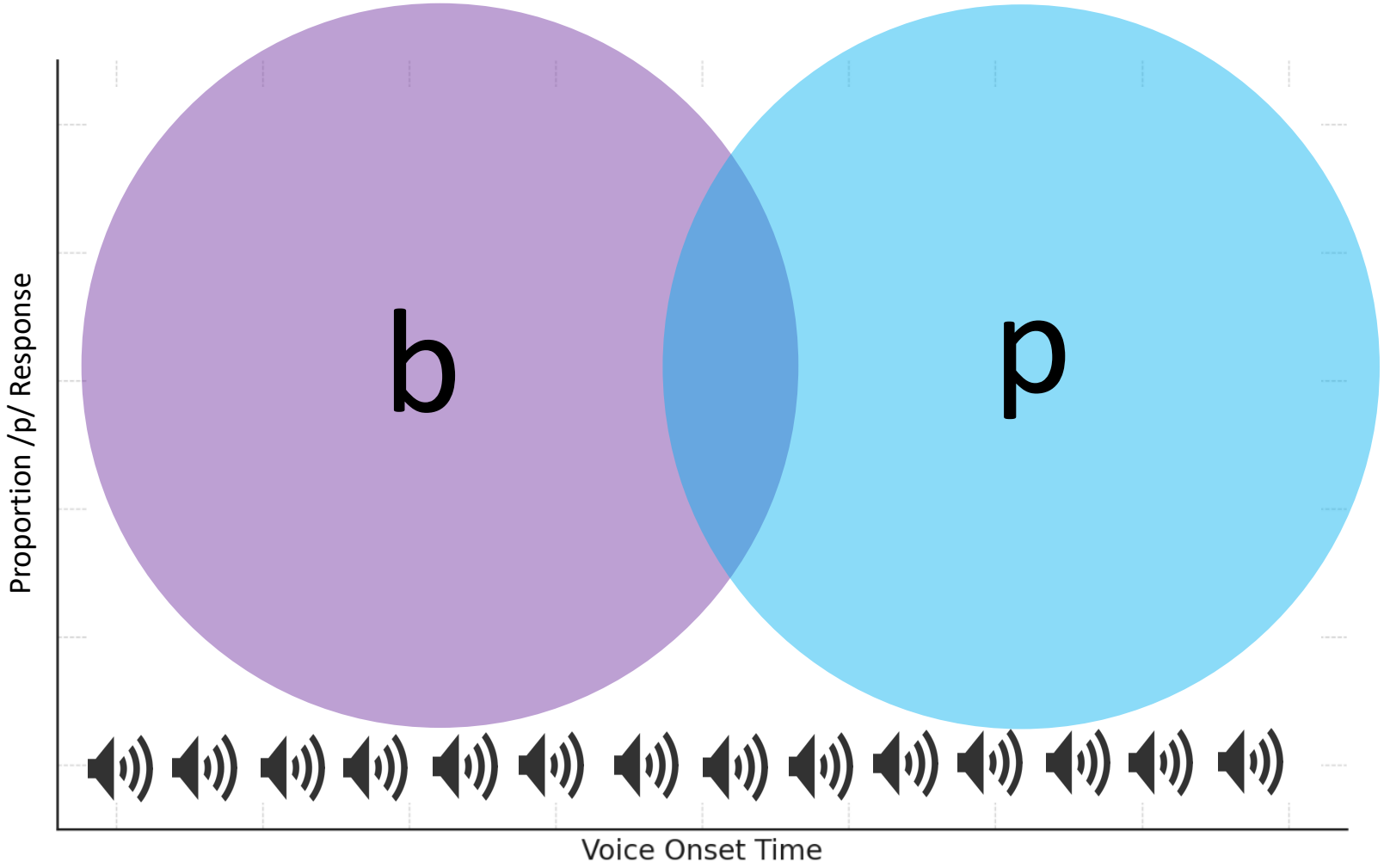

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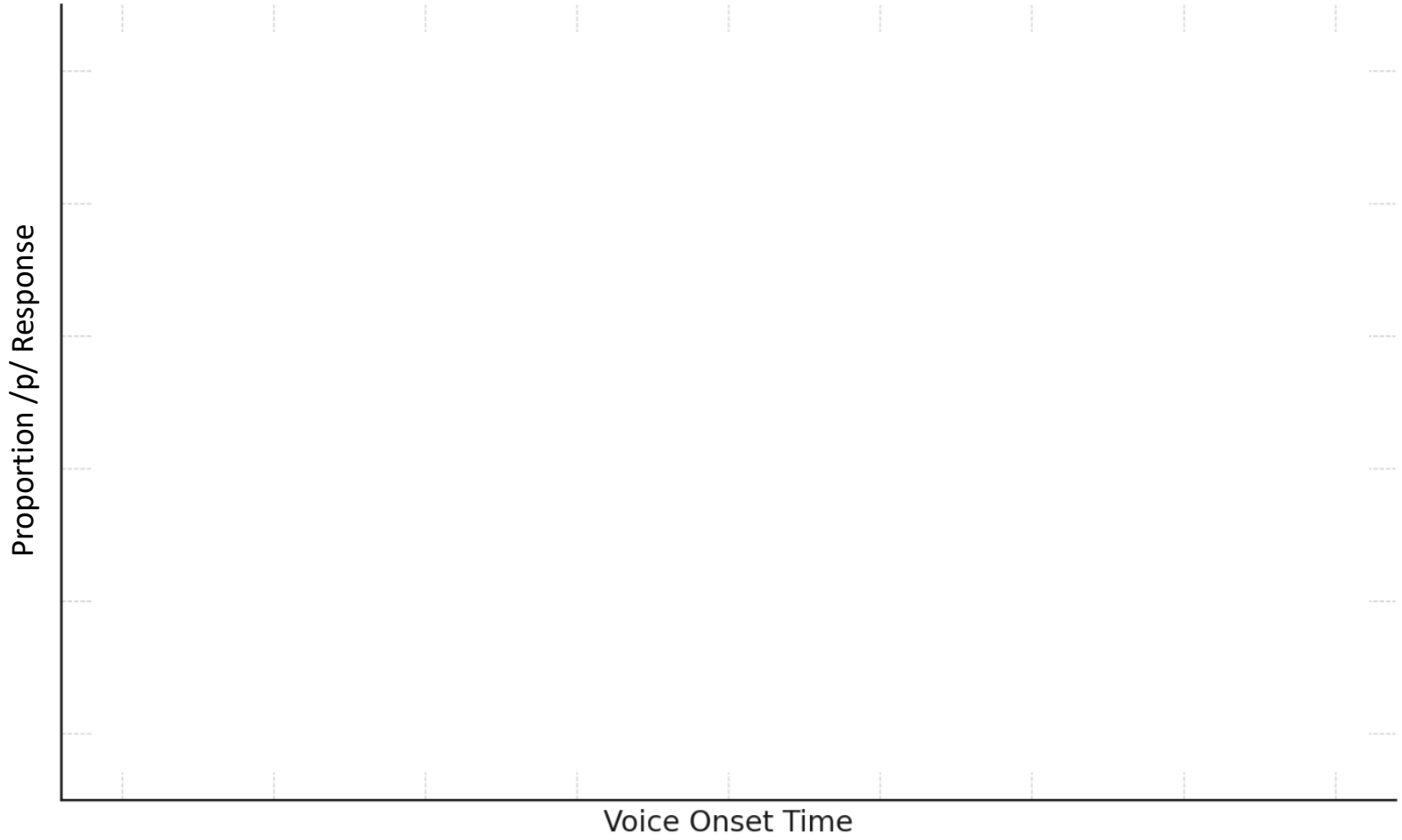

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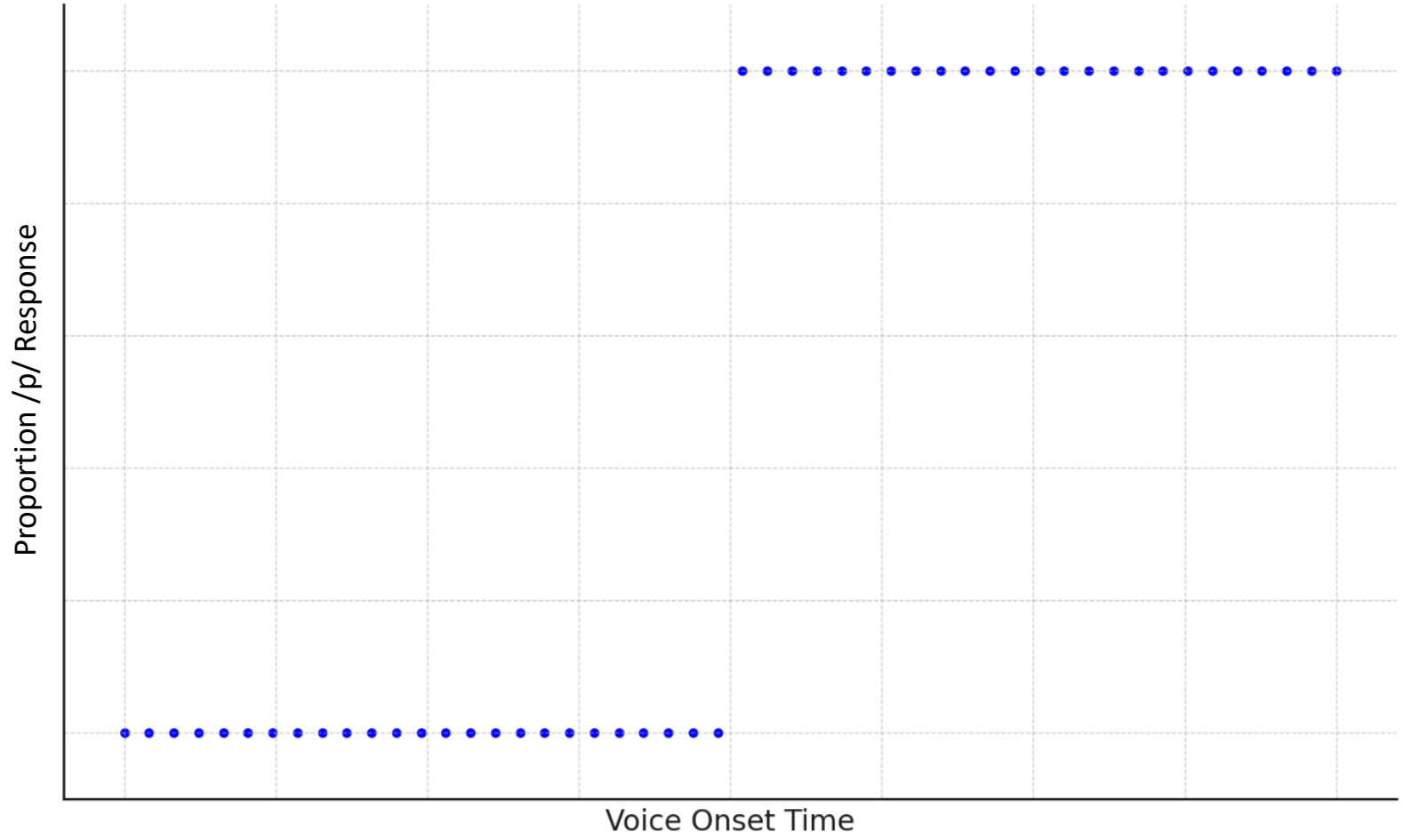

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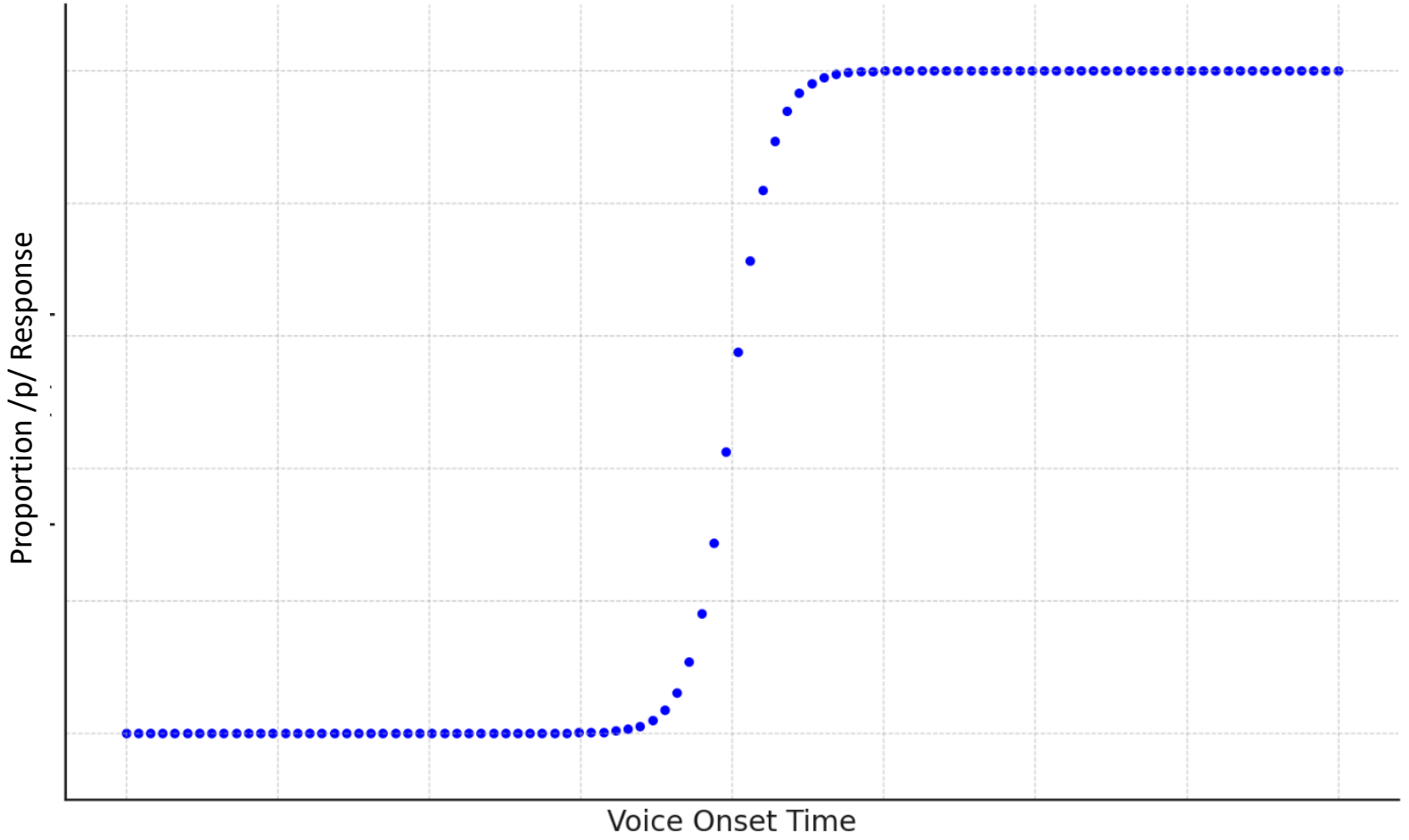

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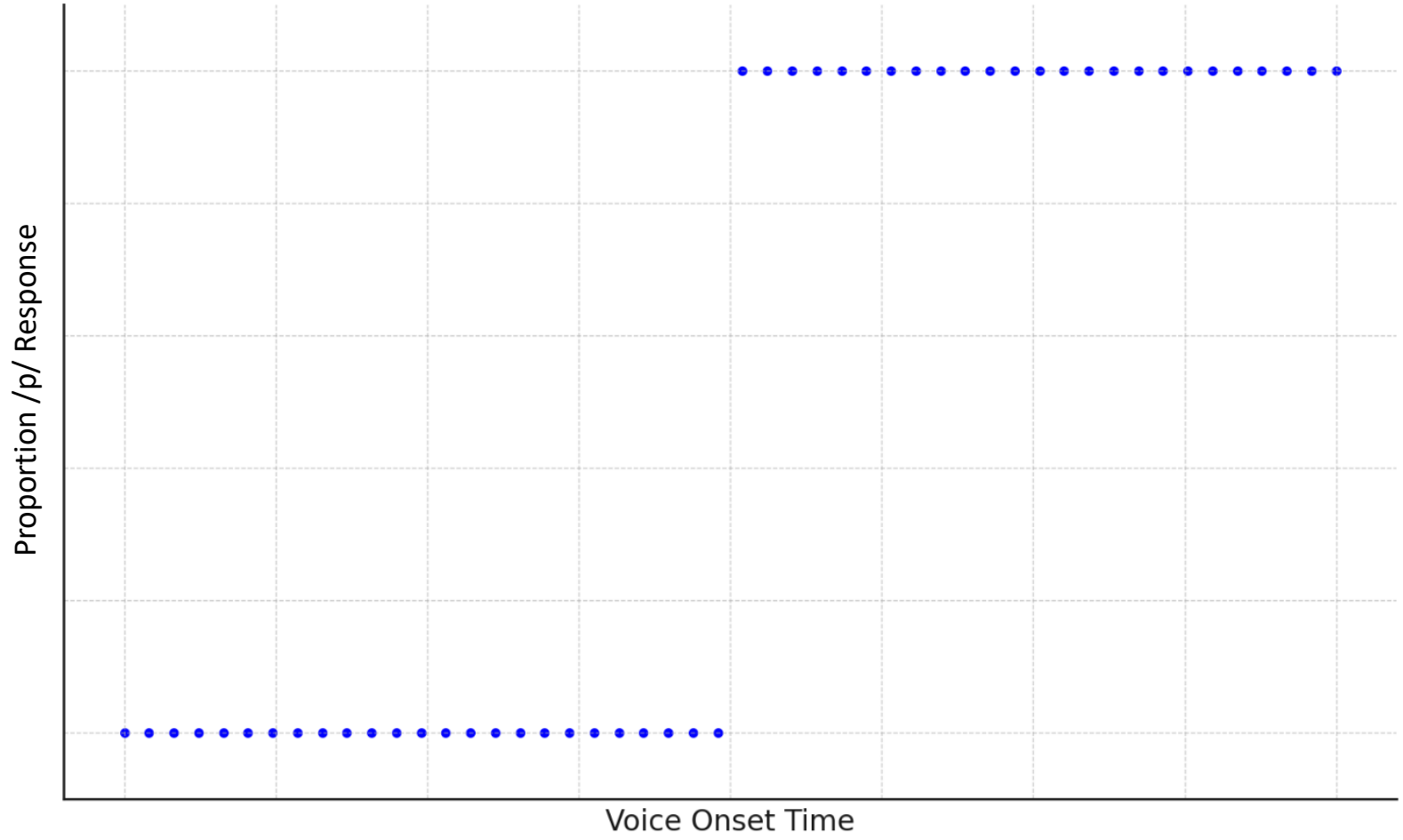

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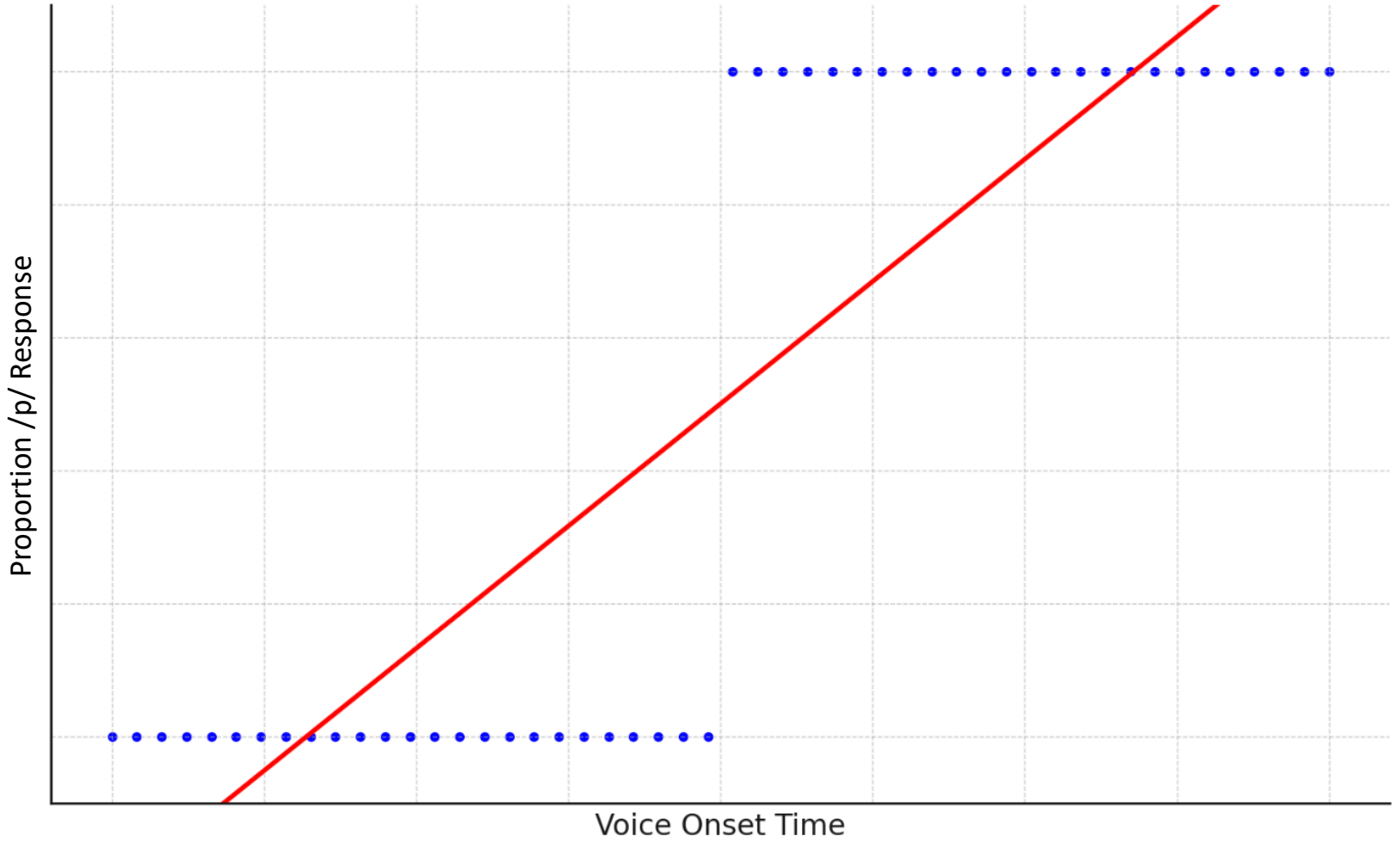

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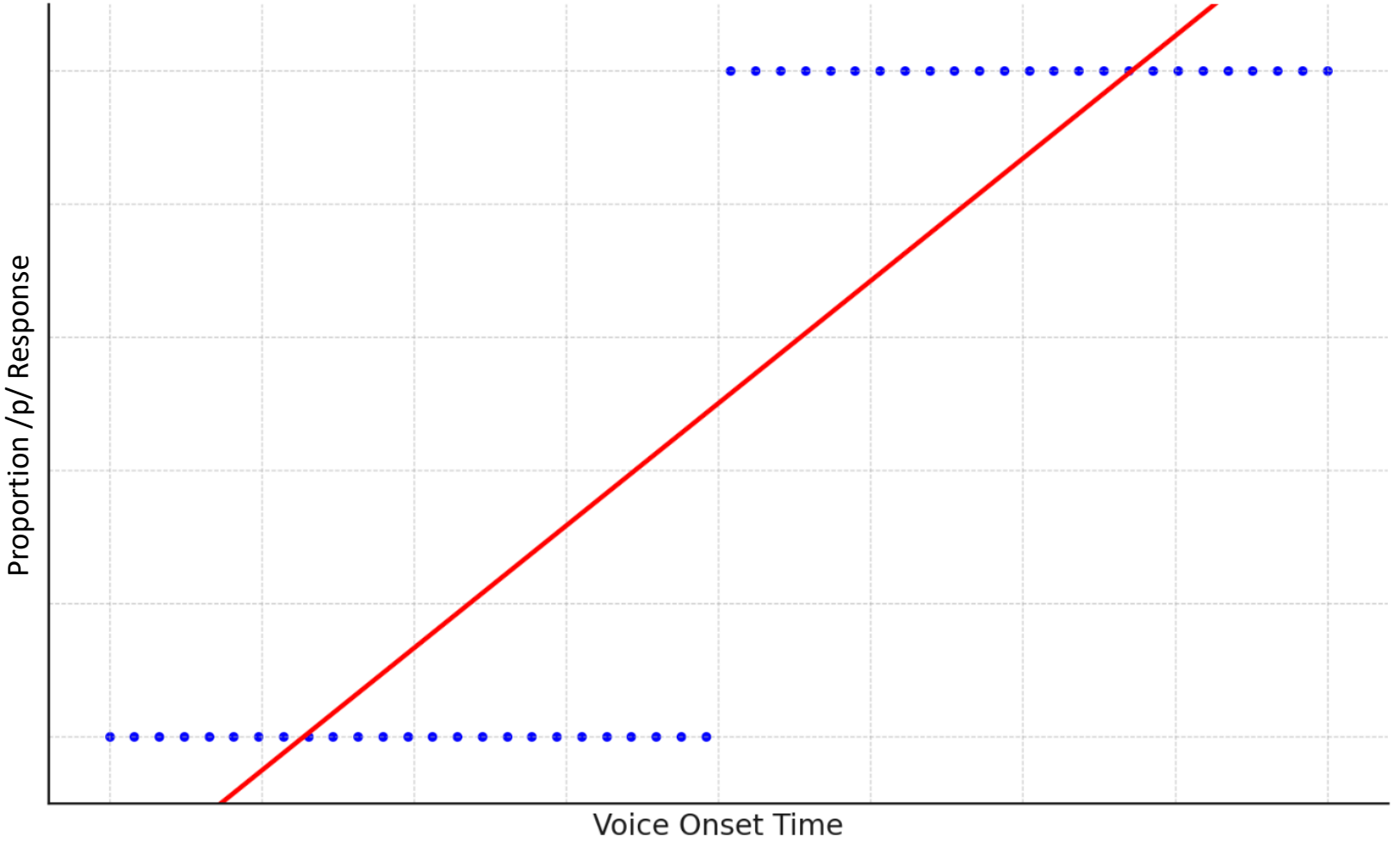

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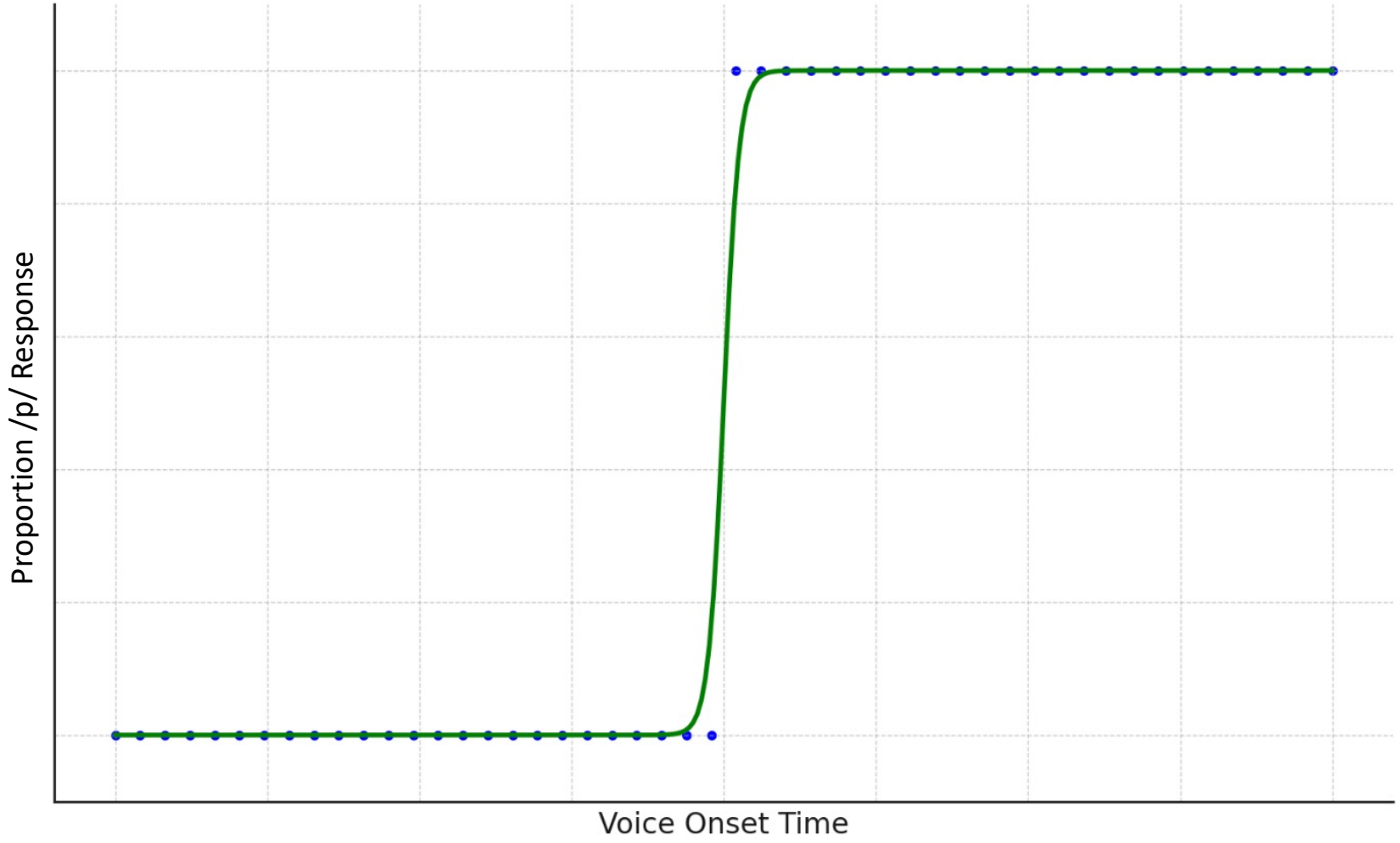

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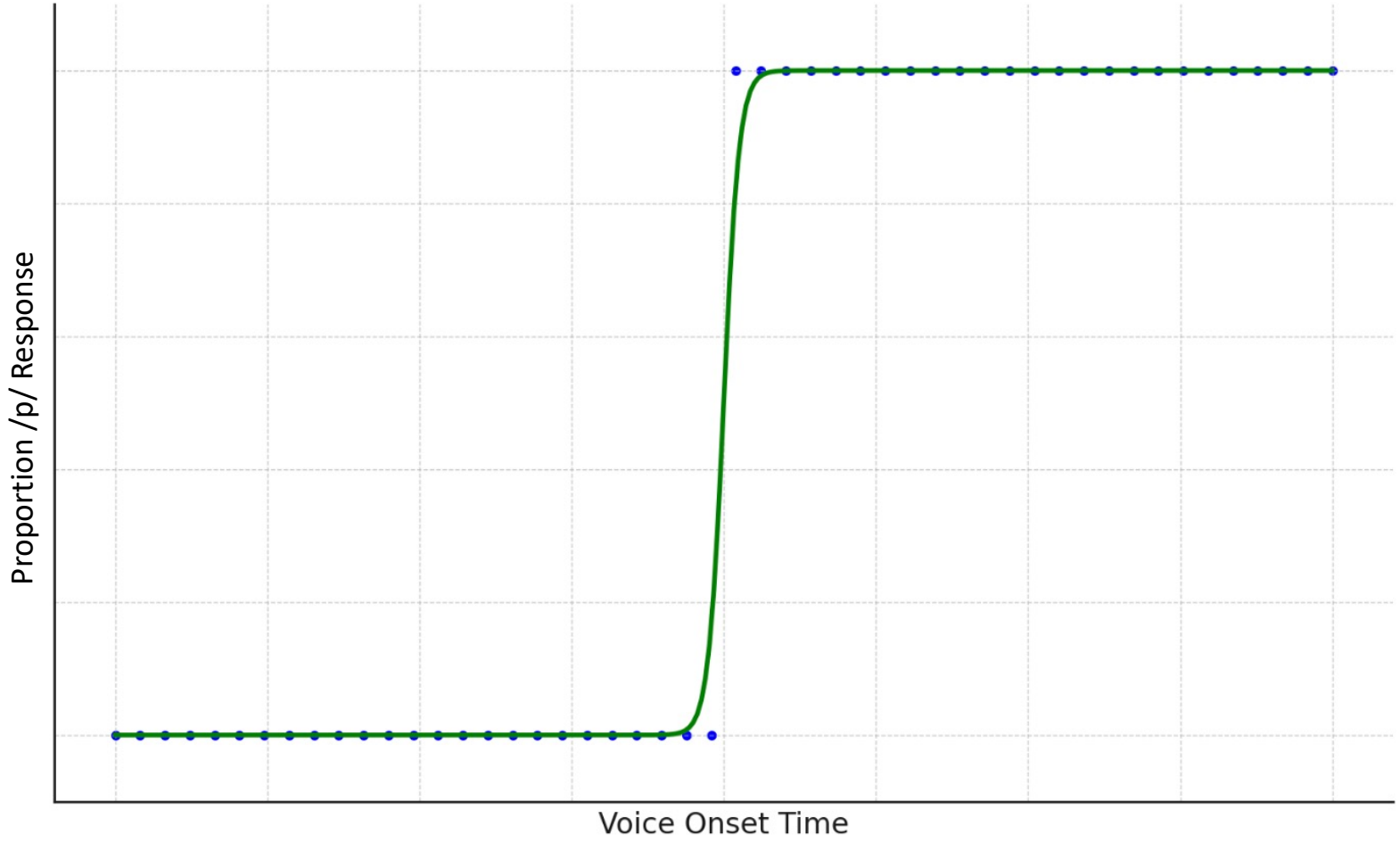
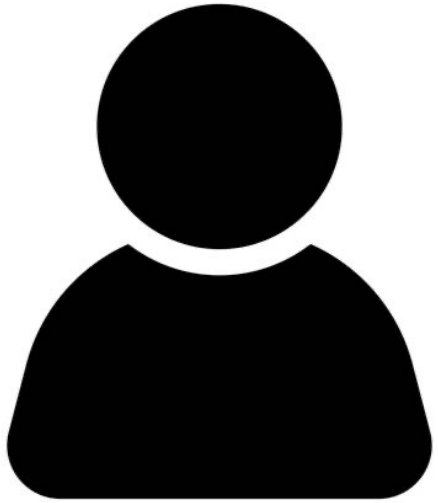


Another example



Another example

They cooked a casserole for him.

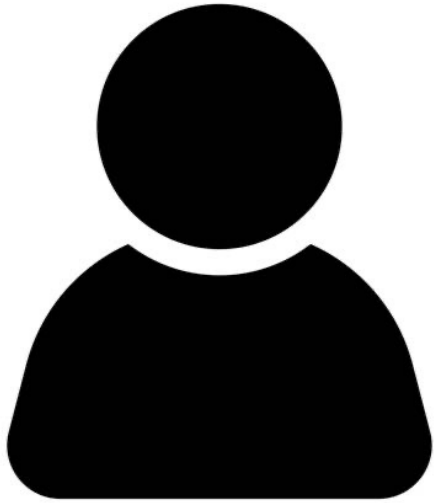
The parents grilled a chicken breast for Maria.

Maya baked home-made cookies for them.

Sarah made a burger for the kid.

The chef boiled a few carrots for her.

Amir sliced some vegetables for Luca.



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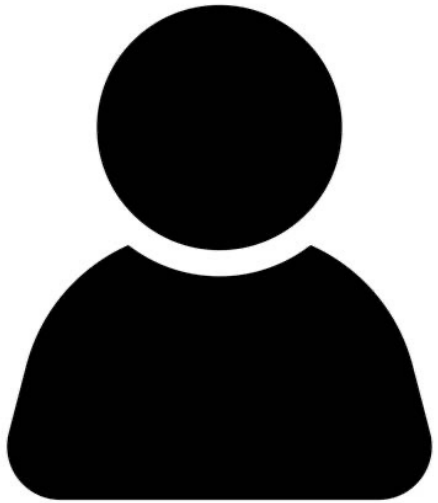

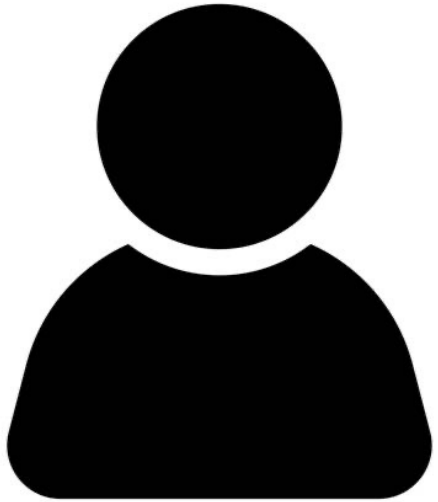

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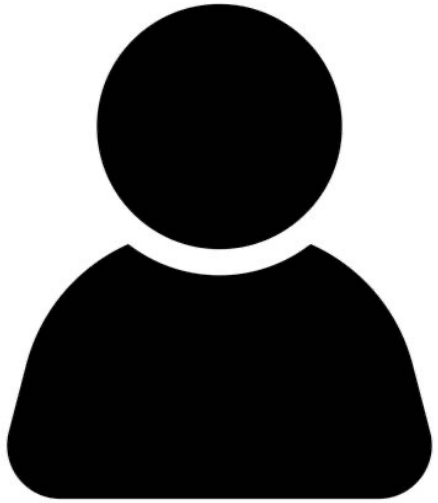
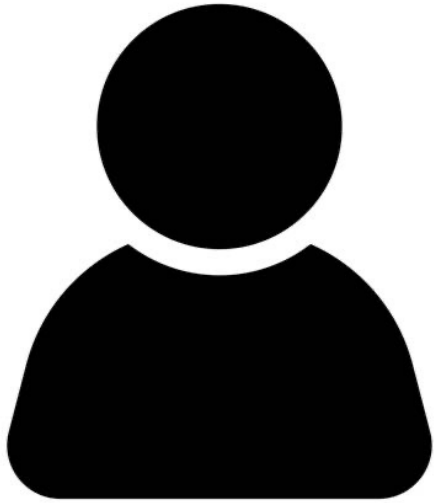


Did you read this exact sentence?

They made Maria home-made cookies.

- ◯ Yes
- ◯ No



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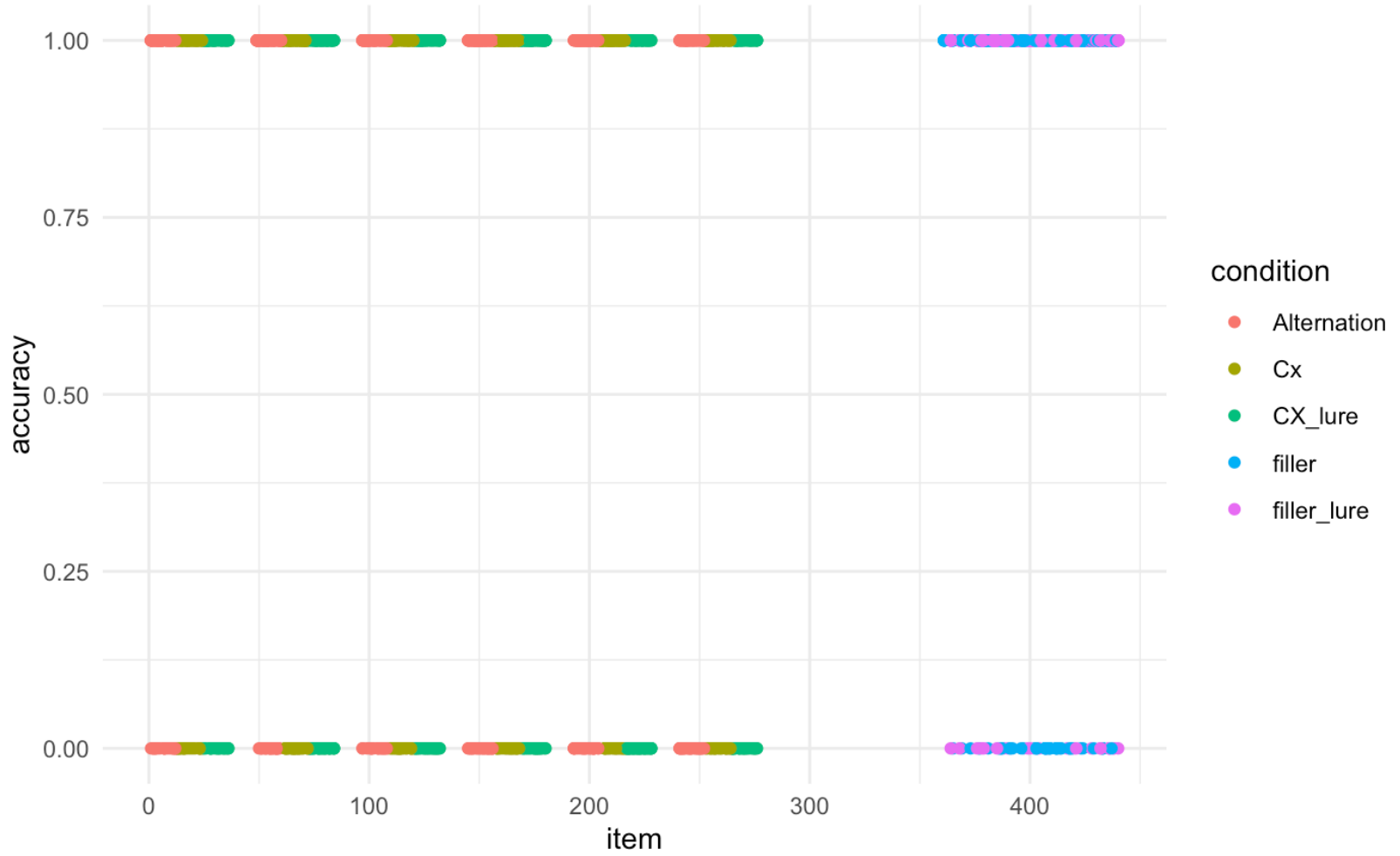

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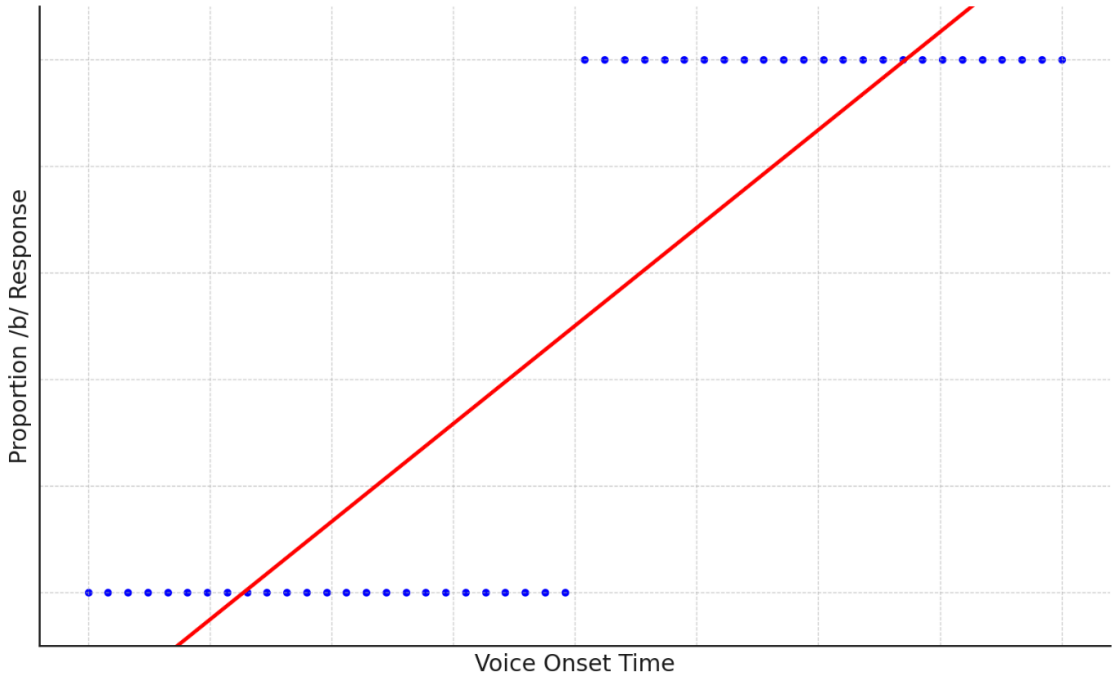

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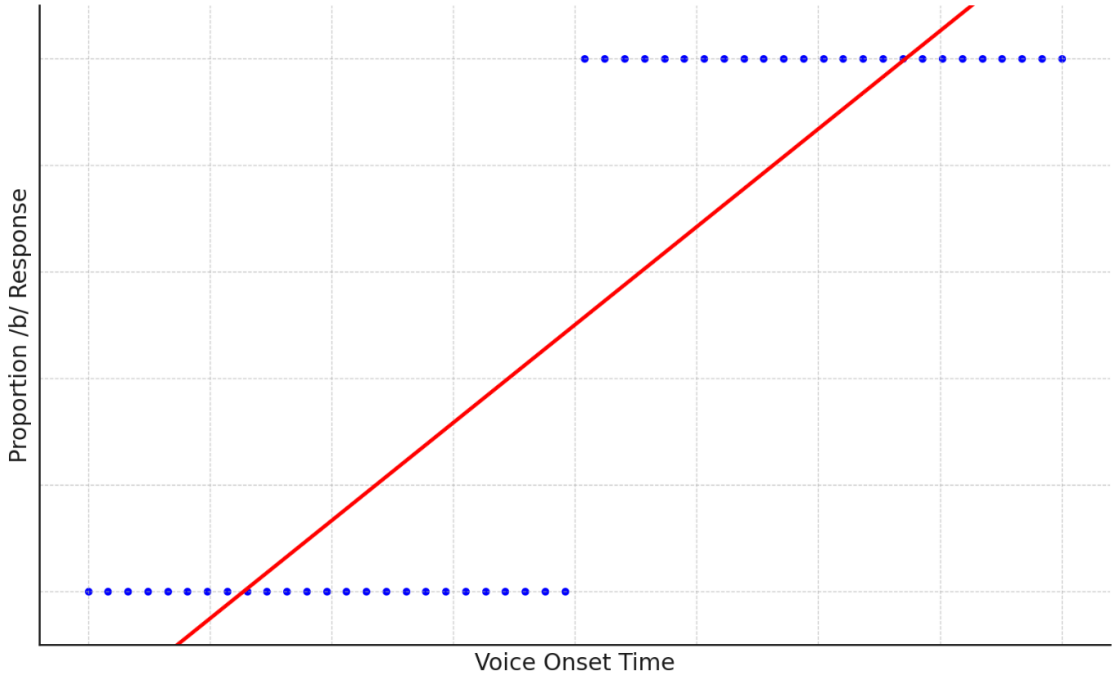

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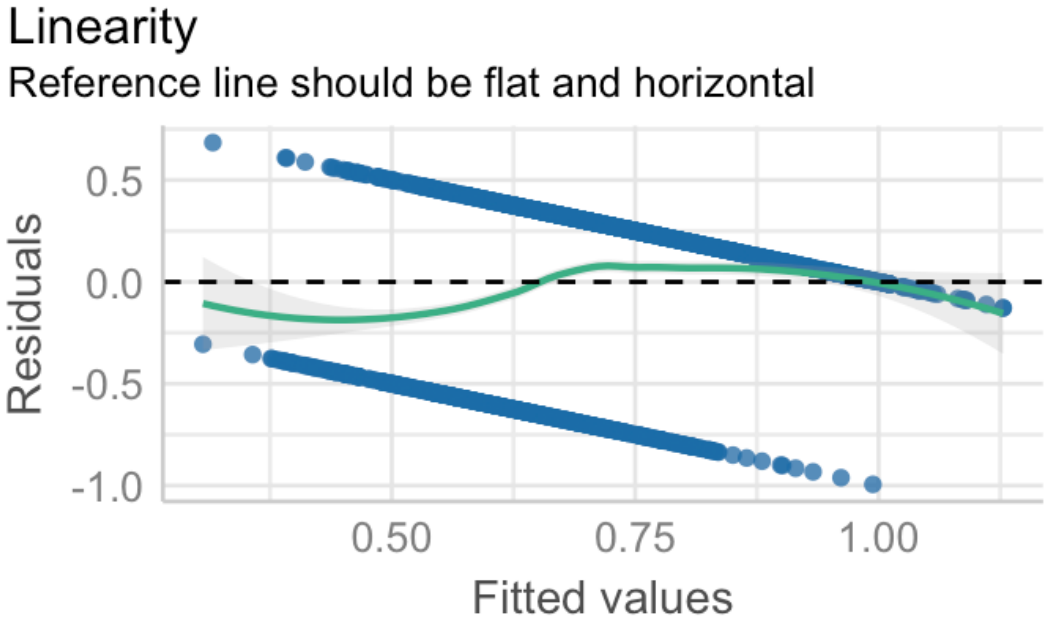

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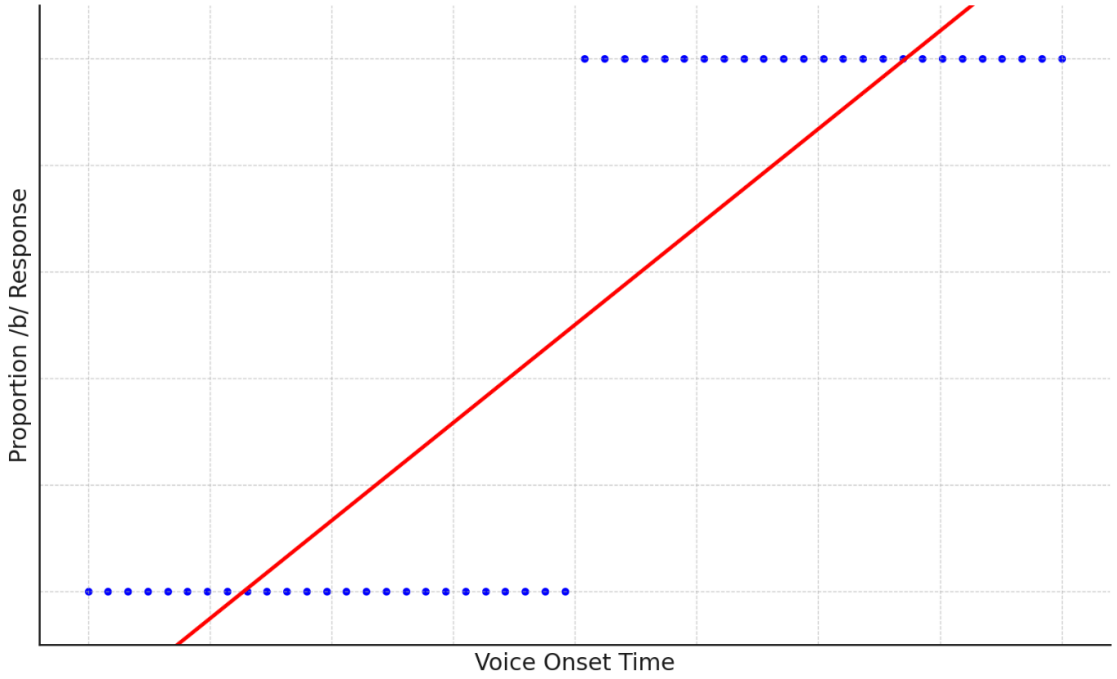

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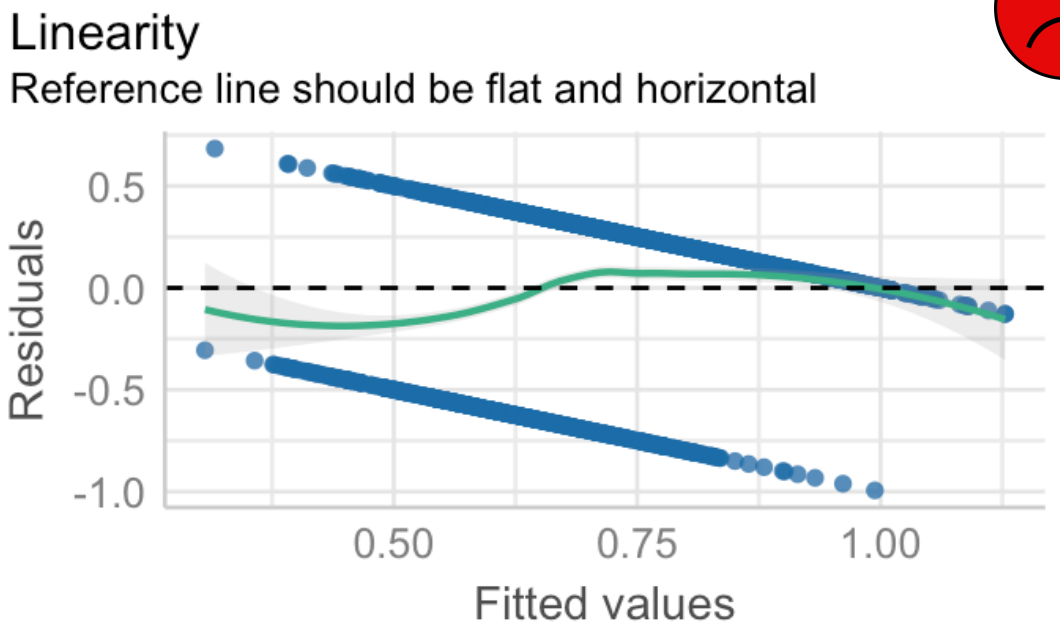

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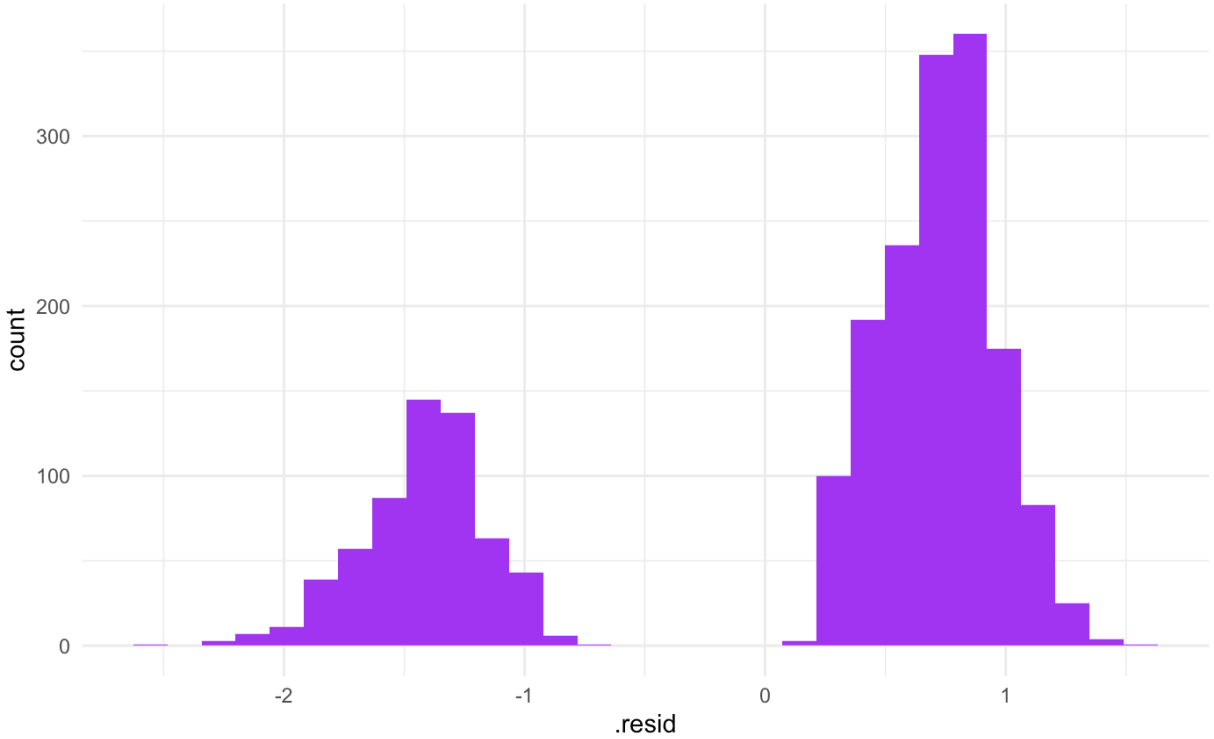

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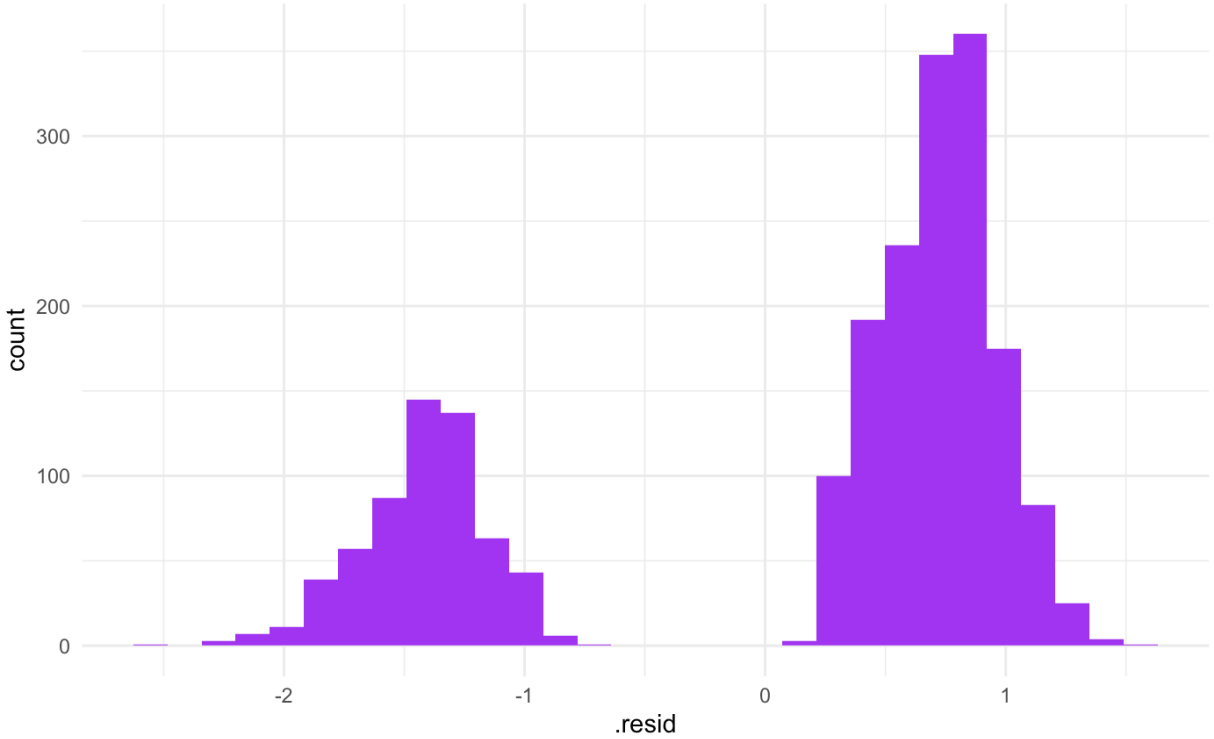

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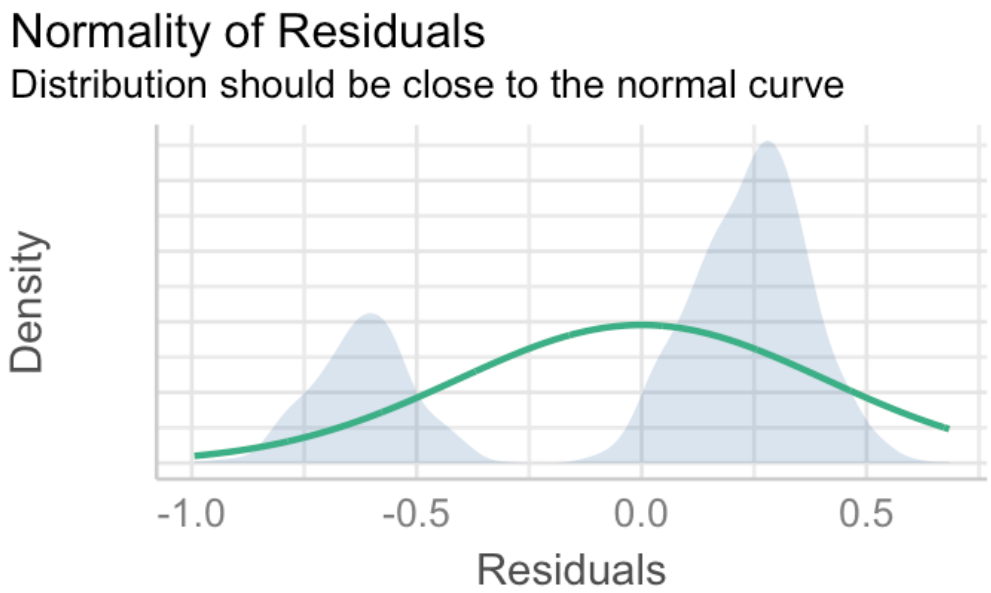

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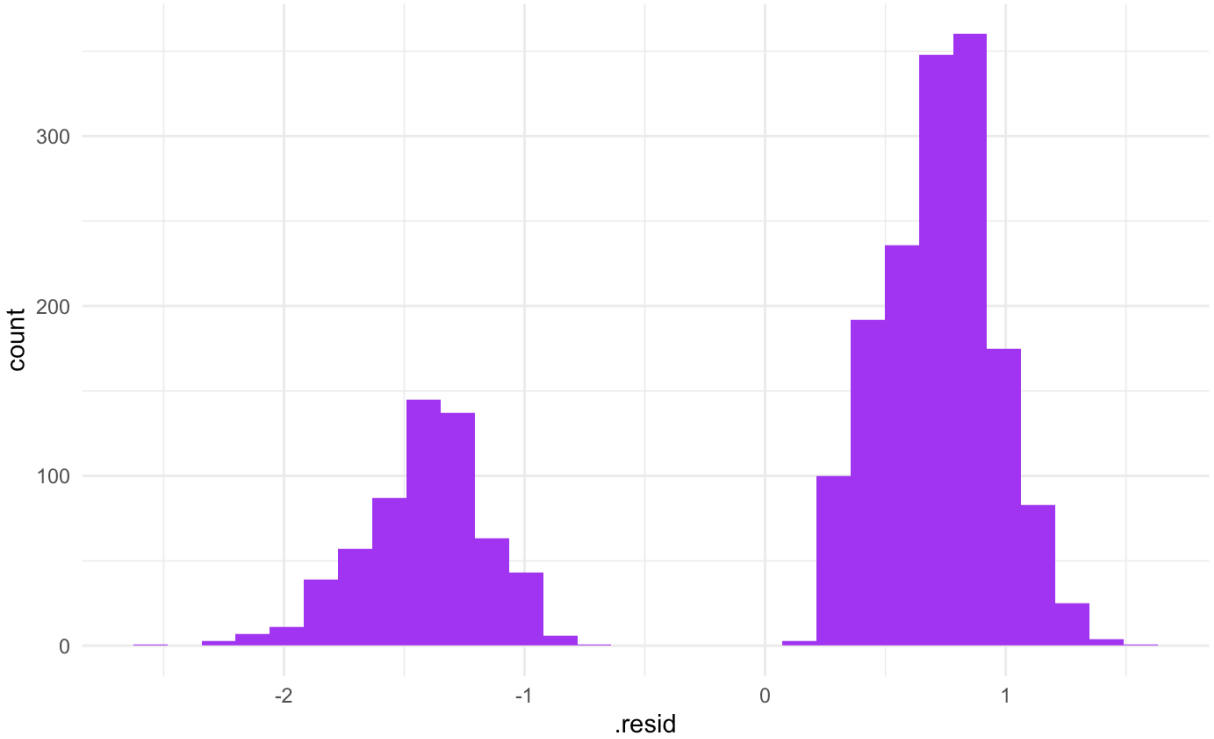

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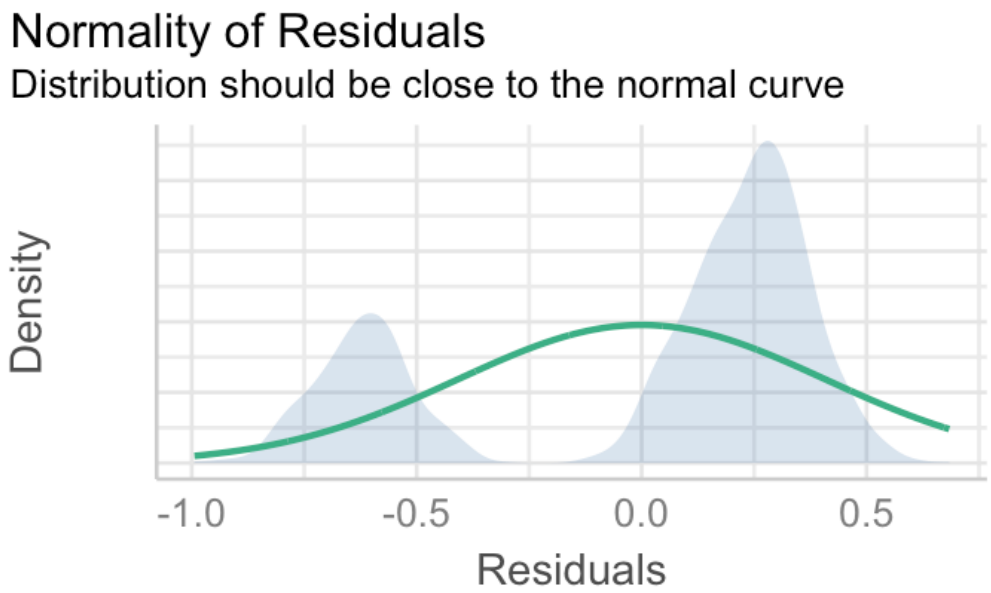

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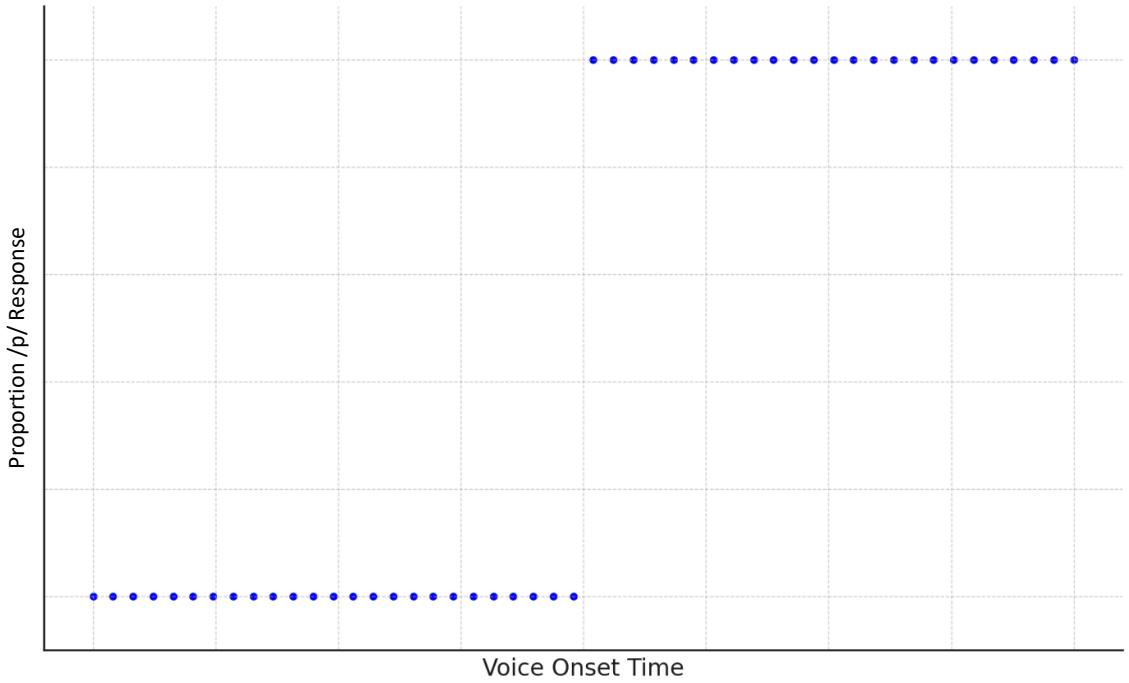

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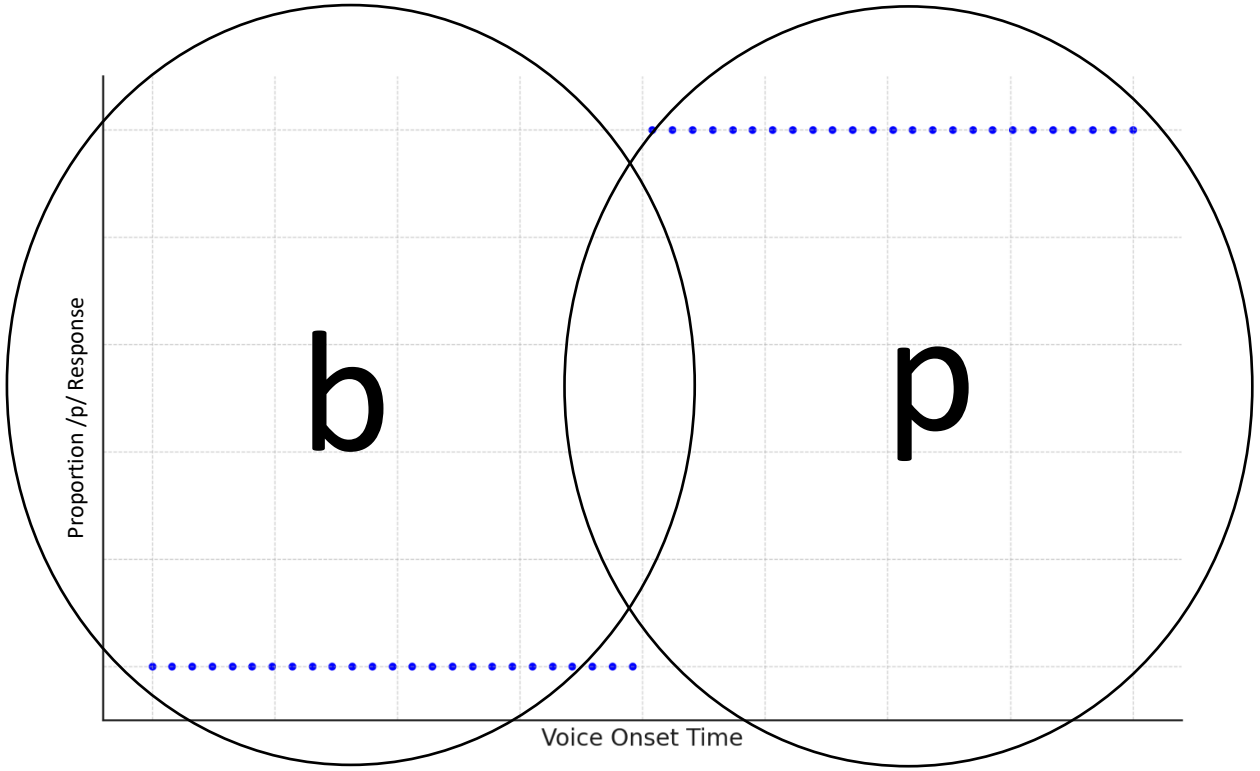

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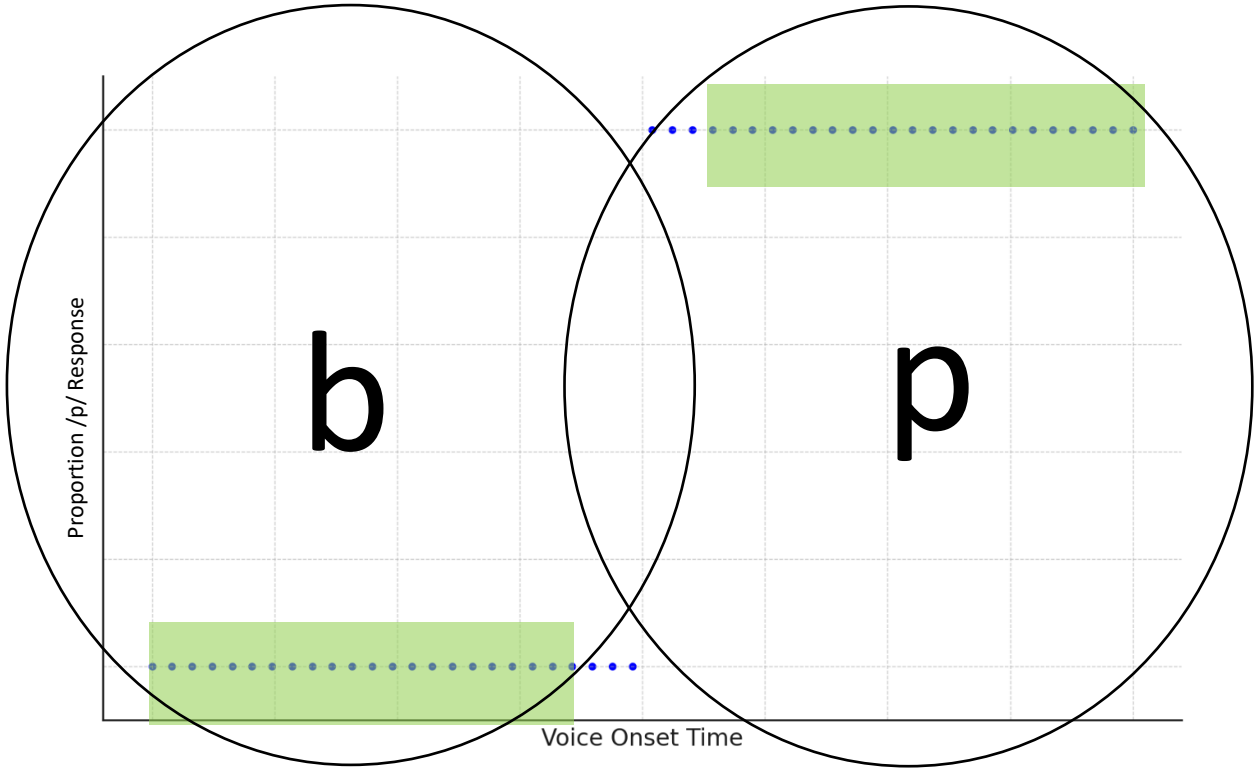

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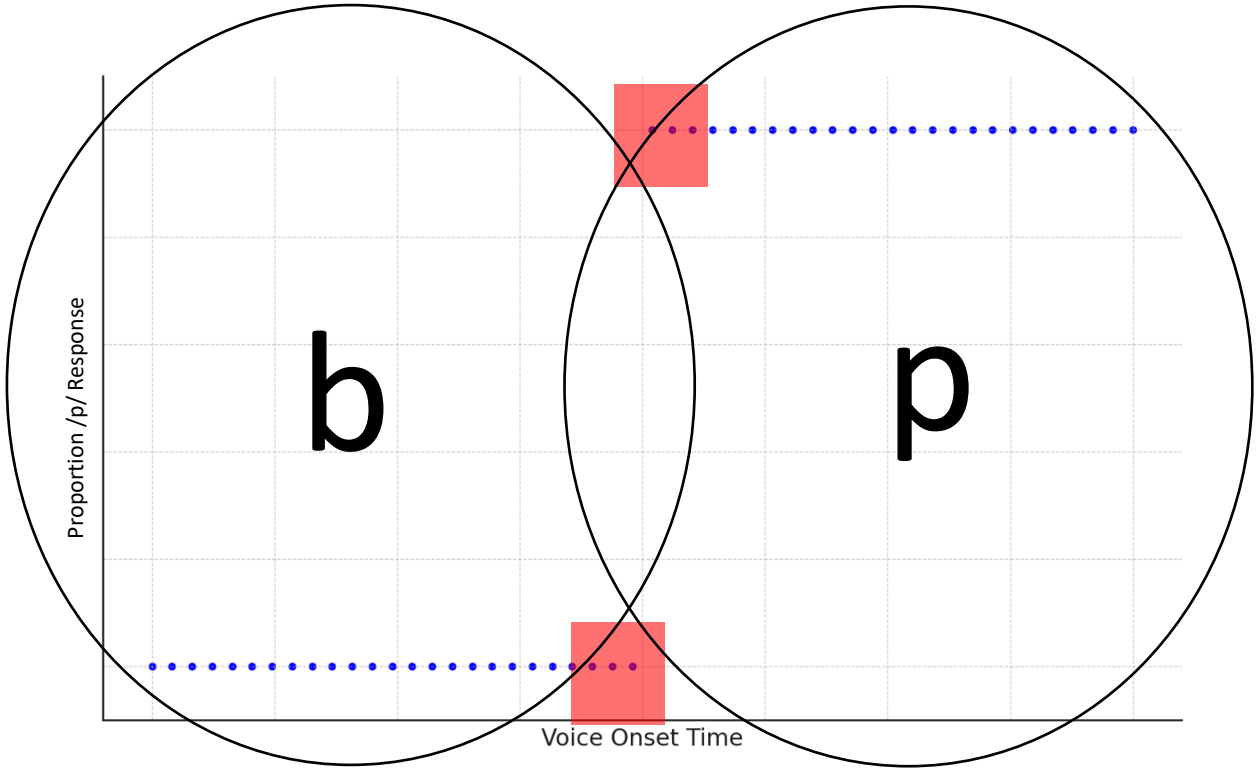

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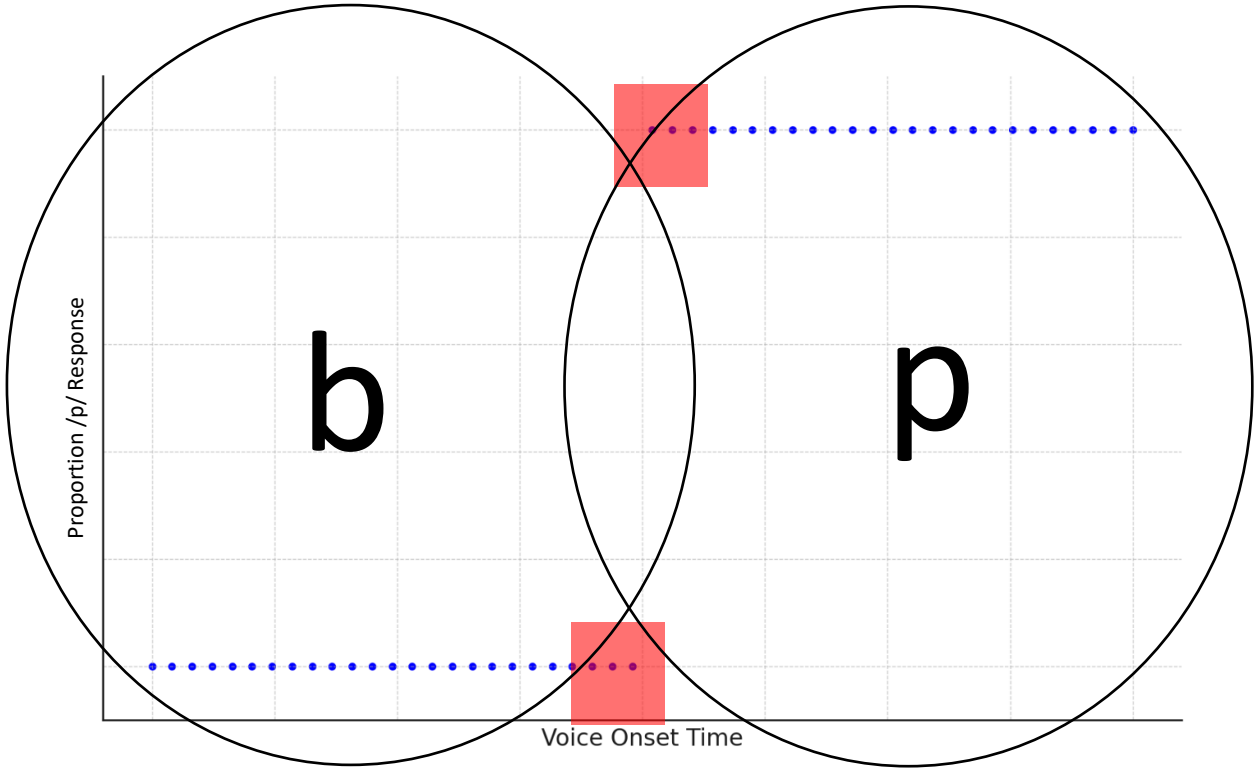

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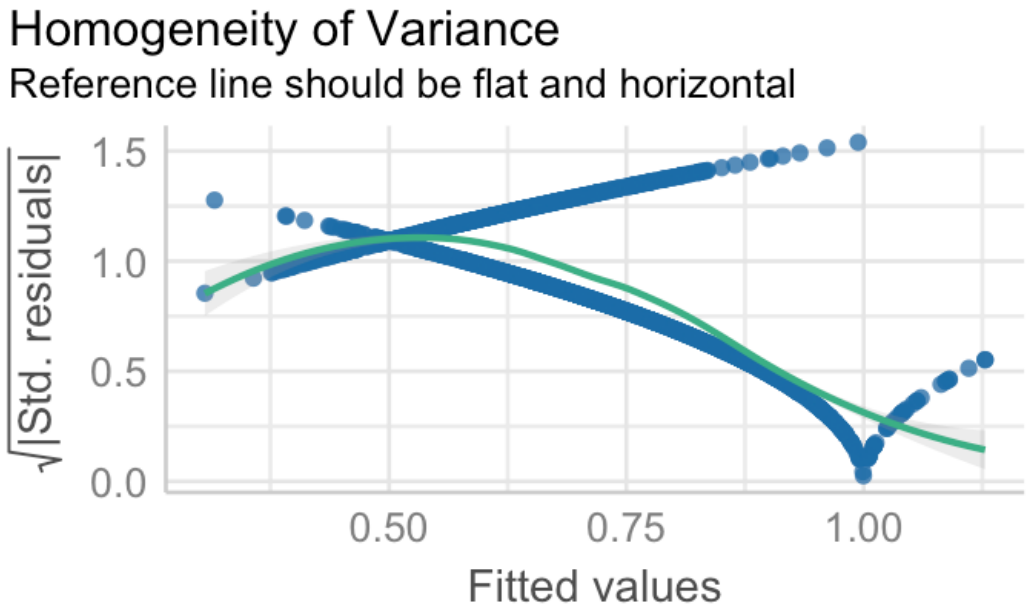

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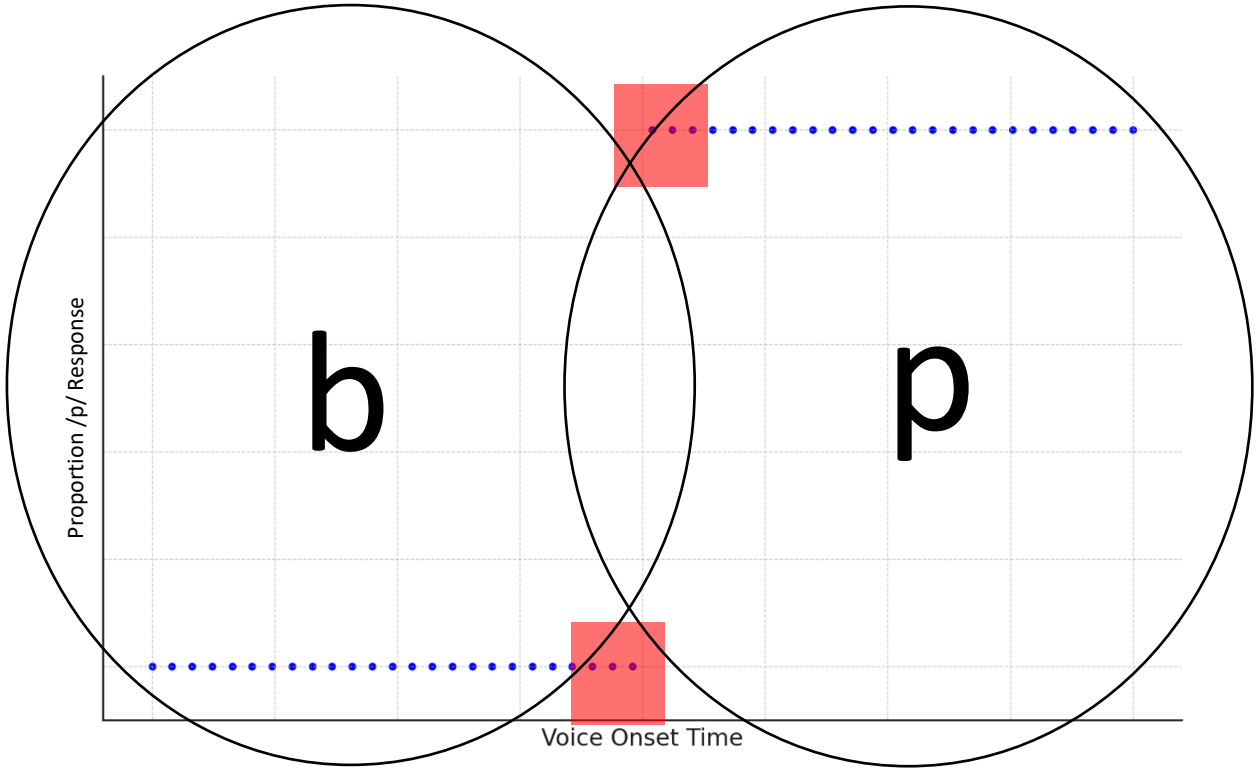

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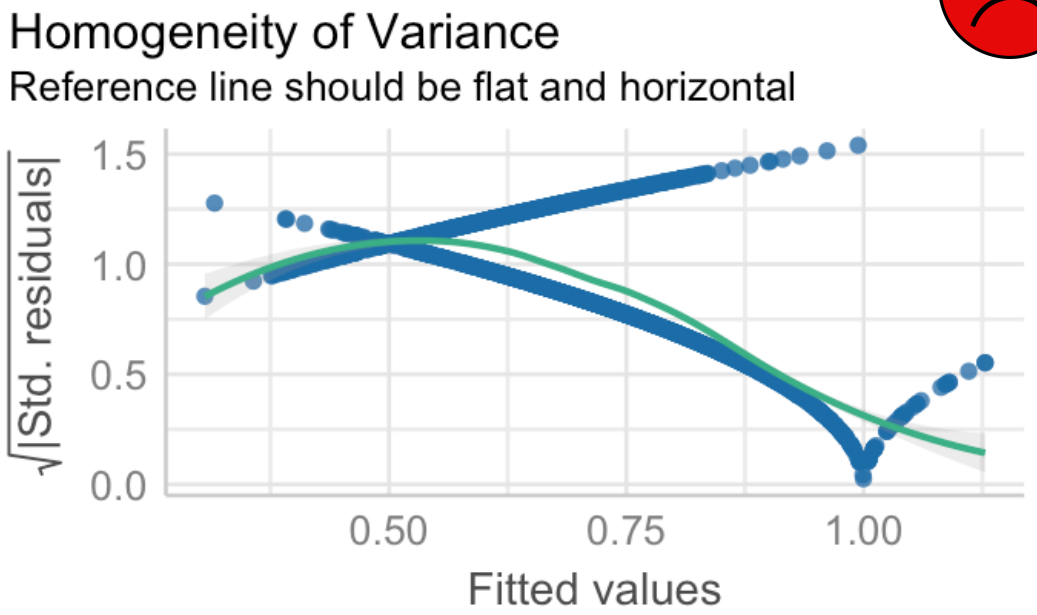

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Binary outcome!

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Anything with two choices

Ex: b vs. p

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$$Y = \beta_0 + \beta_1 X$$

Logistic regression

$$Y = \beta_0 + \beta_1 X$$

$$\text{logit}(p) = \beta_0 + \beta_1 X$$

Logistic regression

Linear regression: predicting Y value

$$Y = \beta_0 + \beta_1 X$$

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Logistic regression

Linear regression: predicting Y value

$$Y = \beta_0 + \beta_1 X$$

$$\text{logit}(p) = \beta_0 + \beta_1 X$$

Logistic regression: predicting log odds

Logistic regression

$$\text{logit}(p) = \beta_0 + \beta_1 \text{X}$$

p = the probability of a “success” or the dependent variable being 1

Logistic regression

$$\text{logit}(p) = \beta_0 + \beta_1 \text{X}$$

p = the probability of a “success” or the dependent variable being 1

logit*(p)* = logistic transformation of the probability of “success”

Logistic regression

$$\text{logit}(p) = \beta_0 + \beta_1 X$$

p = the probability of a "success" or the dependent variable being 1

logit(p) = logistic transformation of the probability of "success"

β_0 = intercept

Logistic regression

$$\text{logit}(p) = \beta_0 + \beta_1 \text{X}$$

p = the probability of a “success” or the dependent variable being 1

logit(p) = logistic transformation of the probability of “success”

β_0 = intercept

β_1 = logistic regression coefficient

Logistic regression

$$\text{logit}(p) = \beta_0 + \beta_1 X$$

p = the probability of a "success" or the dependent variable being 1

logit(p) = logistic transformation of the probability of "success"

β_0 = intercept

β_1 = logistic regression coefficient

X = predictor variable

Log odd, odds, probability?

$$\frac{p}{1-p}$$

Log odd, odds, probability?

probability of an event (p)

$$\frac{p}{1-p}$$

Log odd, odds, probability?

probability of an event (p)

$$\frac{p}{1-p}$$

probability of no event (1- p)

Log odd, odds, probability?

probability of an event (p)

Odd: ratio between probability of an event and probability of no event

$$\frac{p}{1-p}$$

probability of no event (1- p)

In our example

They cooked a casserole for him.

The parents grilled a chicken breast for Maria.

Maya baked home-made cookies for them.

Sarah made a burger for the kid.

The chef boiled a few carrots for her.

Amir sliced some vegetables for Luca.

Did you read this exact sentence?

They made Maria home-made cookies.

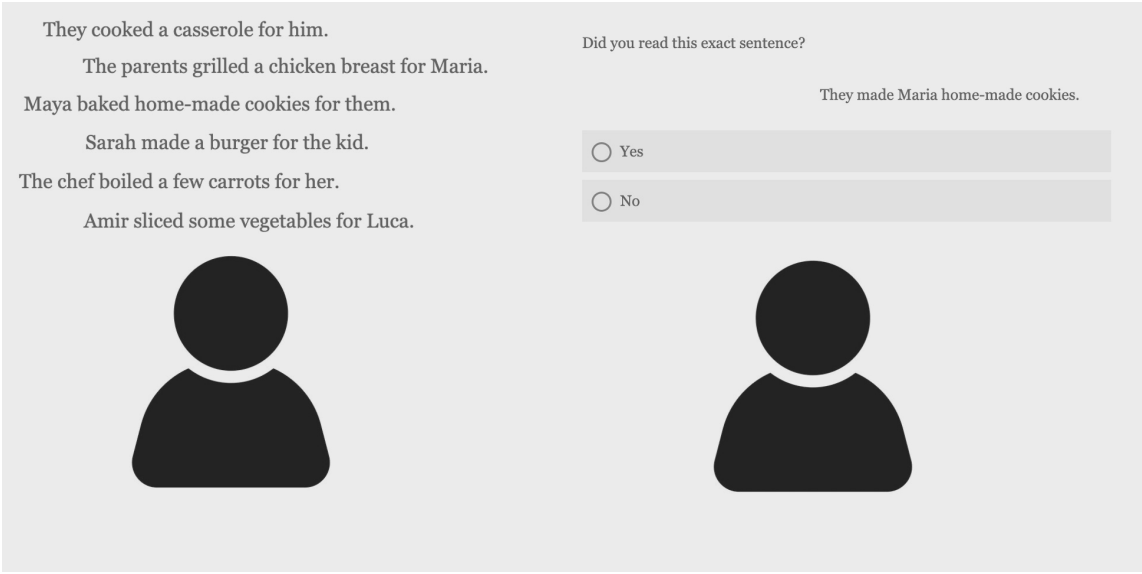
- ◯ Yes
- ◯ No

$$\frac{p}{1-p}$$

In our example

probability of getting it right (hits or correct rejects)

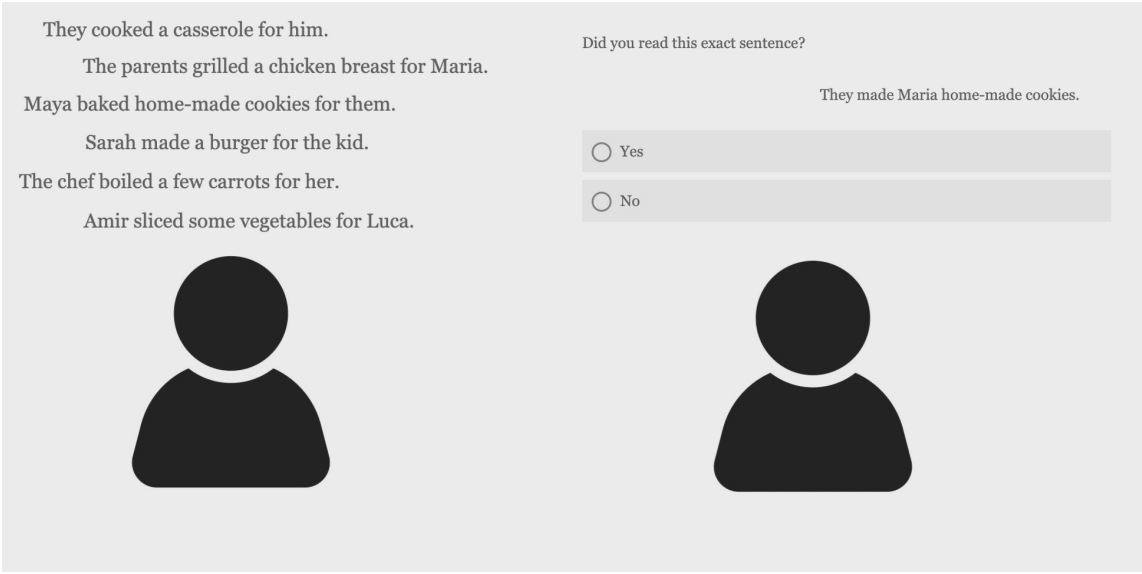
$$\frac{p}{1-p}$$



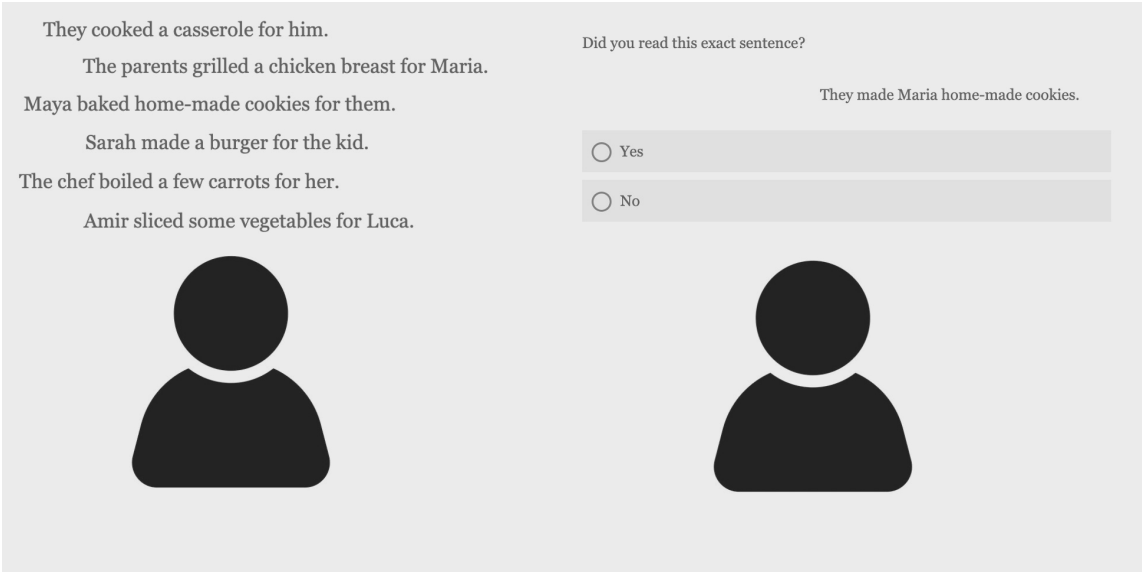
In our example

probability of getting it right (hits or correct rejects)

$$\frac{.4}{1-p}$$



In our example

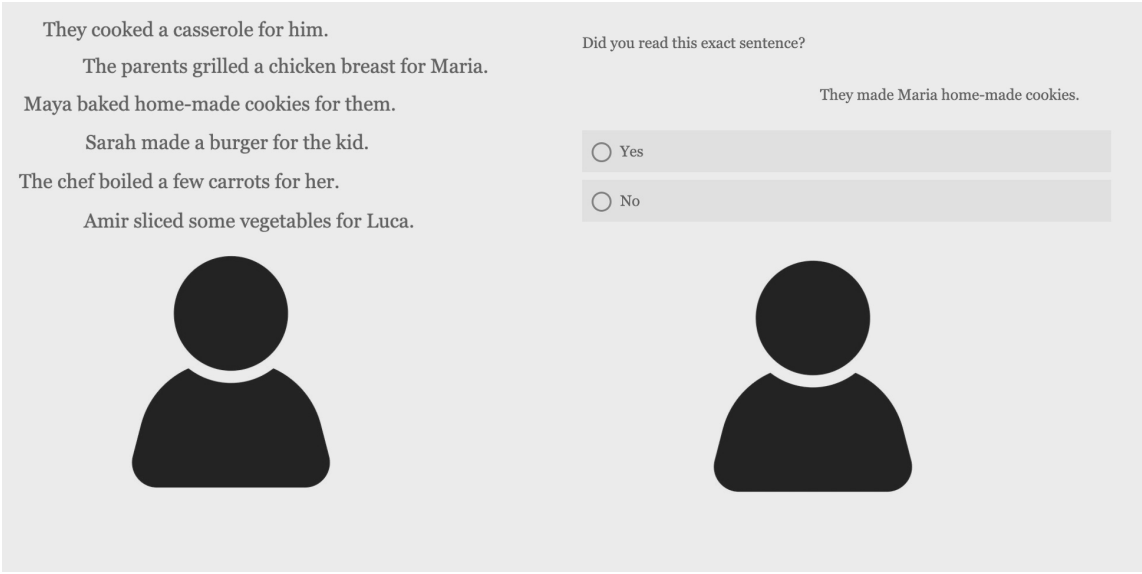


probability of getting it right (hits or correct rejects)

$$\frac{p}{1 - .4}$$

probability of getting it wrong (misses or false alarms)

In our example



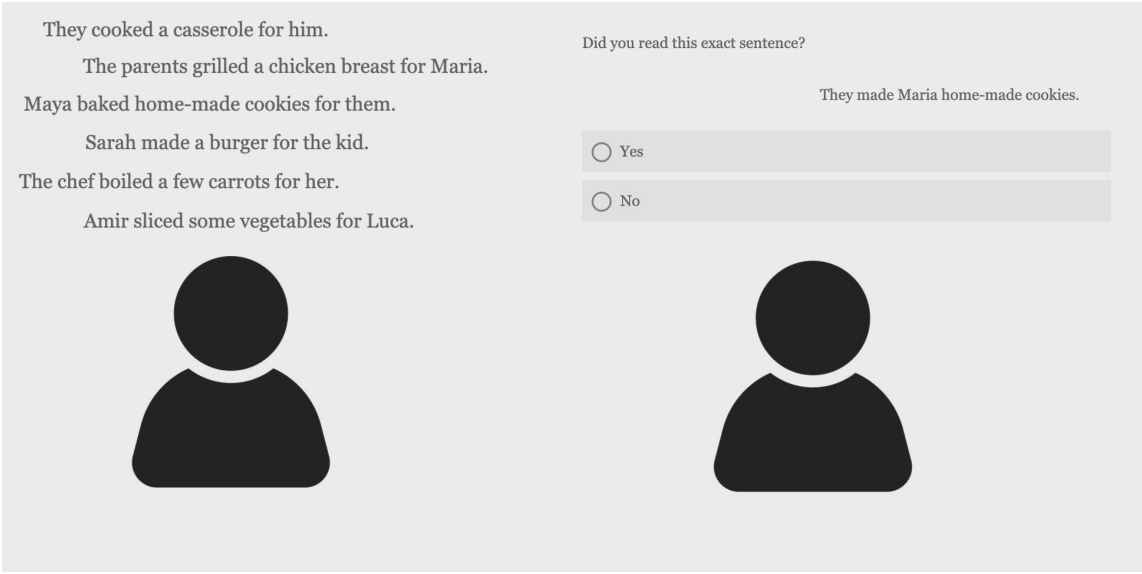
probability of getting it right (hits or correct rejects)

probability of getting it wrong (misses or false alarms)

$$\frac{p}{1-p}$$

Odd: ratio between correct and incorrect probabilities

In our example



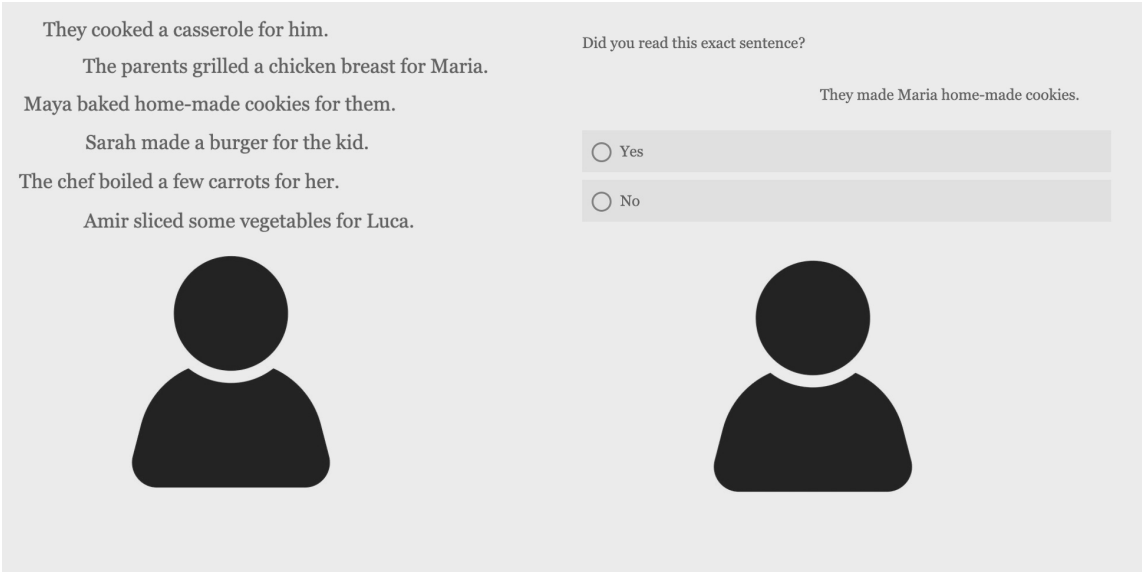
probability of getting it right (hits or correct rejects)

probability of getting it wrong (misses or false alarms)

$$\frac{.4}{1 - .4}$$

Odd: ratio between correct and incorrect probabilities

In our example



probability of getting it right (hits or correct rejects)

.67

probability of getting it wrong (misses or false alarms)

Odd: ratio between correct and incorrect probabilities

Logistic regression

$$\text{logit}(p) = \beta_0 + \beta_1 \text{X}$$

Logistic regression

$$\text{logit}(p) = \beta_0 + \beta_1 \text{X}$$

logit of probability

Logistic regression

$$ln(\frac{p}{1-p}) = \beta_0 + \beta_1 X$$

Logistic regression

$$ln(\frac{p}{1-p}) = \beta_0 + \beta_1 X$$

natural log of odds

Log odd, odds, probability?

$$ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X$$

logit/log odd

Log odd, odds, probability?

$$ln(\frac{p}{1-p}) = \beta_0 + \beta_1 X$$

Log odd, odds, probability?

$$ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X$$

odds

Log odd, odds, probability?

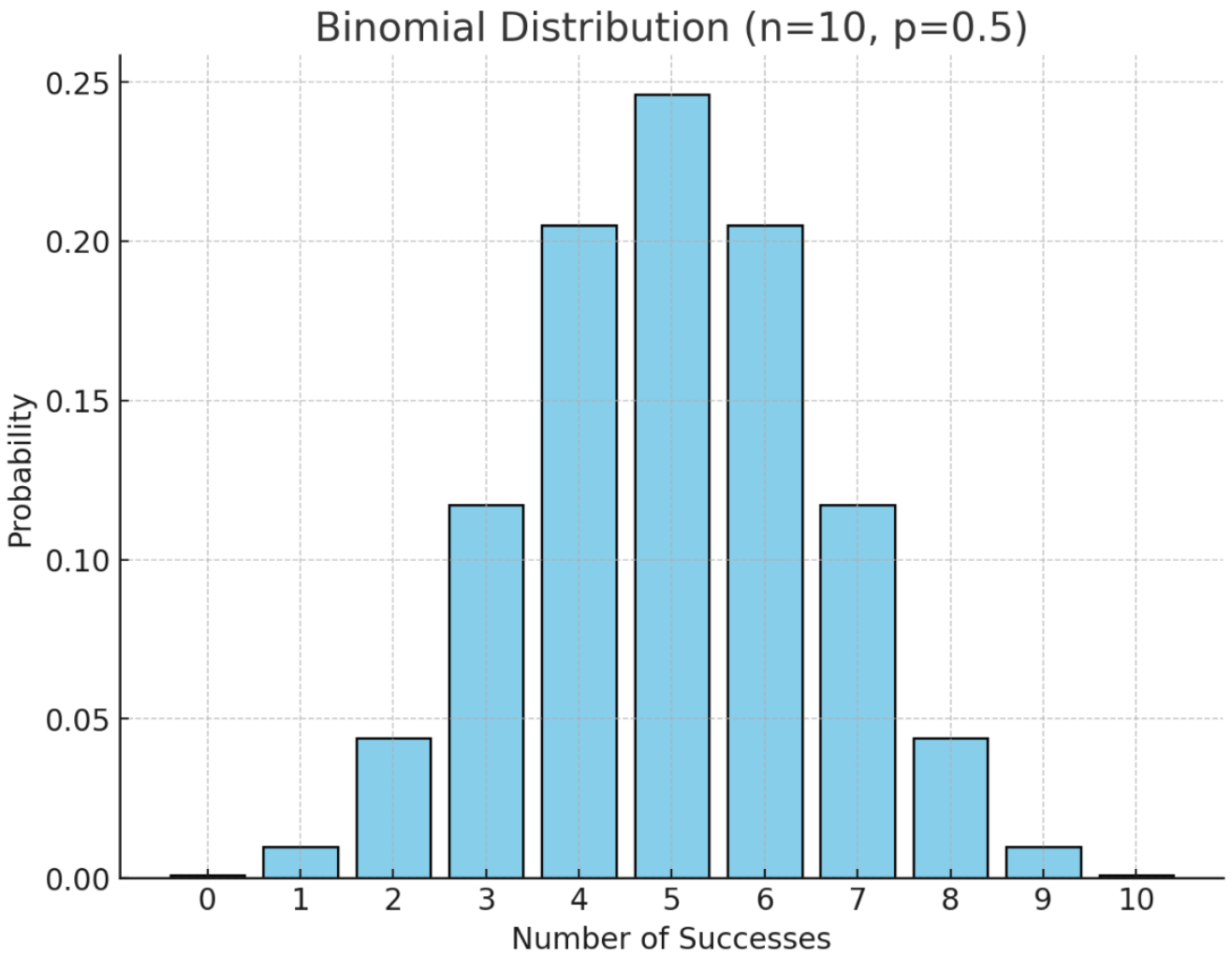
$$ln(\frac{p}{1-p}) = \beta_0 + \beta_1 X$$

Log odd, odds, probability?

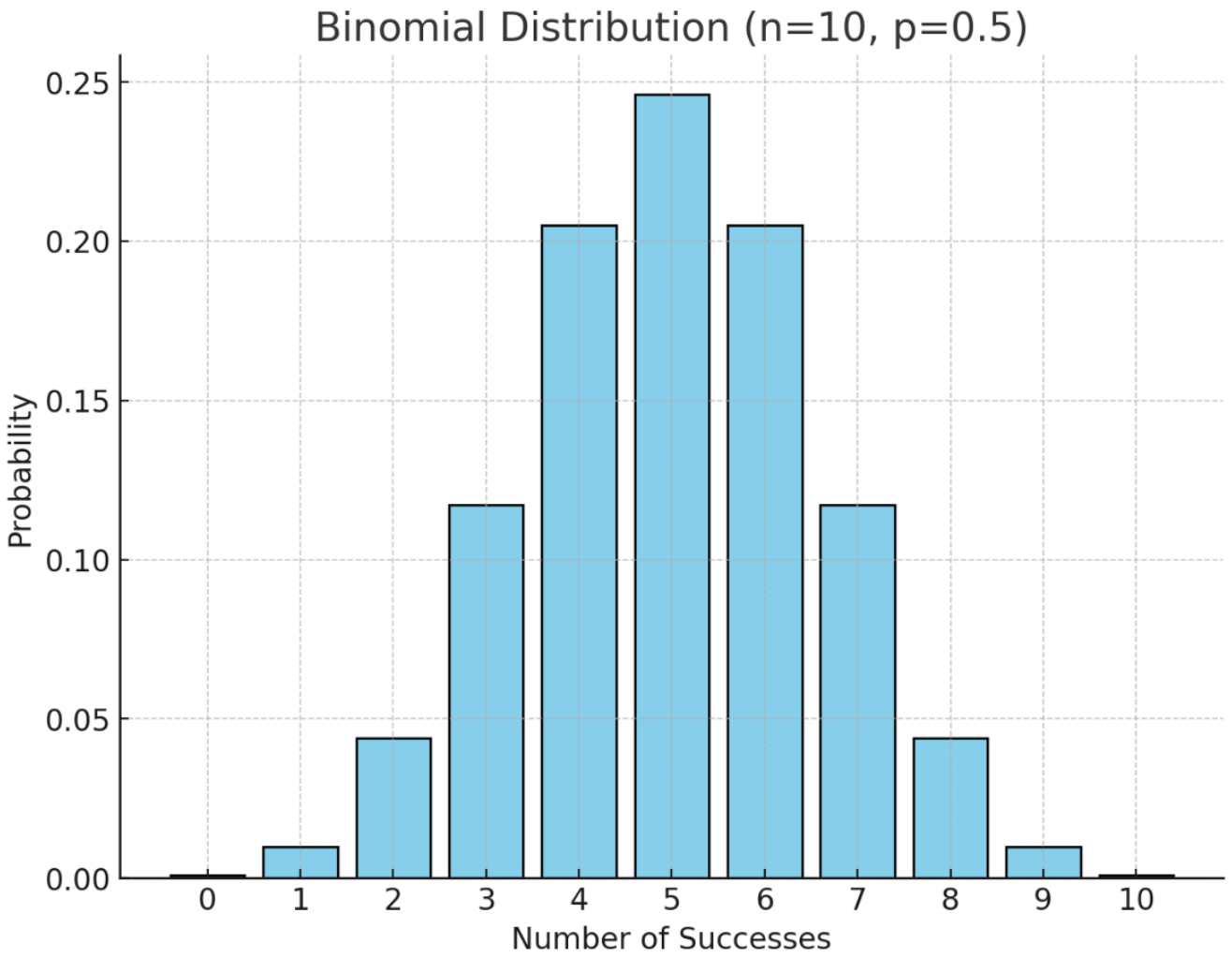
$$ln(\frac{p}{1-p}) = \beta_0 + \beta_1 X$$

probability

Binomial distribution



Binomial distribution



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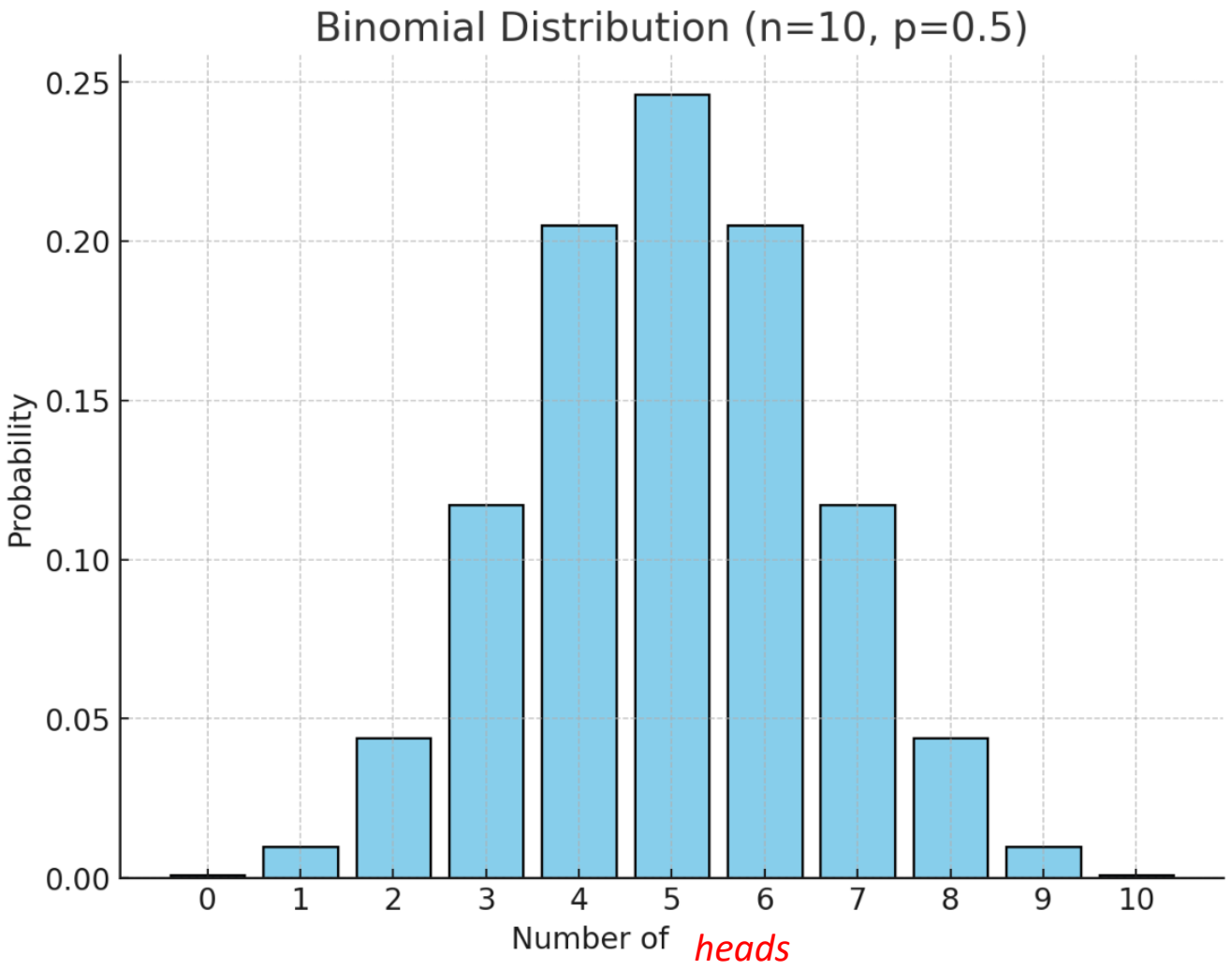
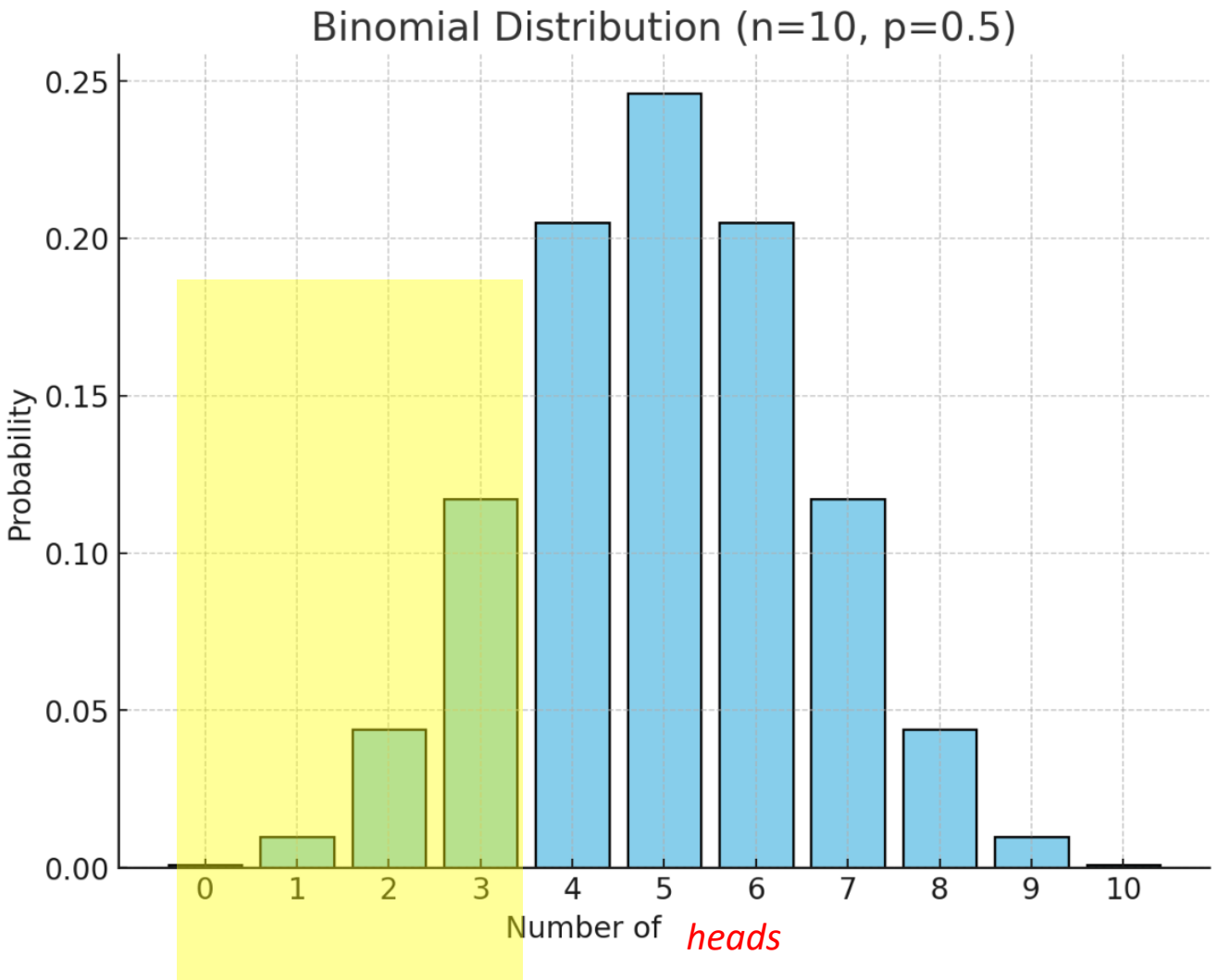
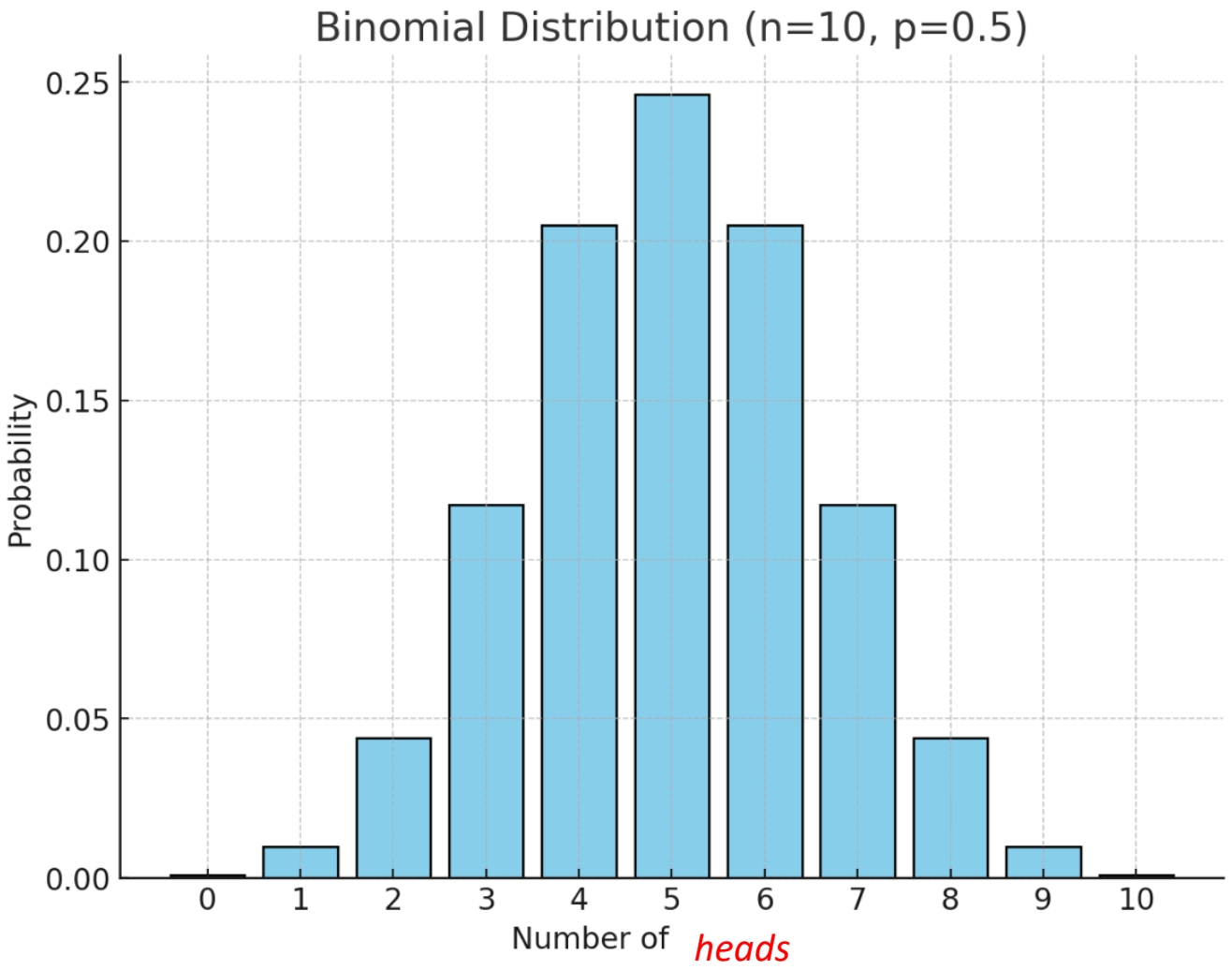


Binomial distribution

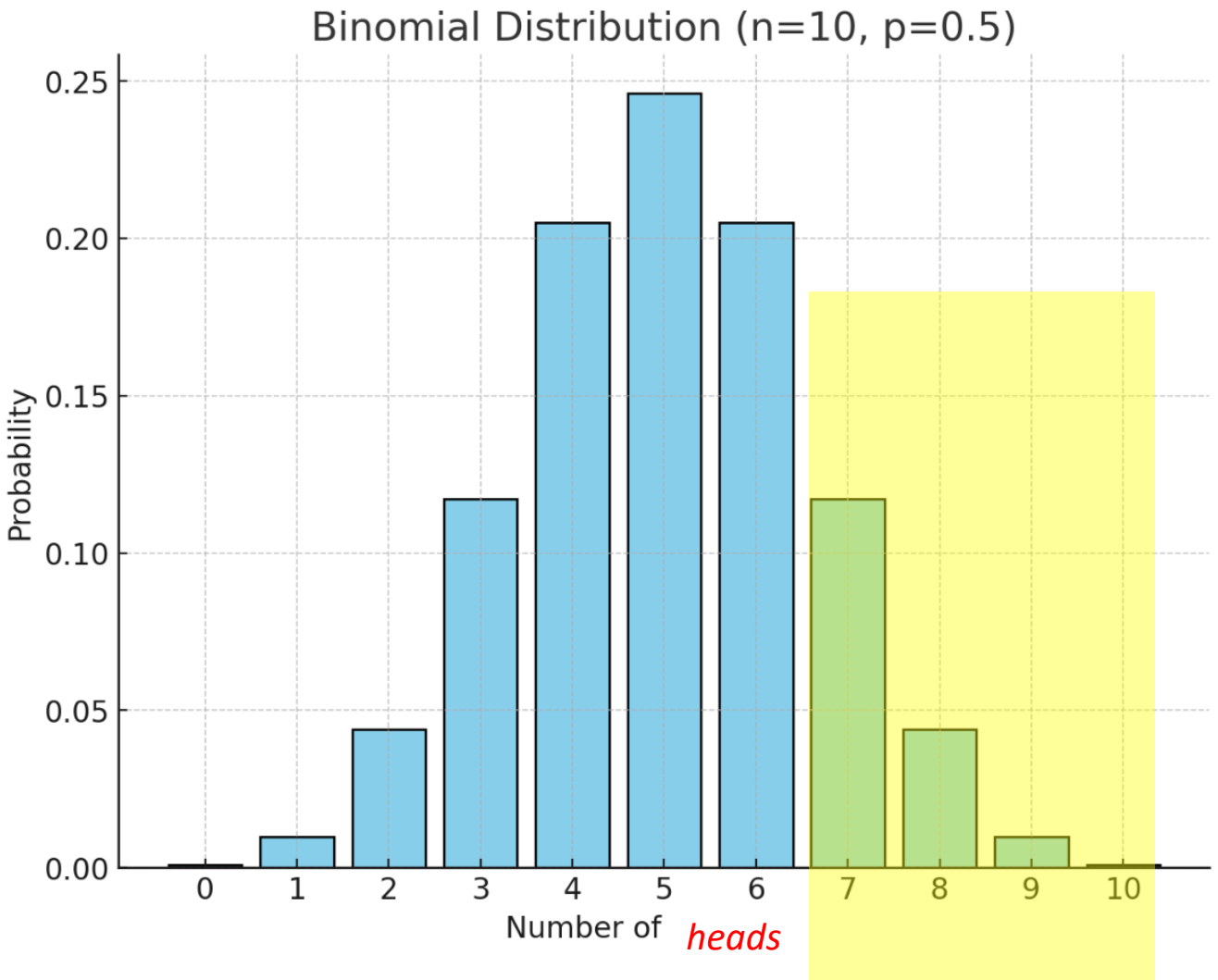
unlikely to get all tails



Binomial distribution

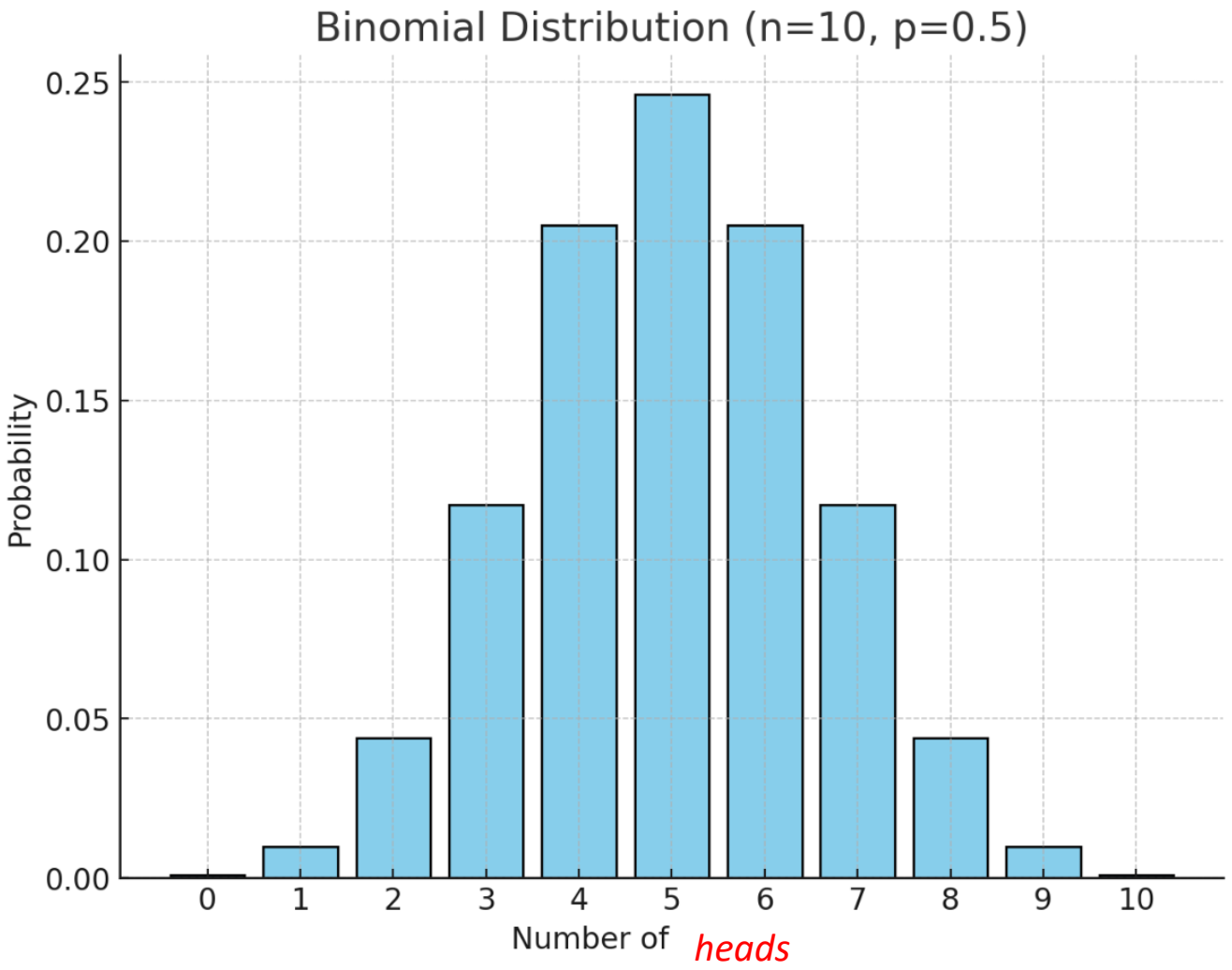


Binomial distribution



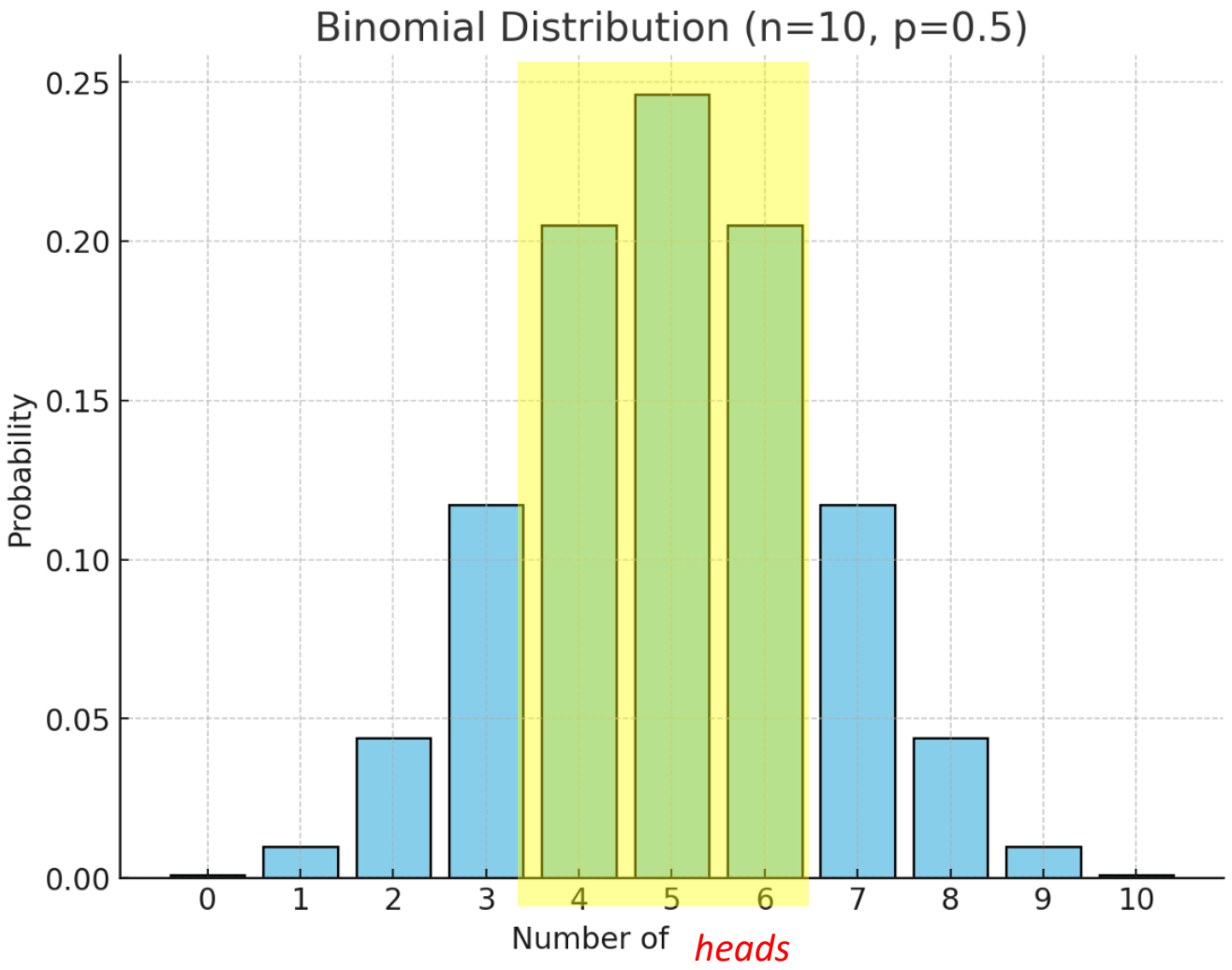
unlikely to get all heads

Binomial distribution

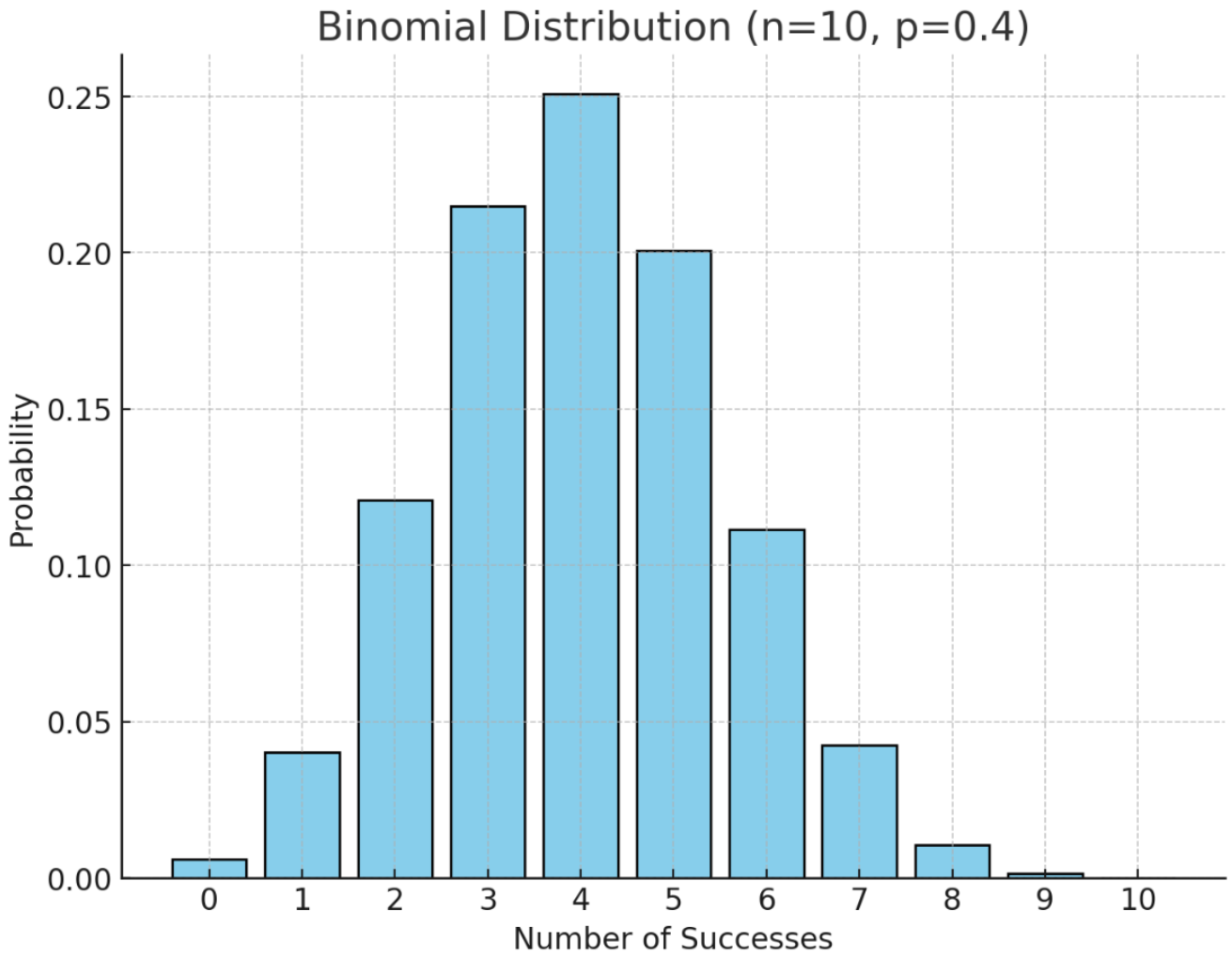


Binomial distribution

most likely to get even split



Our example



They cooked a casserole for him.

The parents grilled a chicken breast for Maria.

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Sarah made a burger for the kid.

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Amir sliced some vegetables for Luca.

Did you read this exact sentence?

They made Maria home-made cookies.

- ◯ Yes
- ◯ No

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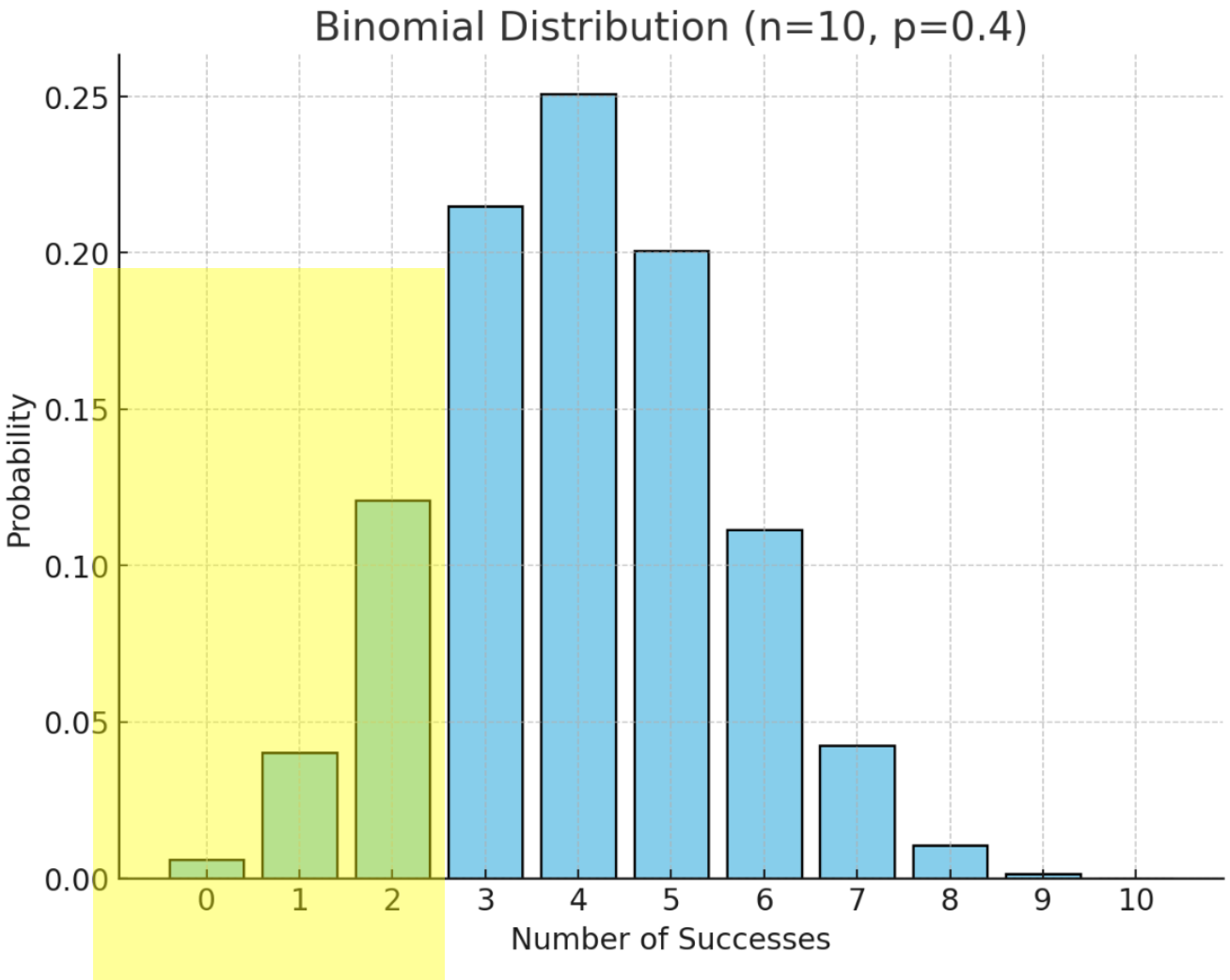
Did you read this exact sentence?

They made Maria home-made cookies.

Yes

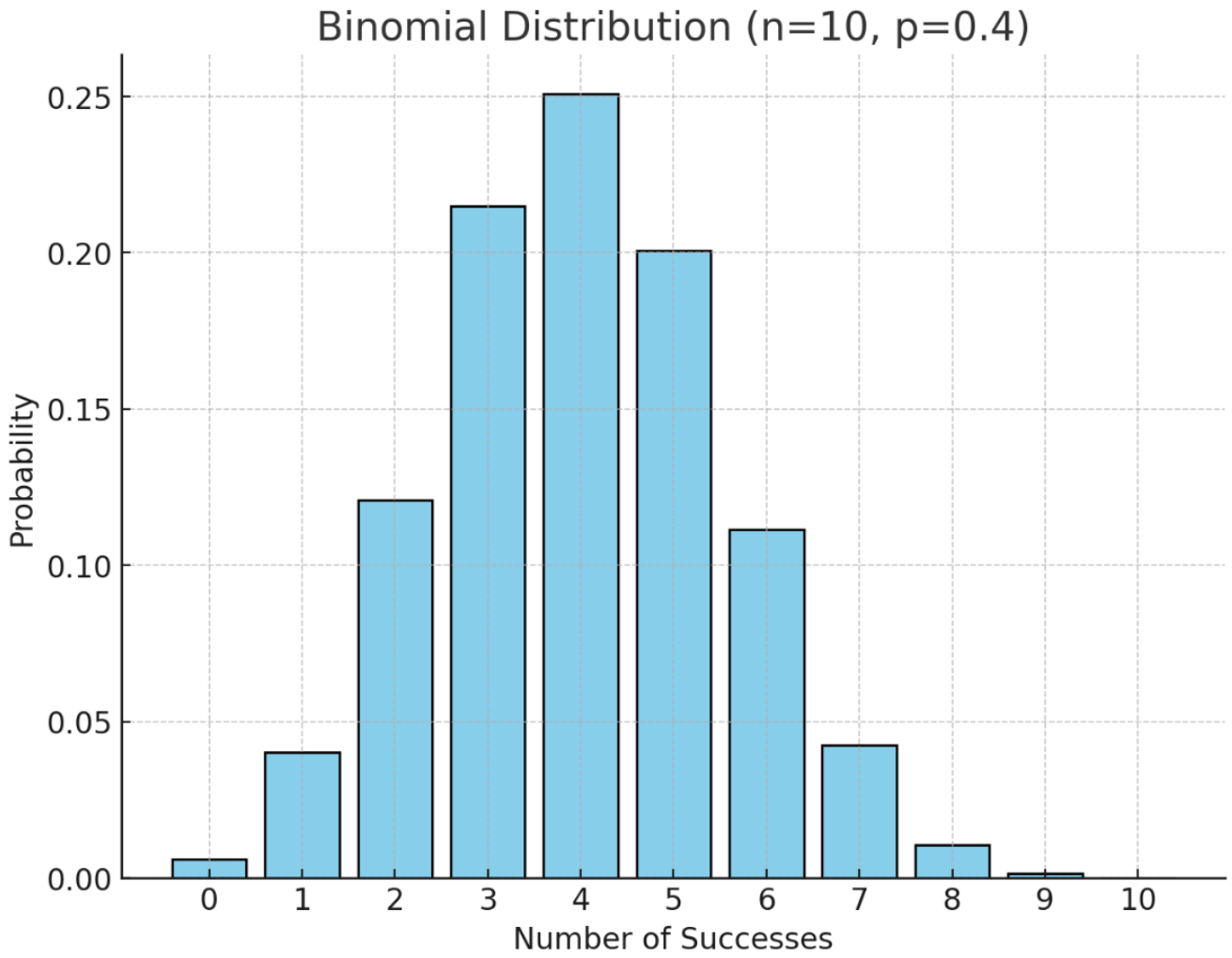
No

Our example



unlikely to only get them all wrong

Our example



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- ◯ Yes
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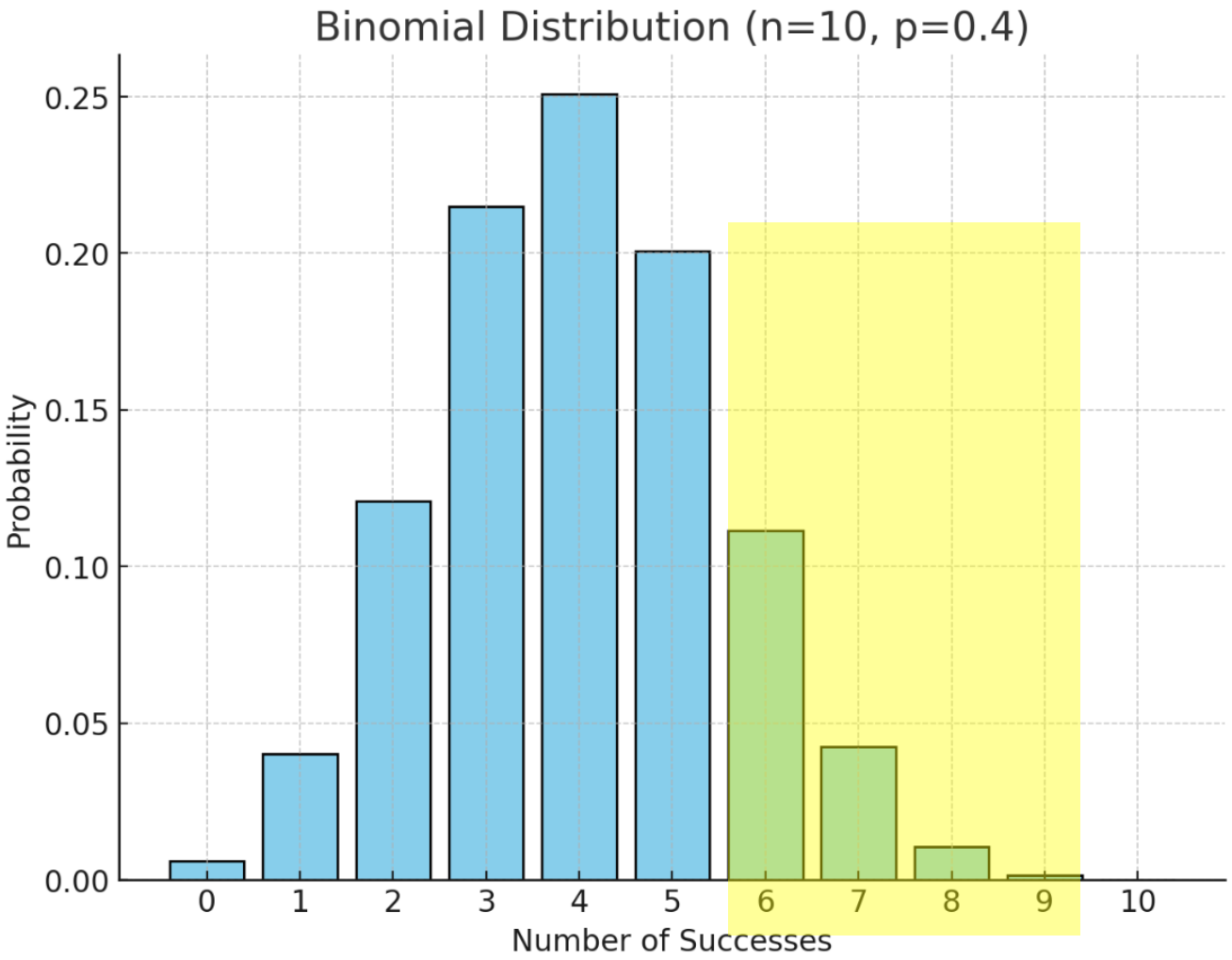
Our example



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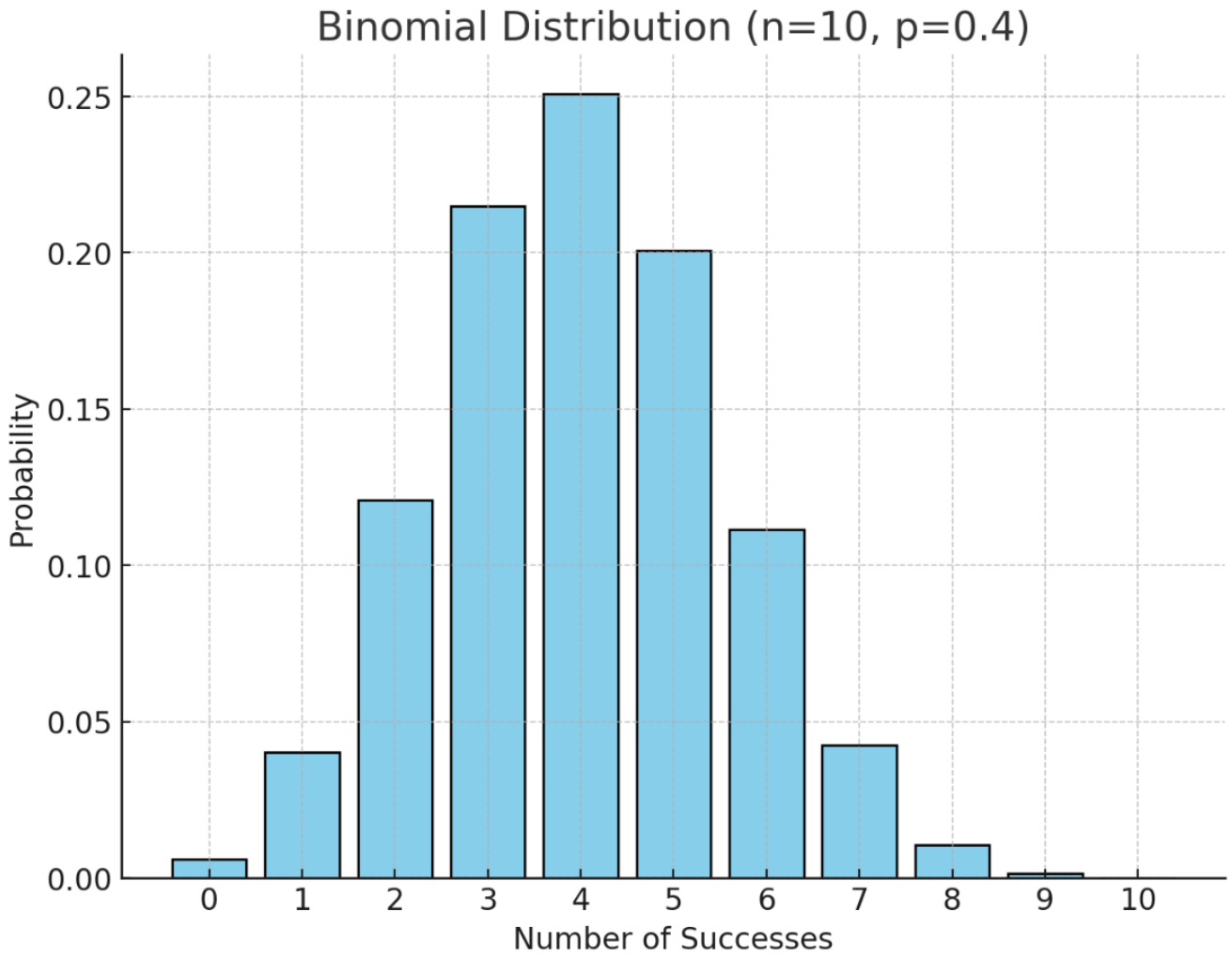
Our example



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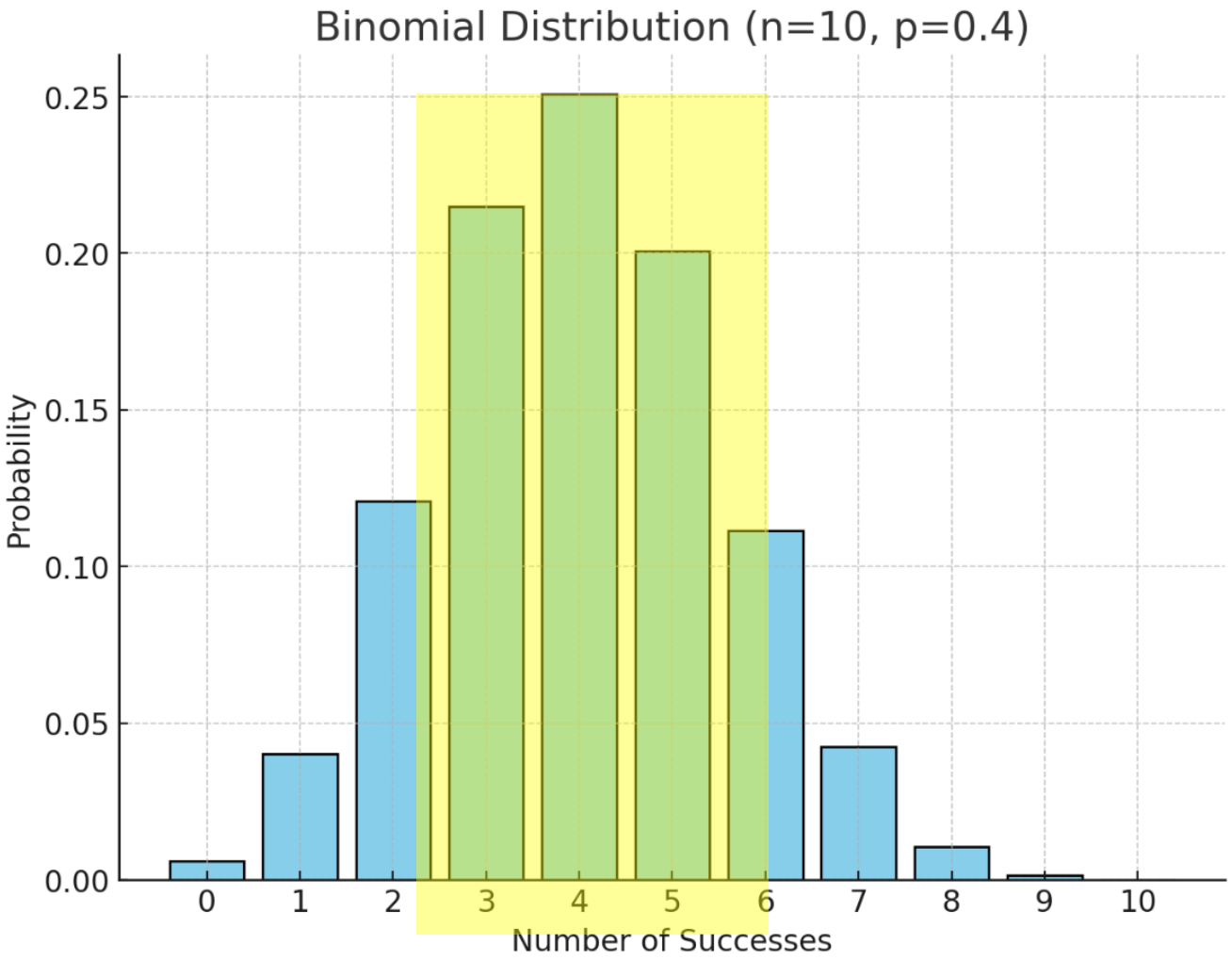
Yes

No

Our example



most likely to be in between

In R!

lm -> glm

```
model_all <- glm(accuracy ~  condition, family = binomial, data)
```

In R!

lm -> glm

```
model_all <- glm(accuracy ~  condition, family = binomial, data)

model_all <- glmer(accuracy ~  condition + (1 | RandomID) +  (1| sentence/item),family = binomial, data)
```

lmer -> glmer

In R!

lm -> glm

```
model_all <- glm(accuracy ~  condition, family = binomial, data)

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```

lmer -> glmer

In R!

also can specify the ”link”

```
model_all <- glmer(accuracy ~  condition + (1 | RandomID) +  (1| sentence/item),family = binomial (link = "logit"), data)

model_all <- glmer(accuracy ~  condition + (1 | RandomID) +  (1| sentence/item),family = binomial (link = "probit"), data)
```

In R!

also can specify the ”link”

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```

Thank you!