

IOWA STATE UNIVERSITY

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# Bayesian Hierarchical Model for Reward Probabilities in Star Wars: Galaxy of Heroes

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<https://github.com/jarad/swgoh-analysis>



# Star Wars: Galaxy of Heroes (SWGOH)

Star Wars: Galaxy of Heroes is a mobile game developed by Capital Games and published by Electronic Arts.

Galaxy of Heroes is set in a cantina in a distant corner of the Star Wars galaxy, where people of varying species compete in simulated holographic battles involving notable figures throughout Star Wars history for fame and fortune.



# Key Words from Star Wars: Galaxy of Heroes



Terms:

1. Rewards
2. Equipment Drops
3. Character Shards

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[https://www.reddit.com/r/SWGalaxyOfHeroes/comments/kekRpq/so\\_glad\\_these\\_shards\\_drop\\_rate\\_scales\\_with\\_energy/](https://www.reddit.com/r/SWGalaxyOfHeroes/comments/kekRpq/so_glad_these_shards_drop_rate_scales_with_energy/)

# Data

Collected from December 2019 to September 2020 among 4 players

Data collected per battle:

- Date
- Battle
- User
- Number of simulations
  - Manual/Simulated
- Rewards
- Equipment
- Shards (Characters)

	battleID	reward	count
1	1	Count Dooku	3
2	1	Ability Material Mk II	2
3	1	Ability Material Mk I	4
4	2	Bastila Shan	2
5	2	Mk 4 CEC Fusion Furnace Prototype Salvage	1
6	2	Mk 3 Arakyd Droid Caller Salvage	3
7	2	Mk 7 BlasTech Weapon Mod Prototype Salvage	1
8	2	Mk 5 BlasTech Weapon Mod Prototype	3
9	3	Royal Guard	1
10	3	Mk 6 BioTech Implant Prototype Salvage	1
11	3	Mk 4 Arakyd Droid Caller Salvage	1
12	3		

	battleID	userID	battle	n_sims
1	1	1	Fleet 1-E (Hard)	5
2	2	1	Fleet 1-C (Hard)	1
3	3	1	Dark Side 1-A (Hard)	2
4	4	1	Light Side 3-E (Hard)	2
5	5	1	Dark Side 2-C (Hard)	5
6	6	1	Cantina 2-A	12
7	7	1	Light Side 5-E (Hard)	1
8	8	1	Light Side 5-E (Hard)	3
9	9	1	Fleet 1-C (Hard)	3

# Scientific Questions

1. How do reward probabilities change over time?
2. How does number of attempts affect reward probabilities?
3. How much does the game reward you if you play manually?
4. How do reward probabilities vary by reward?
5. How do reward probabilities vary by battle?
6. How long to unlock a character ex. Rey Scavenger?

# Bayesian Hierarchical Logistic Regression

Let

- $Y_i$  be the number of rewards obtained,
- $n_i$  be the number of battle attempts,
- $\text{Date}_i$  be the date the battle was fought,
- $\text{Manual}_i$  be an indicator the battle was fought manually,
- $r_i$  be the particular reward, and
- $b_i$  be the particular battle.

$$Y_i \stackrel{\text{ind}}{\sim} \text{Bin}(n_i, \pi_i)$$
$$\log\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_0 + \beta_1 \times \text{Date}_i + \beta_2 \times n_i + \beta_3 \times \text{Manual}_i + \rho_{r_i} + \gamma_{b_i} + \delta_{r_i, b_i}$$

$$\rho_r \stackrel{\text{ind}}{\sim} N(0, \sigma_{\text{reward}}^2)$$

$$\gamma_b \stackrel{\text{ind}}{\sim} N(0, \sigma_{\text{battle}}^2)$$

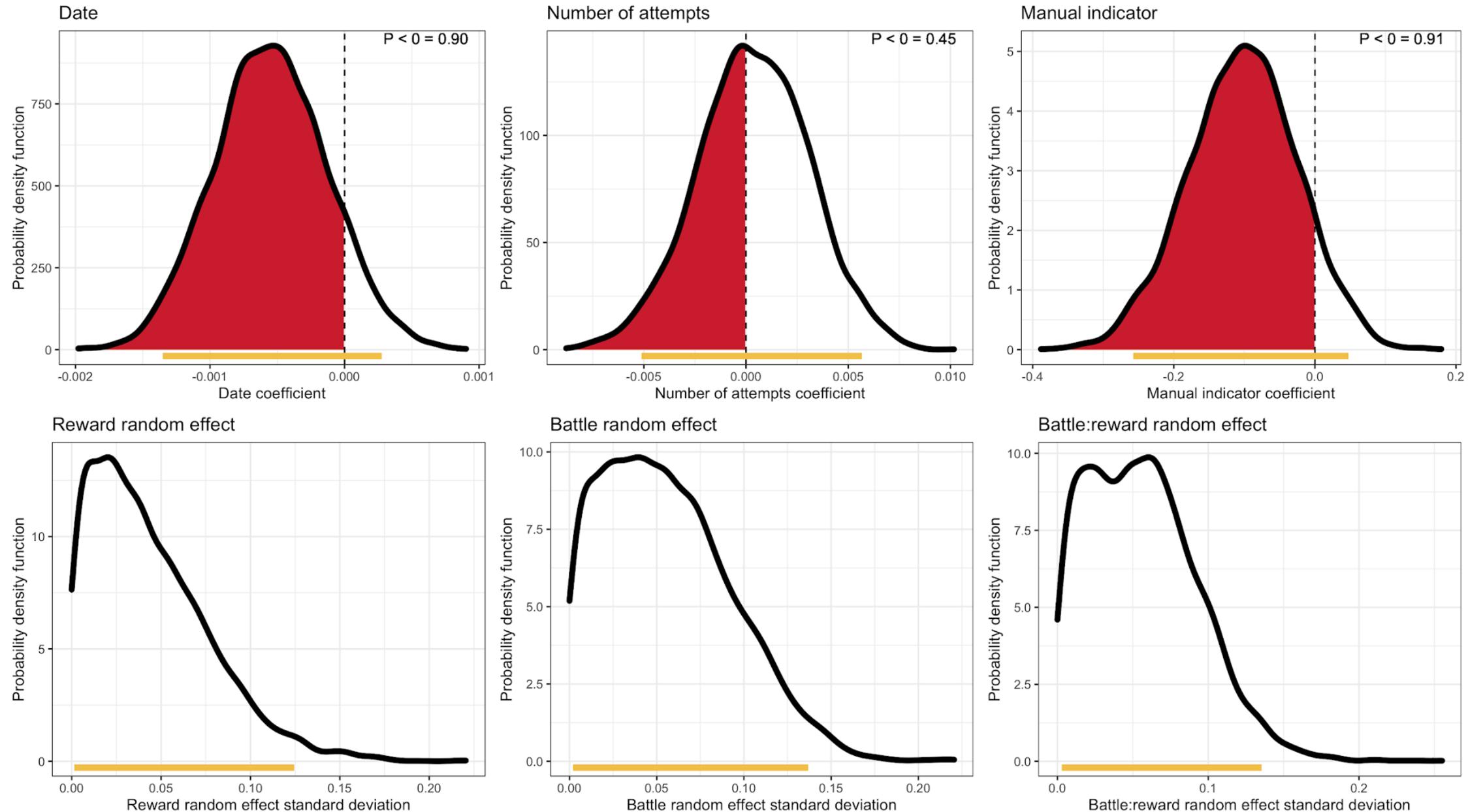
$$\delta_{r,b} \stackrel{\text{ind}}{\sim} N(0, \sigma_{\text{reward:battle}}^2)$$

r-project.org

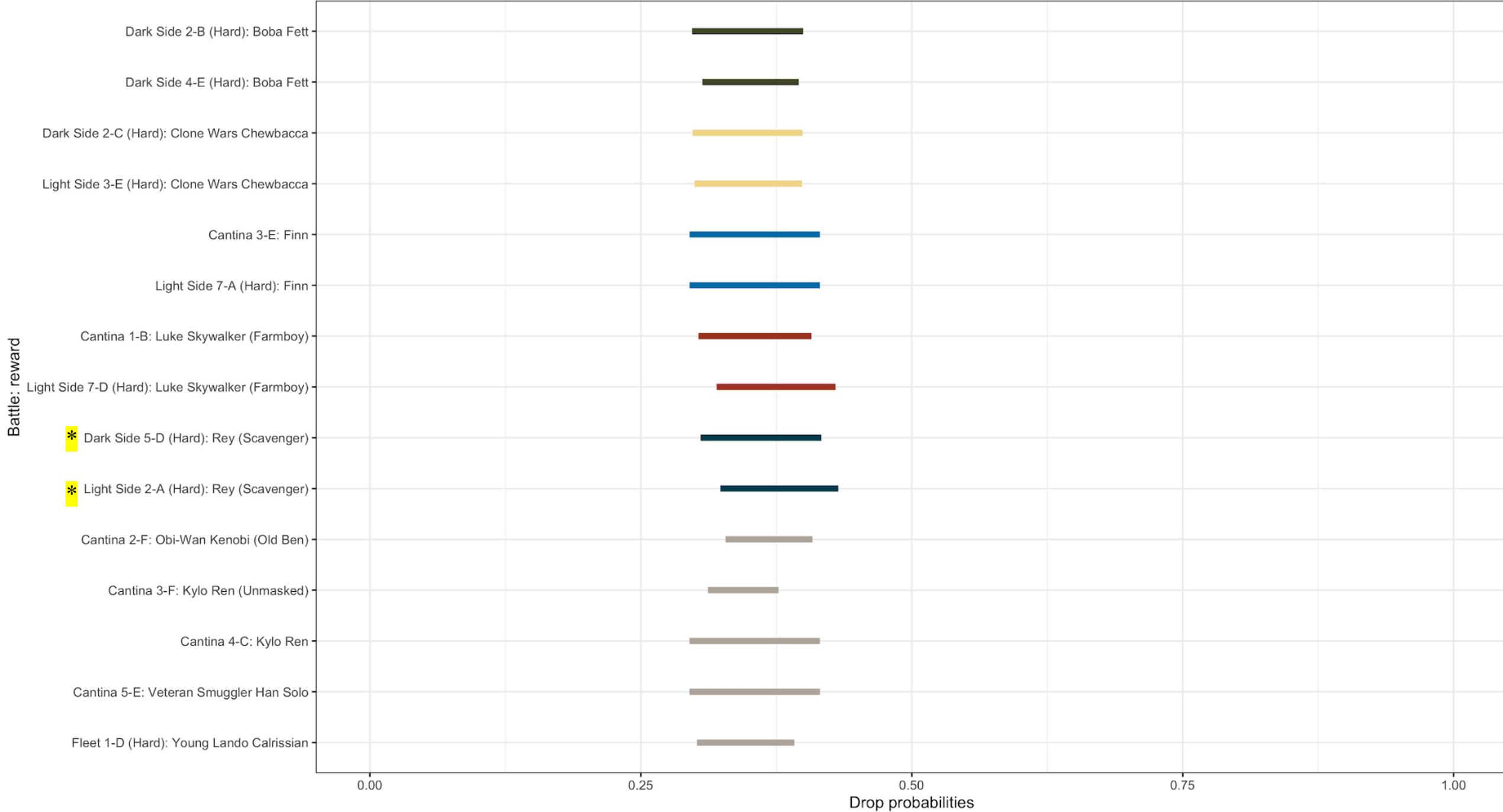


[https://mc-  
stan.org/](https://mc-stan.org/)

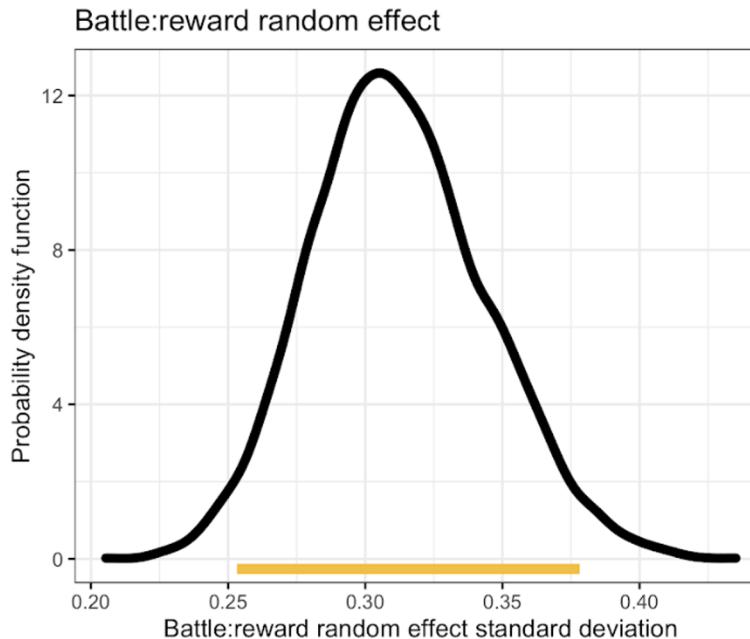
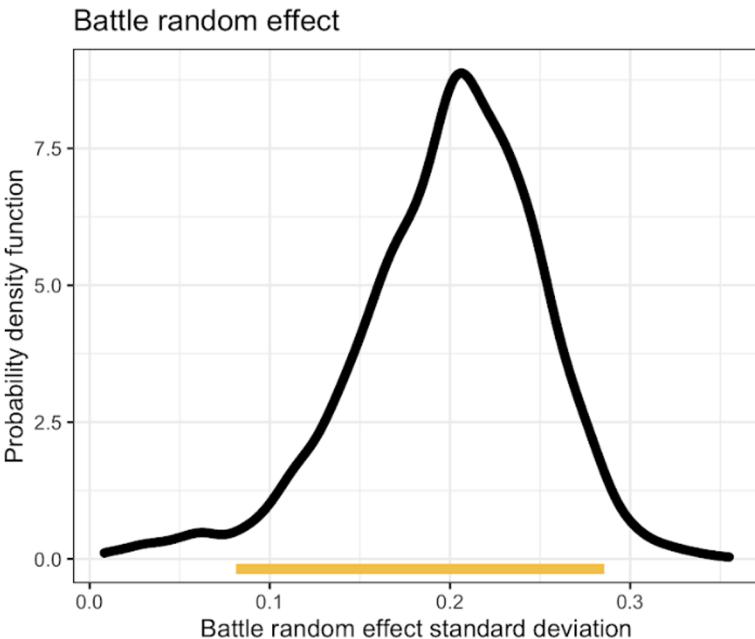
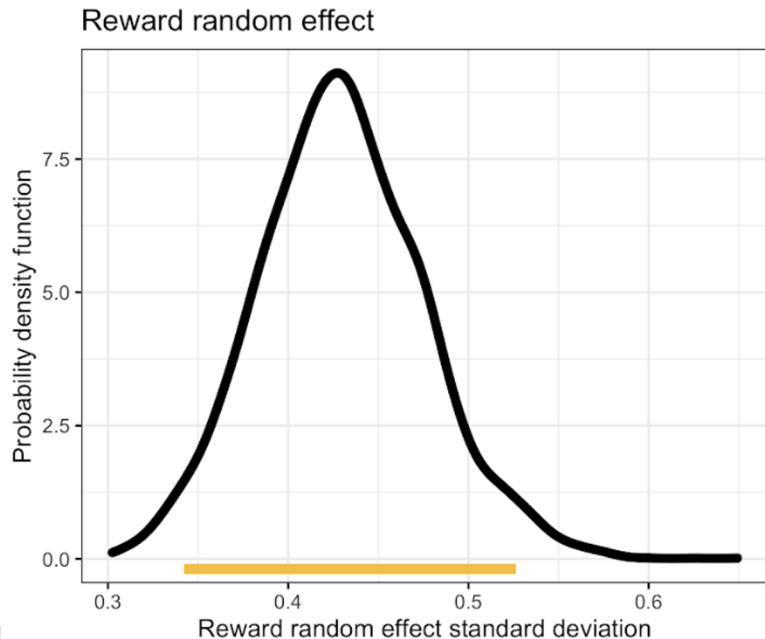
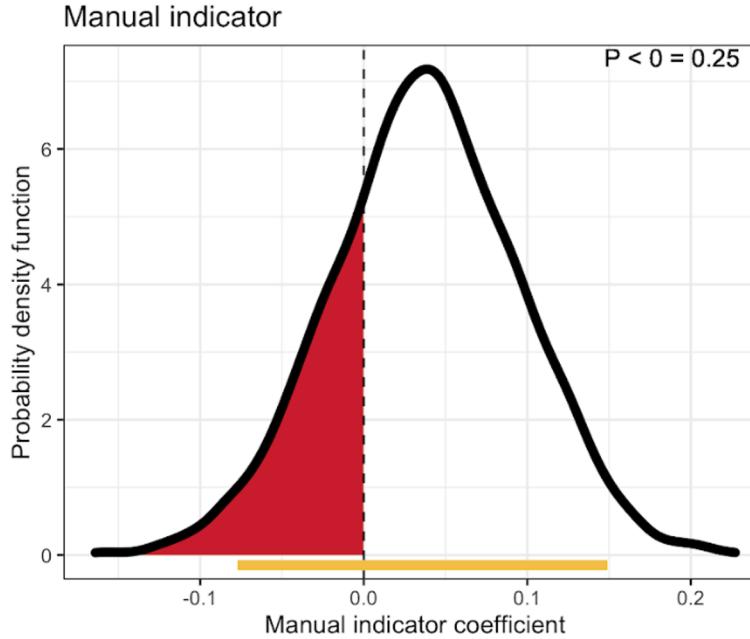
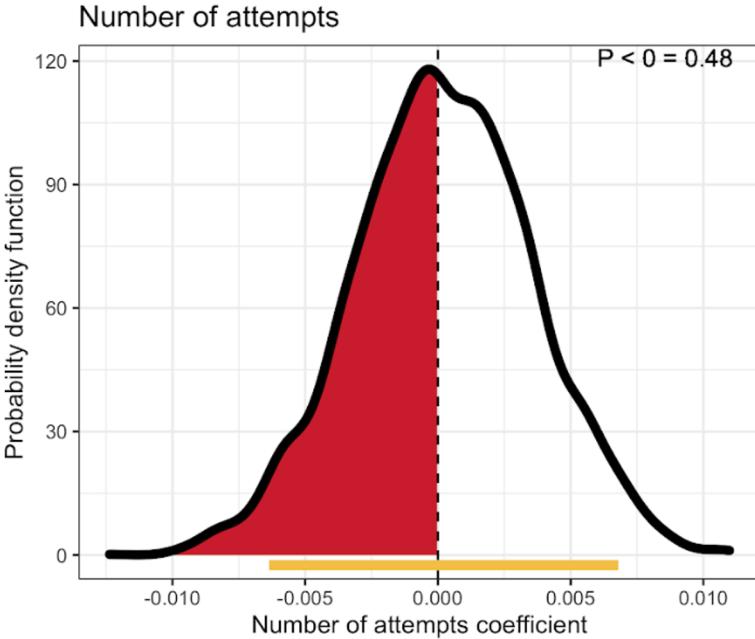
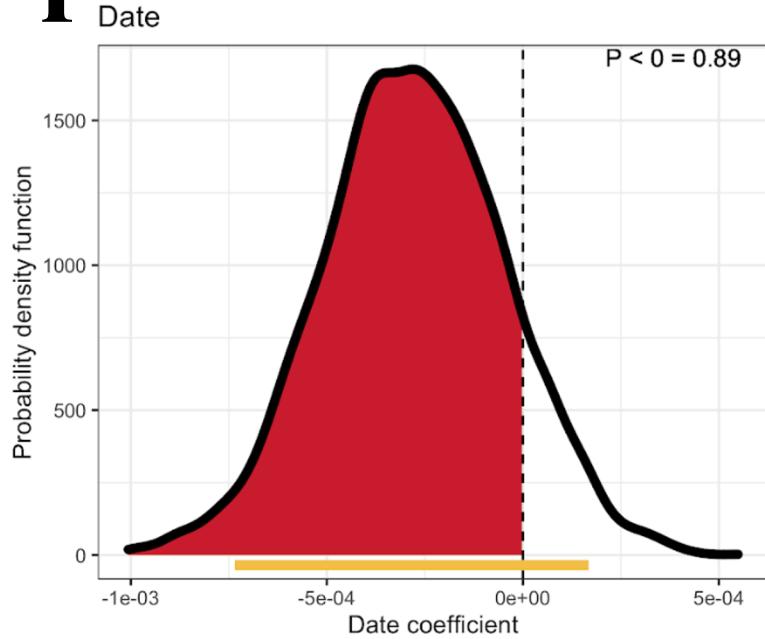
# Character Shard Model Parameters



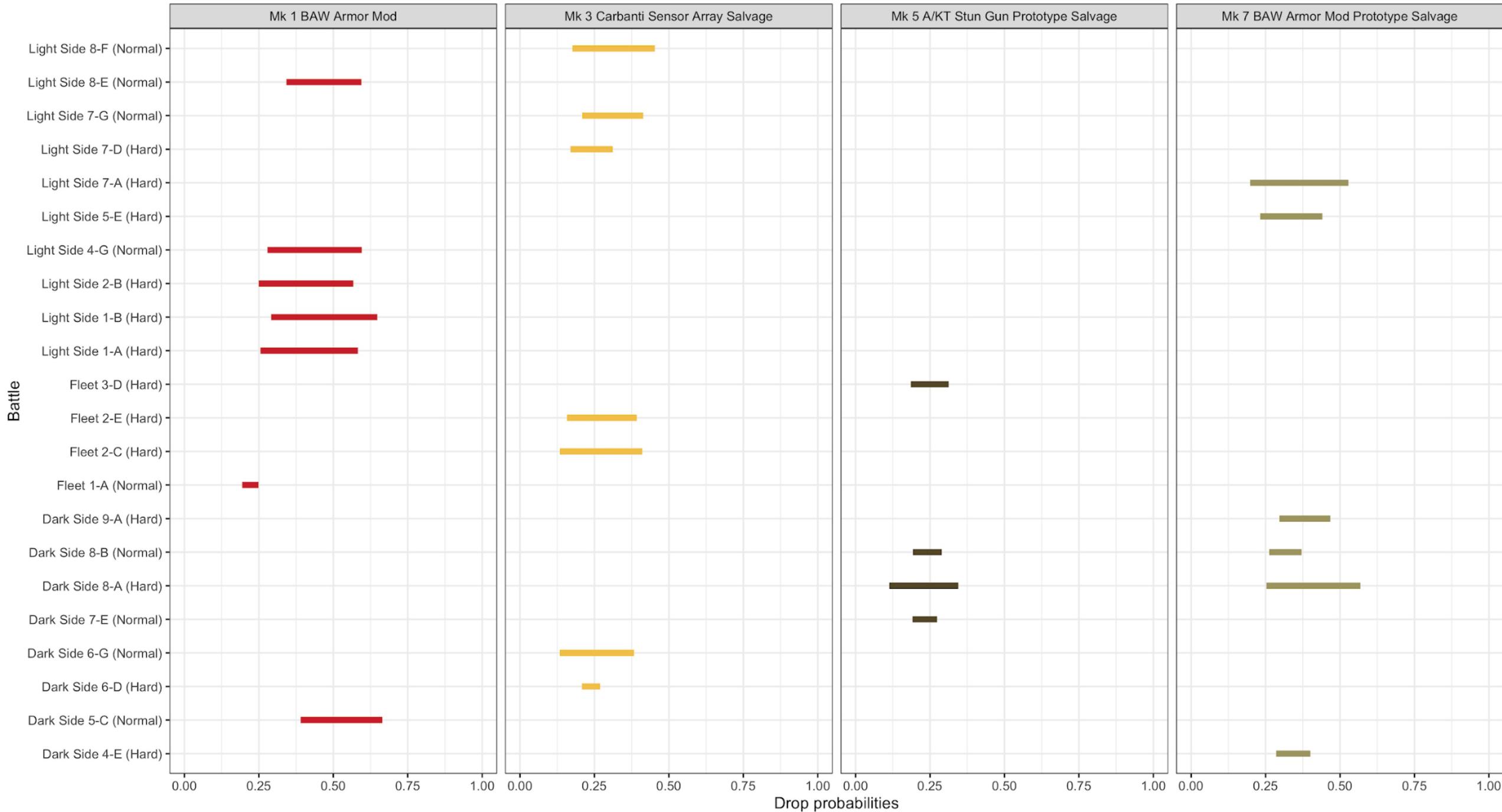
Character shard drop probabilities



# Equipment Model Parameters



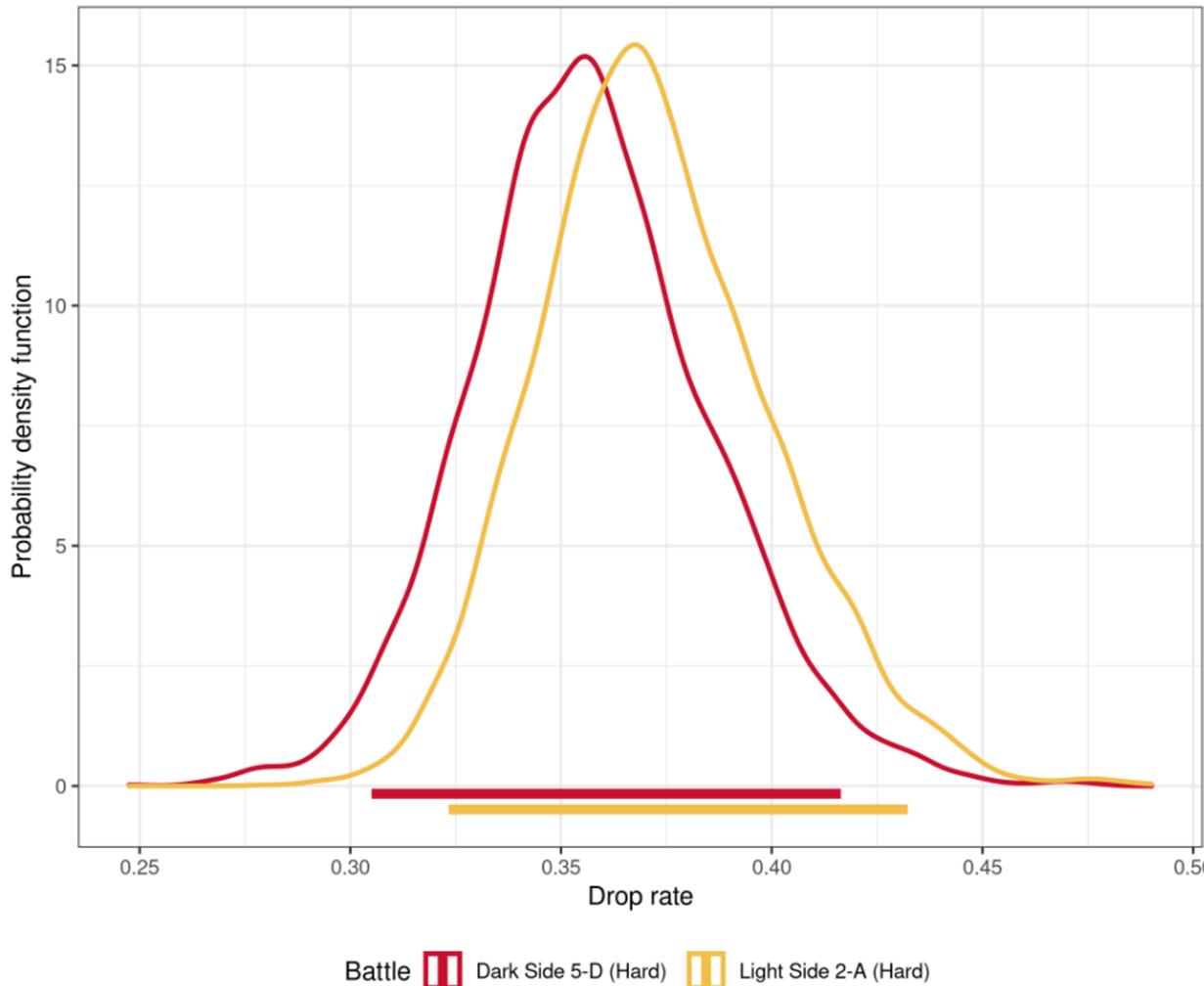
## Equipment drop probabilities



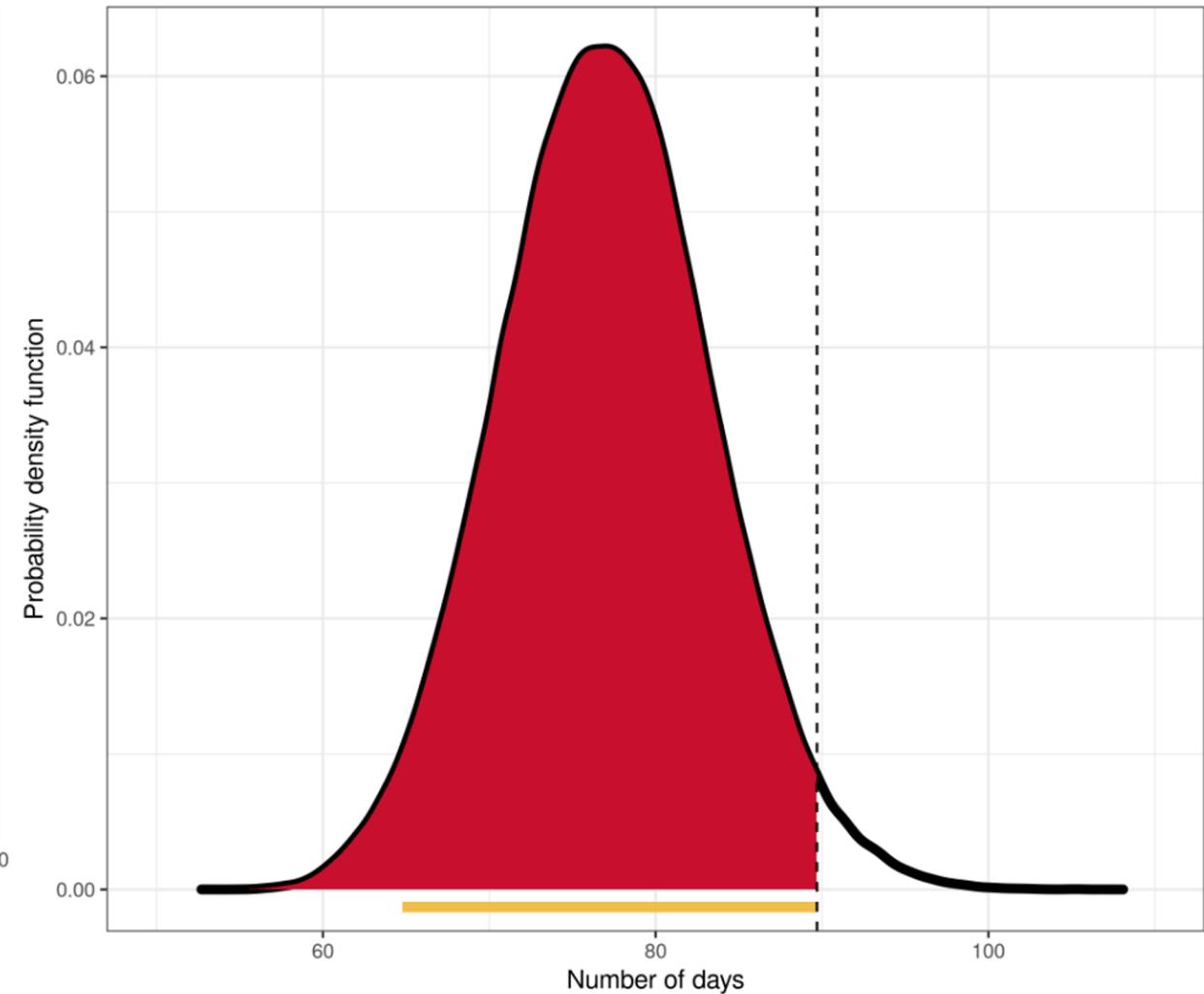
# How long to unlock Rey (Scavenger)?

280 shards needed, 2 battles x 5 attempts = 10 trials per day without refreshes

Drop rate for one Rey (Scavenger) shard



Number of days needed to unlock Rey (Scavenger)



# Conclusion

- No evidence that reward probabilities change
  - Over time
  - By number of simulations
  - Whether the battle is manually fought
- Equipment rewards appear to differ by
  - Equipment
  - Battle
- Starting from scratch collecting Rey (Scavenger) shards,
  - You expect it to take ~75 days
    - i. Anywhere from 60 to 90 days