Foraging for Rare Events

How do extreme outcomes influence patch residence time? We compared between three environments that provided equal expected values: a. produced uniform outcomes, b. included rare treasures, and c. included rare disasters. Extreme outcomes altered patch residence time, as well as the response to patch density. Exposure to multiple environments resulted in positive recency following the extreme rare events.

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Relevance

- Would an employee who is considering leaving their job, postpone this decision after receiving an unexpected gift from the employer? And if so, for how long?
- **Patch leaving** research inquires when it is beneficial to leave and when to stay in a patch (environment), given the rate of depleting rewards [1].
- This study addresses the effects of extreme rare outcomes on patch residence time.

Decision from Experience

- When sequentially choosing between alternatives, people tend to base decisions on the frequently experienced outcomes that the alternatives provide, underweighting the impact of rare outcomes [2].
- After encountering a rare positive outcome (**rare treasure**) people tend to re-choose the same alternative, showing **positive recency in the gain domain**. After encountering a rare negative outcome (**rare disaster**), they tend to switch to another alternative, showing **positive recency in the loss domain** [3].
- **People tend to stay longer and to search more in environments that provide small frequent rewards and rare disasters [4,5] – compared to environments that provide small frequent losses and rare treasures.**

Hypotheses

We inspected the impact of rare events on patch residence time, testing whether:

- ❑ Residence time in the **rare disaster** environment will be higher than residence time in the **rare treasure** environment
- ❑ **Positive recency** will occur in both types of environments

Method

an online 20-min. fishing game. Points were gained by catching (clicking on) fish. All fish that appeared had to be caught.

- The more fish were caught in a pond, the longer it took new fish to appear. One could go to a new pond whenever they chose, travelling for ~15 sec. The goal was to decide how long to stay at each pond.
- The initial amount of fish, **density**, varied between the ponds, ranging from 12 to 19 fish. Three types of ponds were used:

Rare Treasure Ponds			Neutral Ponds			Rare Disaster Ponds		
Species	Probability	Points	Species	Probability	Points	Species	Probability	Points
Purple	0.9	10	Green	1	11	Blue	0.9	12
Gold	0.1	20				Gray	0.1	2
Expected Value		11	Expected Value		11	Expected Value		11

Figure 1: Fish species, probability and point yield in each of the three pond types

Study 1

IV between: Pond Type [Neutral/Rare Treasure/Rare Disaster]
IV within: Density [12-19 fish in a pond]
DV: Pond residence time

N=70*3 Prolific
($M_{(age)}$=26.9, Female=48)

Linear Mixed-Effects model (lmer):

H0: Pond Time ~ (1 | part*)*
H1: Pond Time ~ (1 | part) + Density + Pond Type + Pond Type : Density

Delta AIC=106.47, *p*<.001

	Chi sqr.	*p*
Pond Type	36.91	<.001
Density	62.73	<.001
Pond Type:Density	10.40	0.006

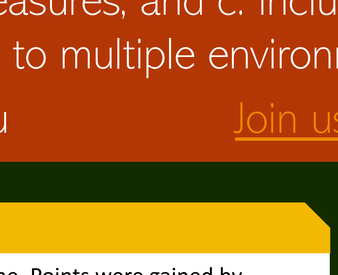

Figure 2: Average pond residence time in Study 1

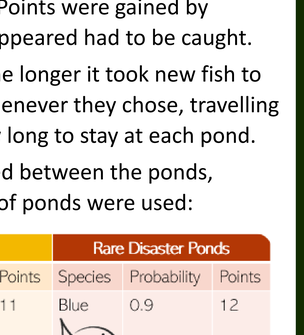

Figure 3: Average pond residence time as a factor of pond density in Study 1

- **Participants prolonged their stay in the rare disaster ponds**
- **Response to pond density varied between the groups**

Study 2

IV 1 within: Pond Type [Neutral/Treasure/Disaster] **DV:** Pond Time
IV 2 within: Density [12-19] **N**=90 Prolific ($M_{(age)}$=24.8, Female=16)

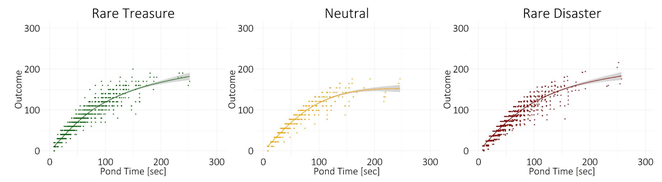

Figure 4: Reward rates in Study 2

Linear Mixed-Effects model (lmer):

H0: Pond Time ~ (1 | part*)*
H1: Pond Time ~ (1 | part) + Density + Pond Type + Pond Type : Density

Delta AIC=41.18, *p*<.001

	Chi sqr.	*p*
Pond Type	10.64	.005
Density	20.45	<.001
Pond Type:Density	0.7	0.71

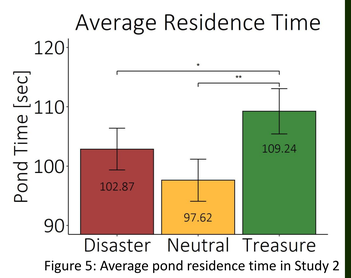

Figure 5: Average pond residence time in Study 2

- **Participants stayed longer in the rare treasure ponds**
- **Positive recency occurred: leaving rate was higher following a rare disaster (14%) than following a rare treasure (6%).**

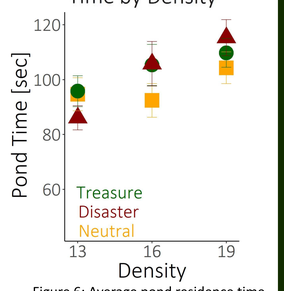

Figure 6: Average pond residence time as a factor of pond density in Study 2

Study 3

IV 1 within: Pond Type [Treasure/Disaster] **DV:** Pond Time
IV 2 within: Density [12-19] **N**=90 ($M_{(age)}$=26.4, Female=34)
Delta AIC=18.95, *p*<.001

	Chi sqr.	*p*
Pond Type	4.77	.029
Density	11.62	<.001
Pond Type:Density	0.53	.465

- **The results replicated the findings of Study 2**
- Participants stayed longer in the rare treasure ponds compared to the rare disaster ponds and were sensitive to density.
- A positive recency of 6% occurred in the two pond types.

Conclusions

- The effects of rare events, common in the decisions from experience literature, were tested in the foraging domain.
- In patches that provided equal expected values, rare events significantly influenced patch residence time.
- Both types of rare events prolonged residence time.
- Participants showed sensitivity to density across patch types and experimental conditions.
- When exposed to one type of environment, participants of the rare event groups suboptimally prolonged their stay in the patches. This tendency was higher in the rare disaster group. No positive recency occurred.
- When exposed to multiple environments, participants stayed longer in the rare treasure patches and positive recency occurred.
- One possible explanation for the effect of environment variability: positive recency in the gain domain caused participants to prolong their stay within rare treasure patches, while positive recency in the loss domain resulted in leaving the rare disaster patches earlier.

References

1. Charnov, E. L. (1976). Optimal foraging: the marginal value theorem. *Theoretical Population Biology* 9:129-136
2. Hertwig, R., Barron, G., Weber, E. U., & Erev, I. (2004). Decisions from experience and the effect of rare events in risky choice. *Psychological science*, *15*(8), 534-539.
3. Erev, I. (2012). On surprise, change, and the effect of recent outcomes. *Frontiers in psychology*, *3*, 24.
4. Teodorescu, K., & Erev, I. (2014). On the decision to explore new alternatives: The coexistence of under-and over-exploration. *Journal of Behavioral Decision Making*, *27*(2), 109-123.
5. Cohen and Erev (2020). Over and Under Commitment to a Course of Action in Decisions from Experience. Manuscript submitted for publication.