Scrutinizing the effects of game elements for learning by experimental research in and out the lab

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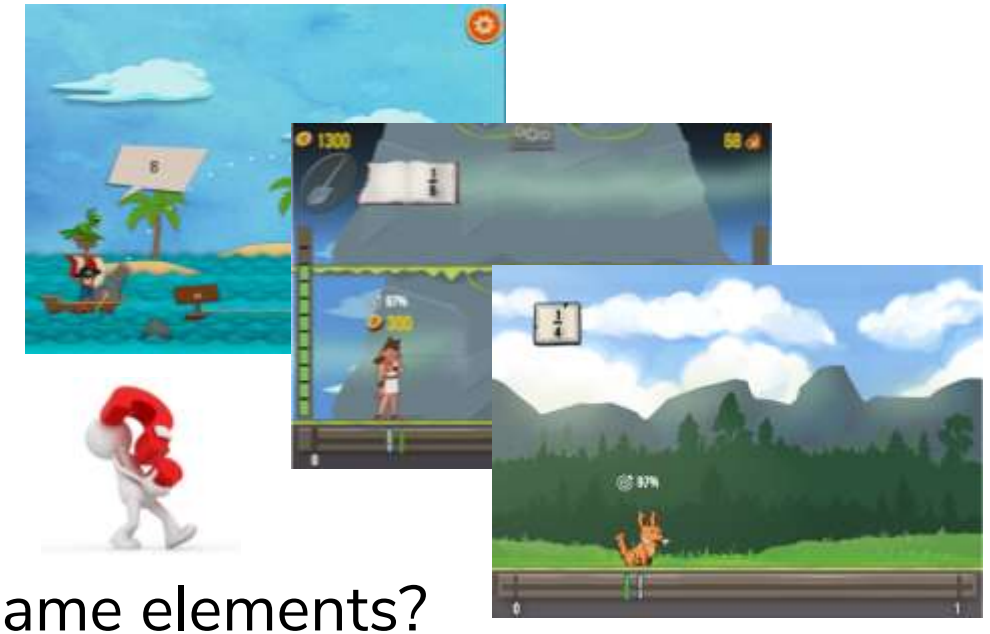
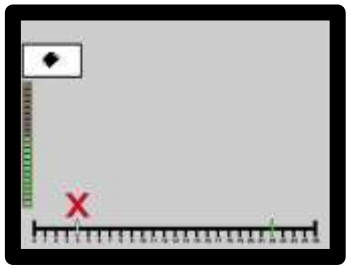
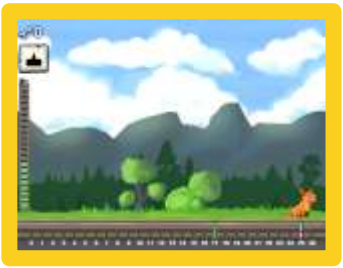
Content



- Why game elements?
- How investigate the effect of game elements?
- **Online study 1**: little incentive
- **Online study 2**: “sufficient” incentive
- **Lab study**: lab situation/context

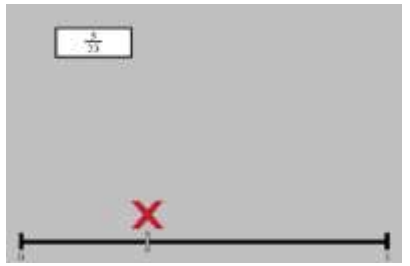


vs.



Why?

vs.



(Ninaus et al., 2023, https://doi.org/10.1007/s11423-023-10263-8)

- Why studying the effect of game elements on learning? Because game elements…
  - …can be associated with **increased motivation** (e.g., Sailer & Homner, 2020, https://doi.org/10.1007/s10648-019-09498-w)
  - …can be related to **increased engagement** (e.g., Ninaus et al., 2019, https://doi.org/10.1016/j.compedu.2019.103641; Huber et al., 2023, https://doi.org/10.1016/j.chb.2023.107948)
  - …might improve **learning performance** (e.g., Wouters et al., 2013, https://doi.org/10.1016/j.compedu.2012.07.018; Mayer, 2020, https://psycnet.apa.org/record/2020-10545-004)
- But game elements can also…
  - …**distract or disturb** (attention, learning) (e.g., Rey, 2012, https://doi.org/10.1016/j.edurev.2012.05.003)
  - …**occupy limited cognitive resources** (e.g., Mayer, 2014, https://doi.org/10.1017/CBO9781139547369.005)

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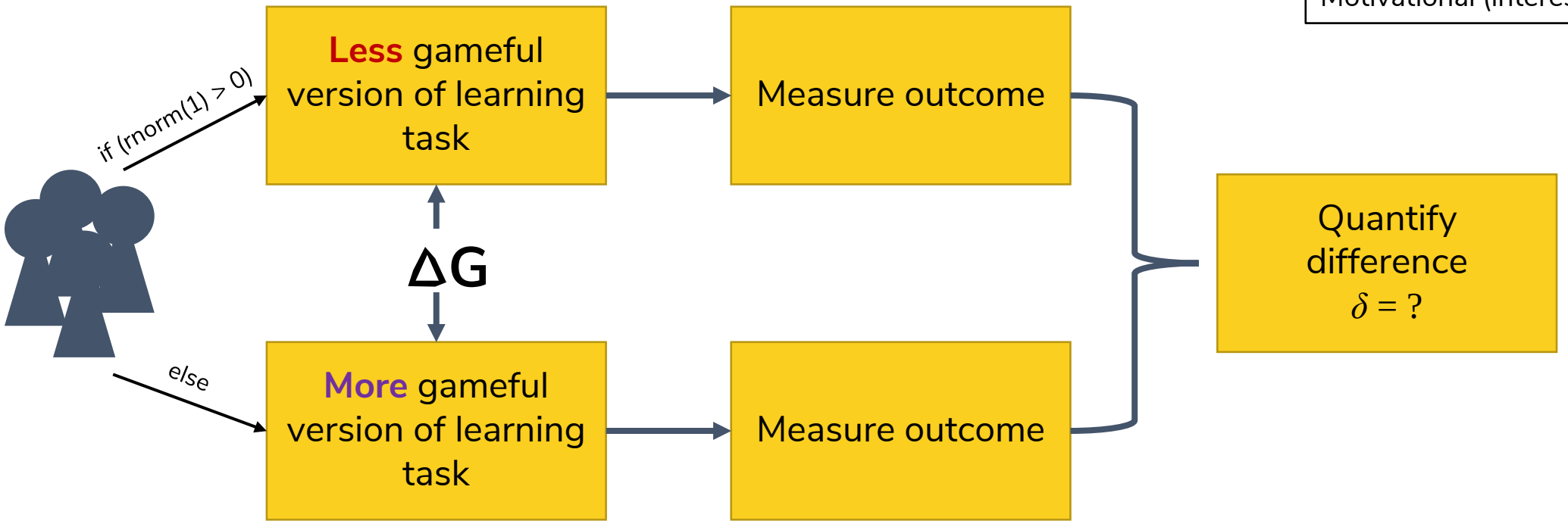
- **What are the exact mechanisms? When have game elements (what kind of) effect?**

How?

- How can we study the effect of game elements?
  - **Value-added** research paradigm: (e.g., Mayer, 2020, https://psycnet.apa.org/record/2020-10545-004)

Outcomes:
Cognitive (memory, math)
Affective (curious, frustrated)
Motivational (interest, attrition)

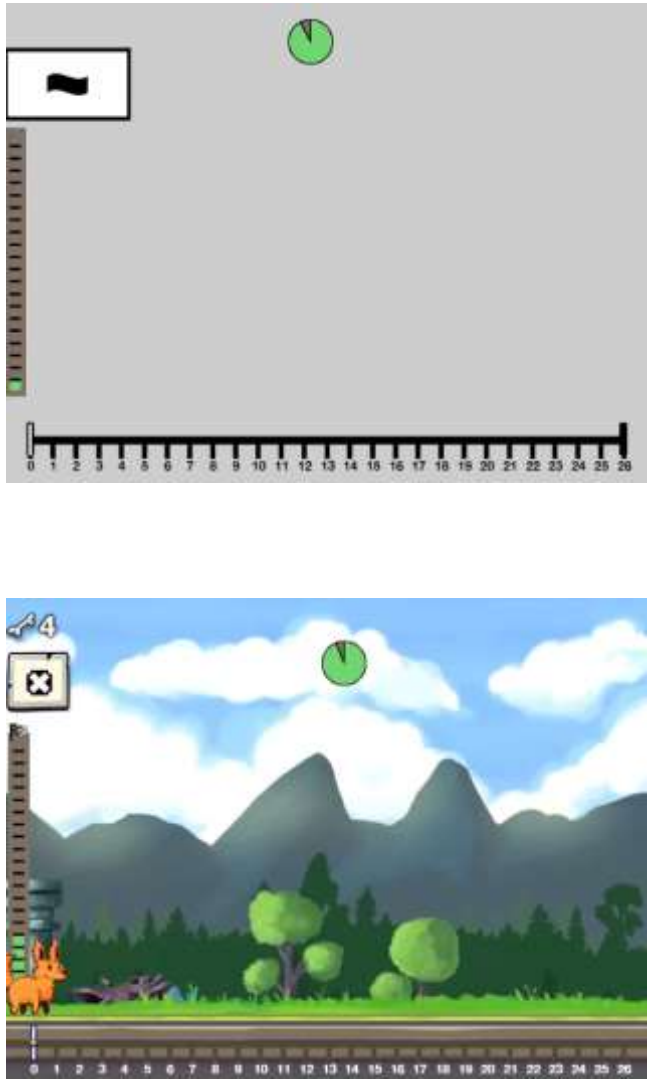


Learning task

- **Associative learning task**:
  - Unknown associations between symbols and numbered positions on number line
  - In each trial a symbol is presented and a position/number on bottom line must be selected
  - Corrective feedback after each trial
  - 20 symbols per level (except online study 1), 20 s per symbol
  - 5 consecutive levels
  - *Goal:* Learn as many associations as possible over 5 levels
- **Game elements (ΔG)**:
  - Visual aesthetics
  - Narrative
  - Scoring system

Typically affecting engagement/motivation (e.g., Toda et al., 2019, https://doi.org/10.1109/ICALT.2019.00028)

Based on the NumberTrace engine (https://www.youtube.com/watch?v=T7s7xSILrac)

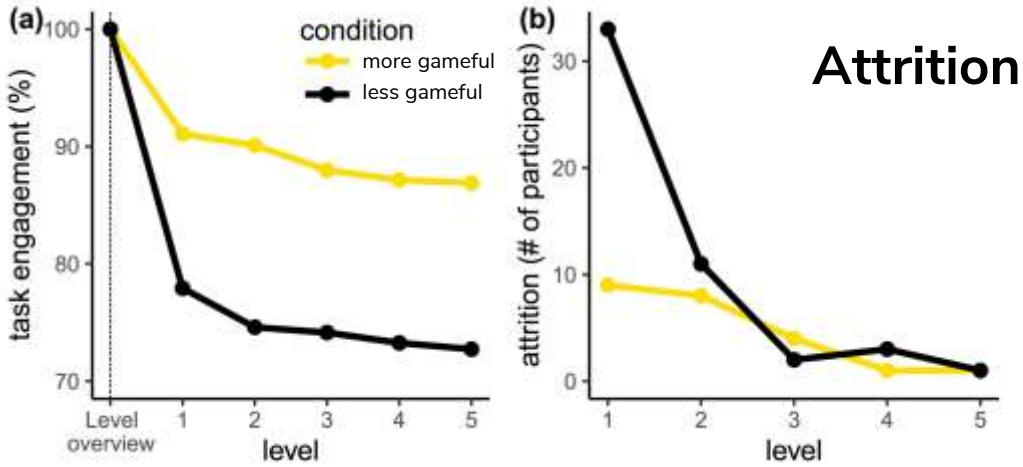


ΔG

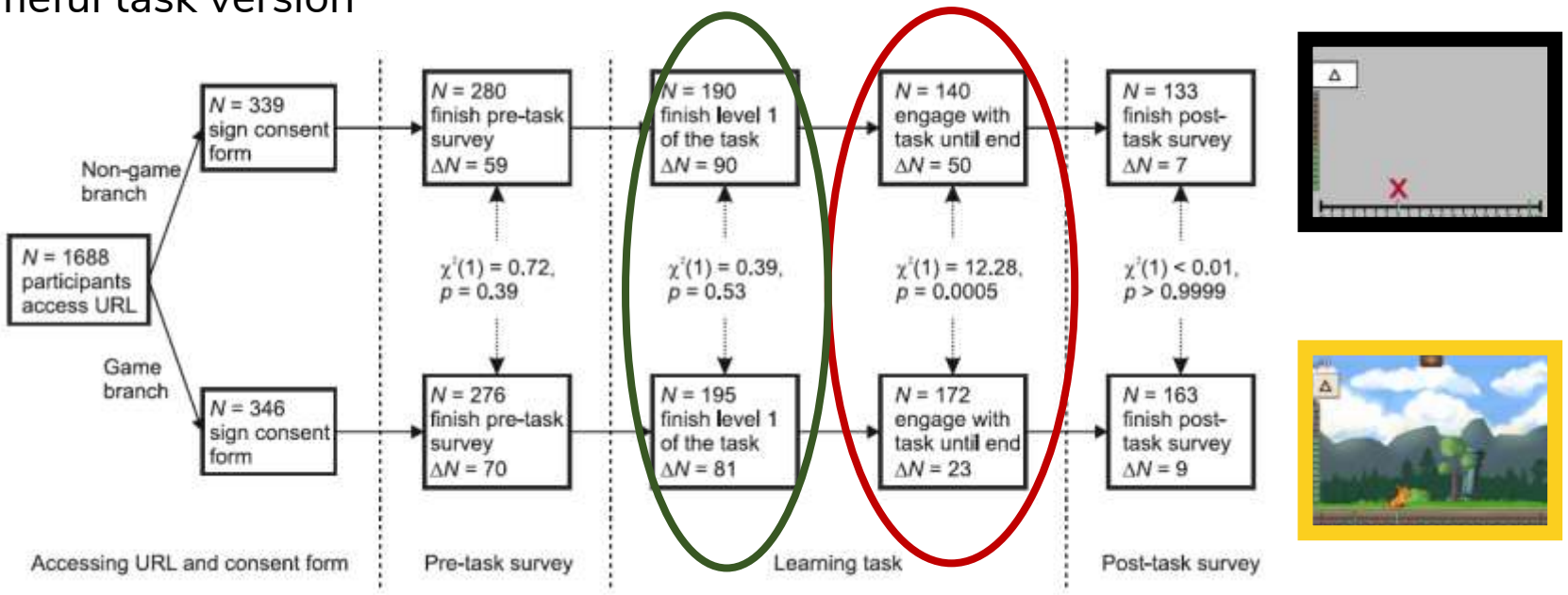
Online study 1

(Huber et al., 2023, https://doi.org/10.1016/j.chb.2023.107948)

- Little incentive: Raffle of 5 times 10 EUR
- 1688 people accessing landing page
- 385 commencing with task
- 312 finishing the task
  - 50 dropping out in less gameful task version
  - 23 in more gameful task version

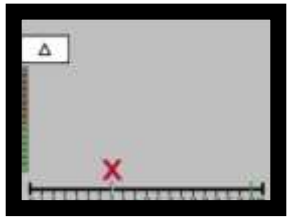


Attrition

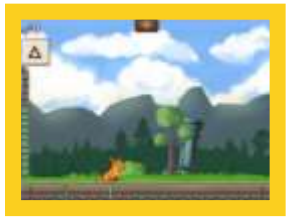


Online study 1

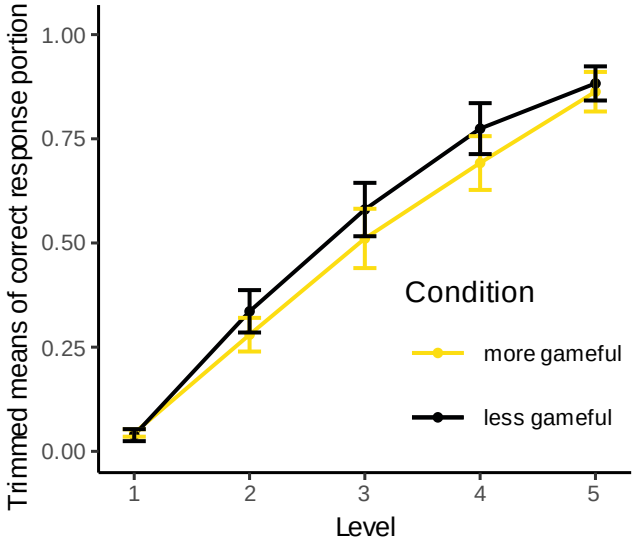
(Huber et al., 2023, https://doi.org/10.1016/j.chb.2023.107948)

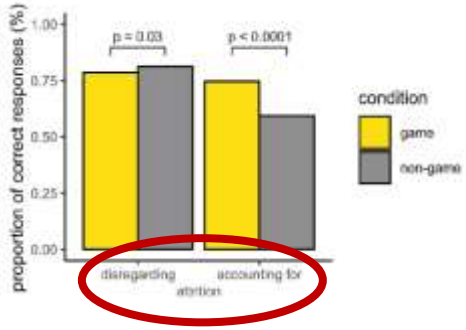


vs. (online)



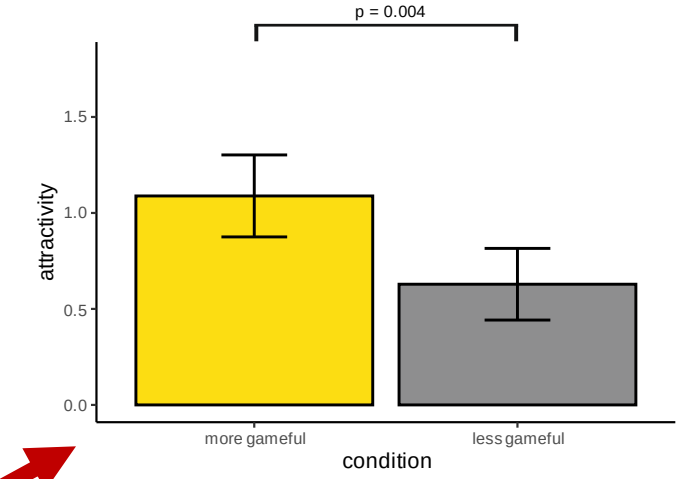
- What about cognitive and motivational outcomes?
- **Cognitive** outcomes:





- **Motivational** outcomes:
  - Task attractivity: $\delta = 0.37$, $p = .004$
  - Stimulation: $\delta = 0.16$, $p = .218$

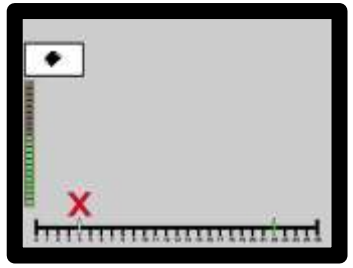
UEQ (Laugwitz et al., 2000, https://doi.org/10.1007/978-3-540-89350-9_6)



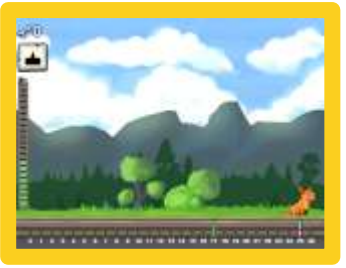
Underestimation due to attrition!

Online study 2

(Huber et al., 2024, https://doi.org/10.1007/978-3-031-49065-1_23)



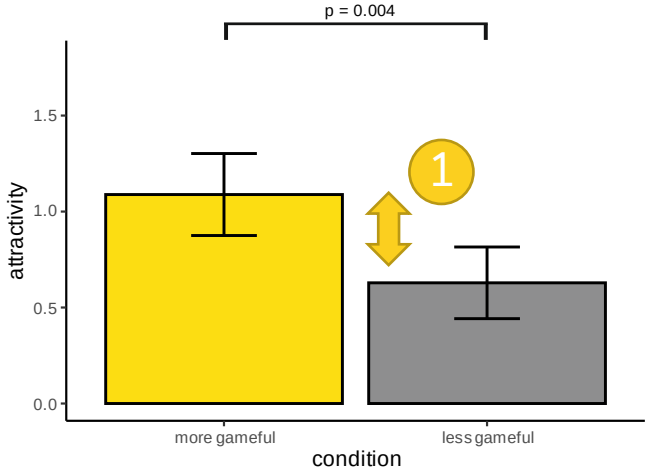
vs. (online)

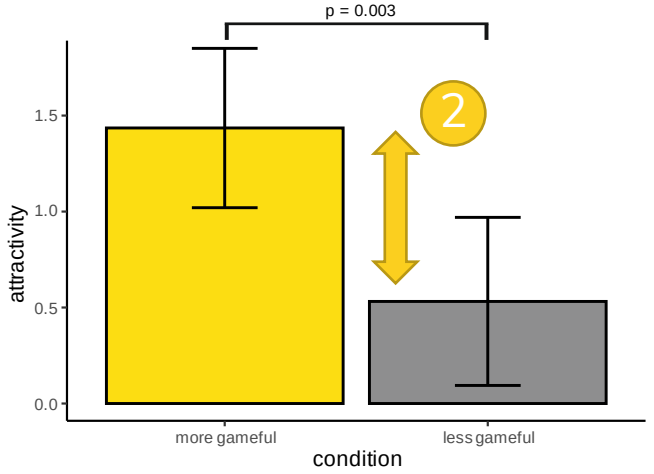


- **Avoiding attrition by changing incentive**:
  - 61 participants, mostly students, taking part for course credit

- Online study 1:
  - Task attractivity: **δ = 0.37**, *p* = .004
  - Stimulation: **δ = 0.16**, *p* = .218

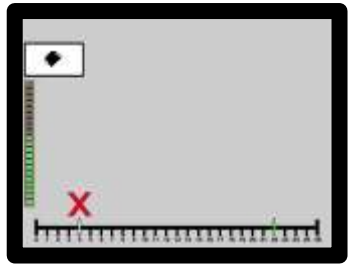
- **Online study 2**:
  - Task attractivity: **δ = 0.82**, *p* = .003
  - Stimulation: **δ = 0.87**, *p* = .002



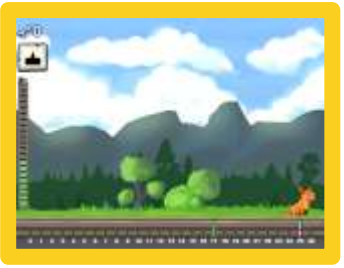


Online study 2

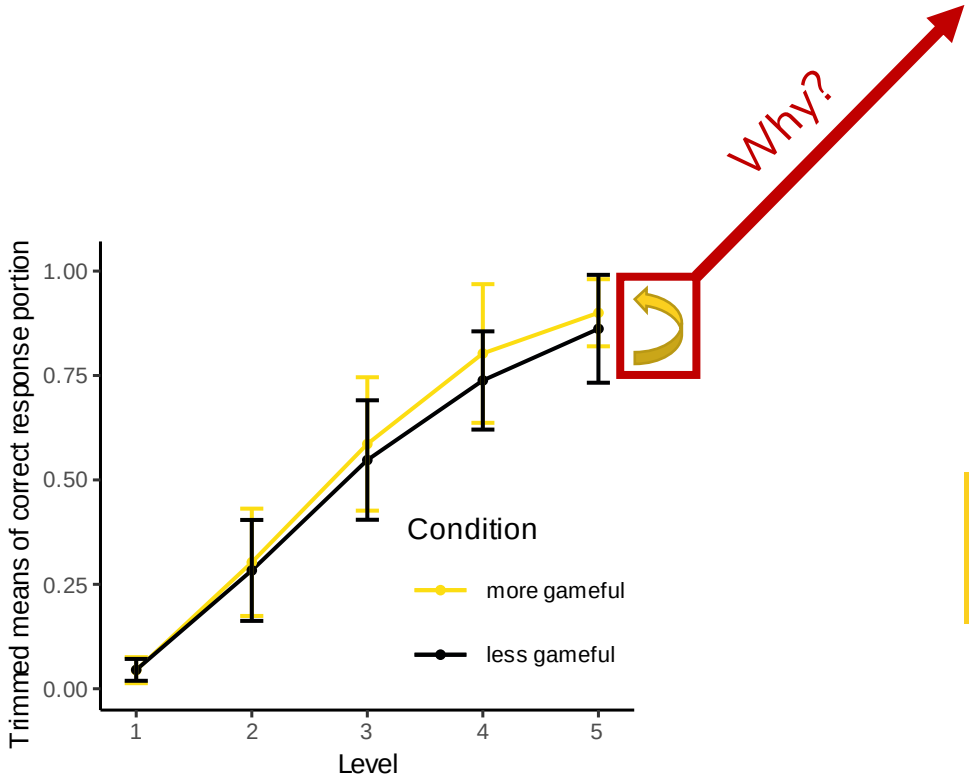
(Huber et al., 2024, https://doi.org/10.1007/978-3-031-49065-1_23)



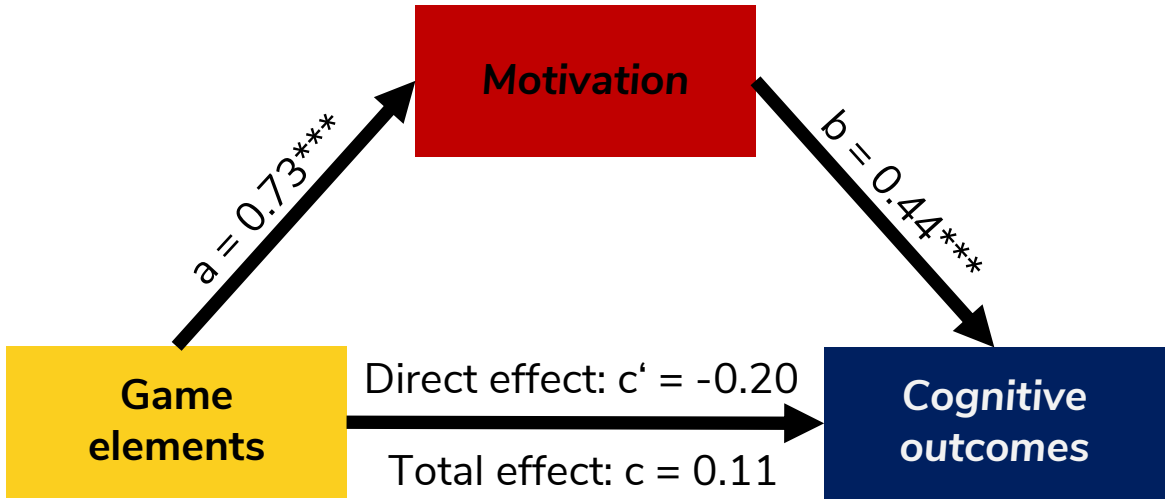
vs. (online)



- **Cognitive** outcomes:



- **Motivation partially mediates cognitive effect of game elements:**

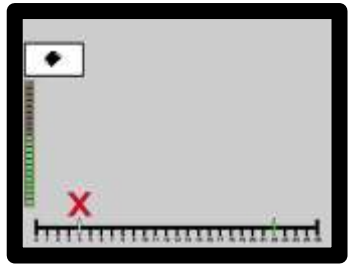


Indirect effect: ab = 0.45*** [0.15, 0.85]

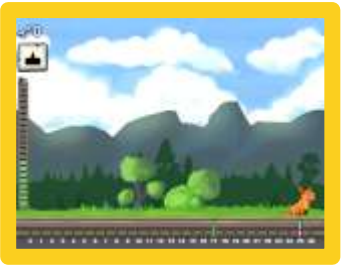
*** $p < .001$

Lab study

(Huber et al., 2024, unpublished)



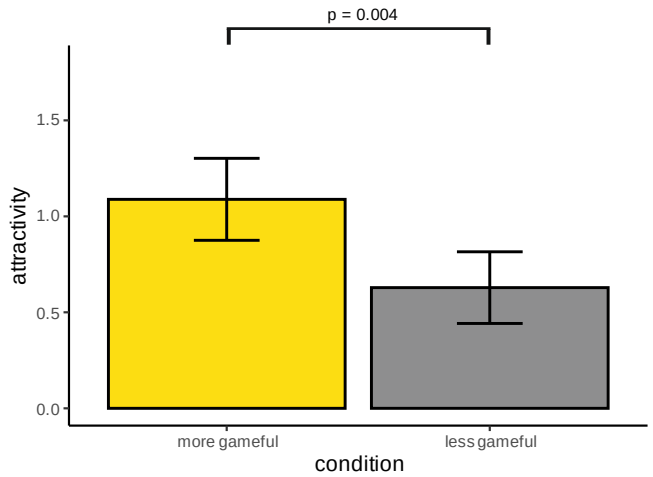
vs. (lab)



- 121 participants, mostly students taking part for course credit, but this time in the lab
- **Motivational** outcomes:

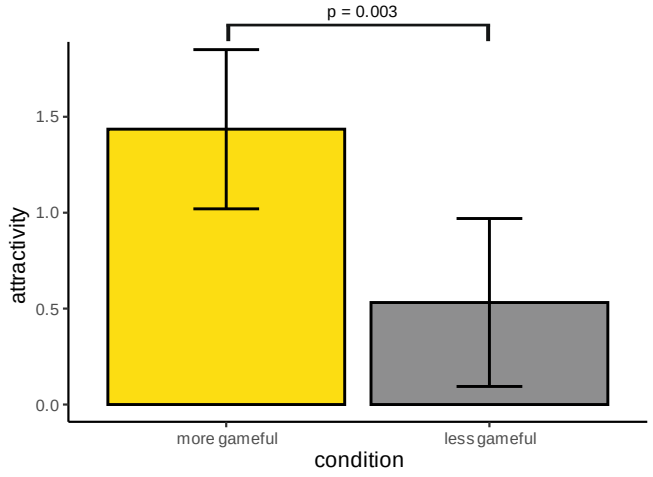
Online study 1 → Online study 2 → **Lab study**

Diff. in motivation: $\delta \approx 0.37$ [0.13, 0.57]



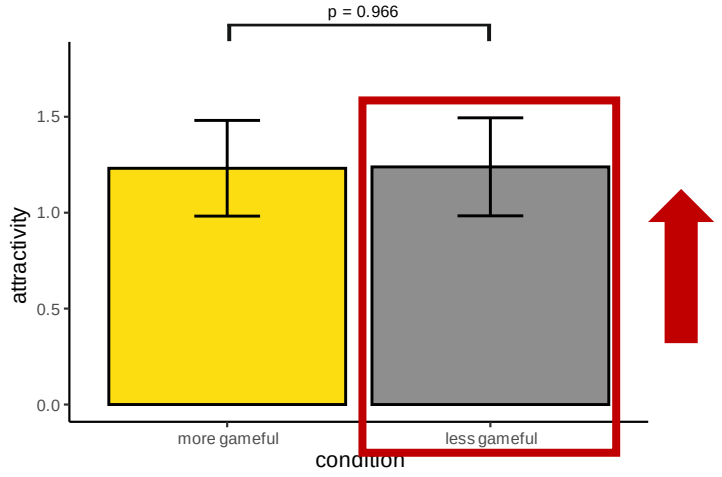
$d \approx 0.31$ [0.08, 0.54]
$B_{21} = 3.88$
$P(H_1|D) = 0.205$

Diff. in motivation: $\delta \approx 0.82$ [0.31, 1.30]



$d \approx 0.78$ [0.26, 1.44]
$B_{21} = 15.62$
$P(H_1|D) = 0.060$

Diff. in motivation: **$\delta \approx -0.01$ [-0.41, 0.37]**



$d \approx 0.01$ [-0.37, 0.35]
$B_{12} = 12.93$
$P(H_2|D) = 0.072$

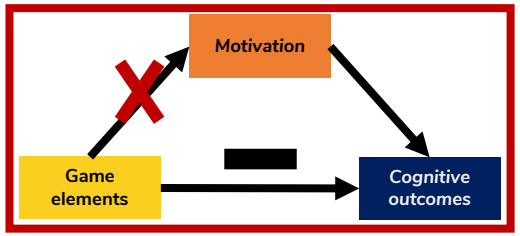
H_1: $\mu_{mg} = \mu_{lg}$, H_2: $\mu_{mg} > \mu_{lg}$

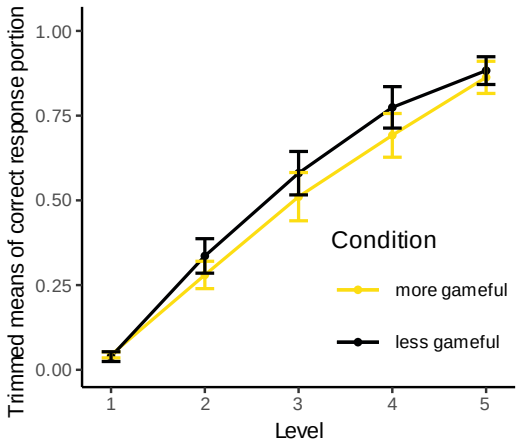
Lab study

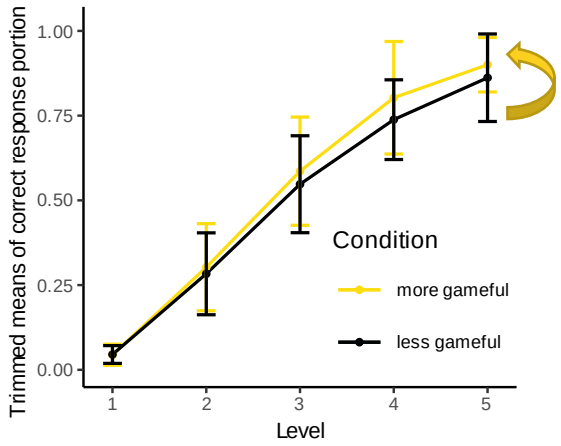
(Huber et al., 2024, unpublished)

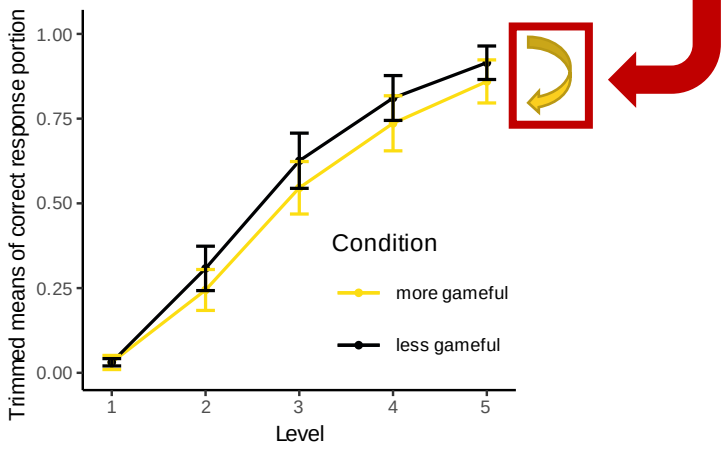
- **Cognitive** outcomes:

Online study 1 → Online study 2 → **Lab study**









Conclusions

- **Context matters. Maybe a lot.**

- If your goal is **research** about the effect of game elements:
  - Game elements can have various effects interacting with each other.
  - Effects of game elements can differ between lab, online, classroom(?), homework(?) settings.

- If your goal is learning or **education**:
  - Devise your learning activity as an intrinsically appealing activity.
  - For how appealing a learning activity appears overall, again, context matters. Possibly a lot.

Thank you!

https://digilab.uni-graz.at/en/

Looking for a PhD student!!!

- well-being

- games

- sustainability

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Questions?

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