

Object-Centric Debugging

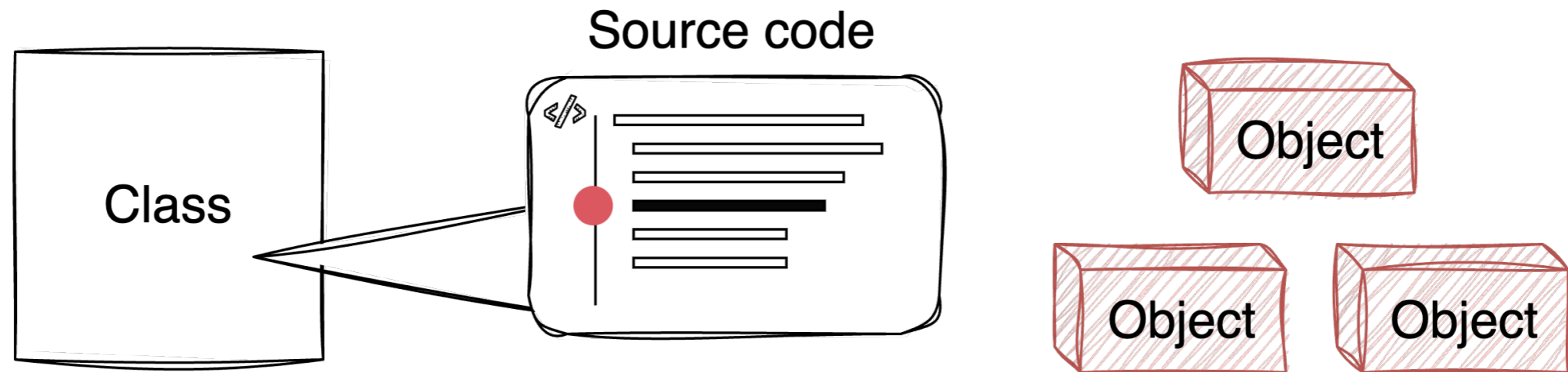
Empirical experiment - preliminary results

Valentin Bourcier, Steven Costiou, Pooja Rani, Alberto Bacchelli

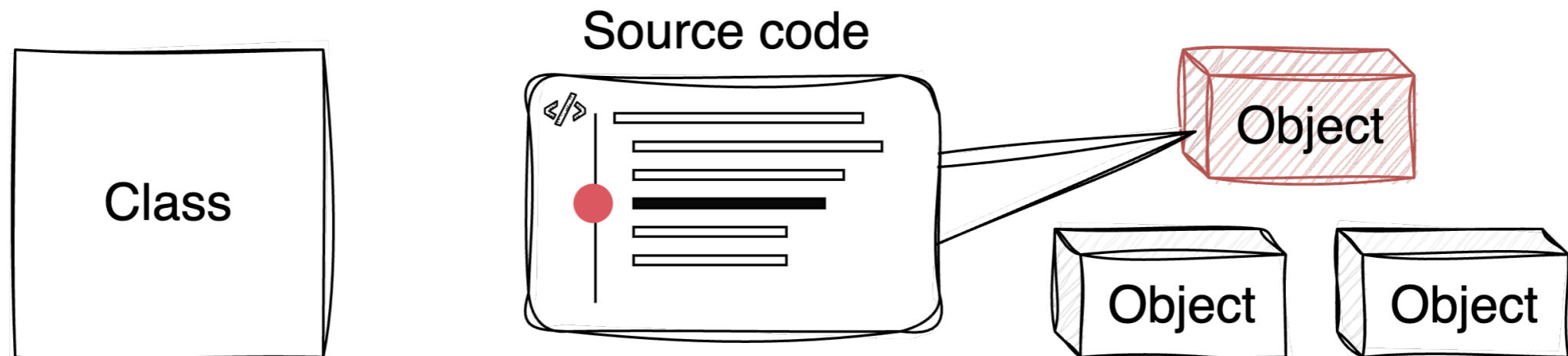
ESUG - 11 July 2024

What is object-centric debugging?

Traditional breakpoint

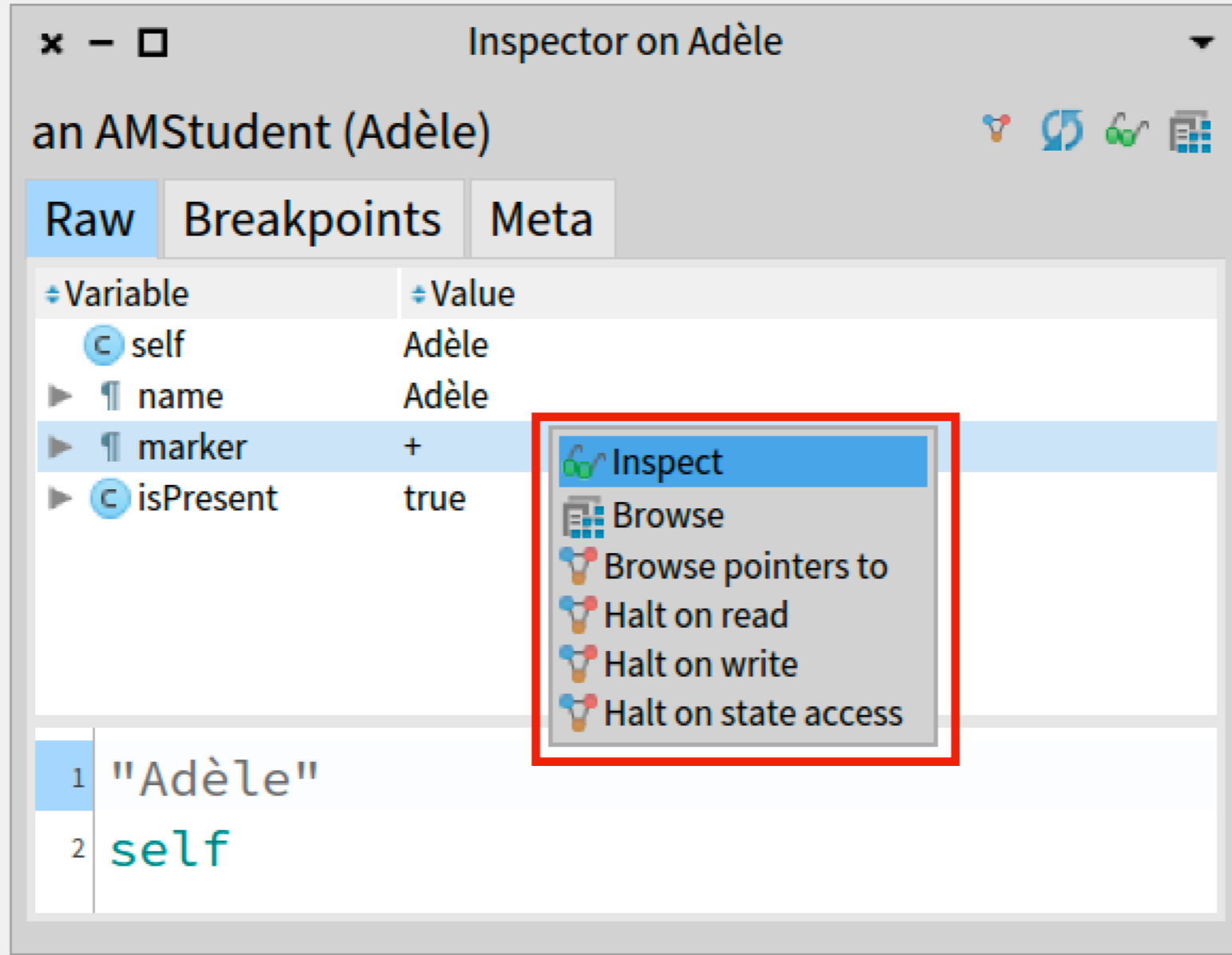


Object-centric breakpoint



What is object-centric debugging?

Object-centric breakpoints in Pharo



The screenshot shows the Pharo Inspector window titled "Inspector on Adèle". The object being inspected is "an AMStudent (Adèle)". The "Raw" tab is selected, displaying a list of variables and their values:

Variable	Value
self	Adèle
name	Adèle
marker	+
isPresent	true

A context menu is open over the "marker" property, listing several debugging actions:

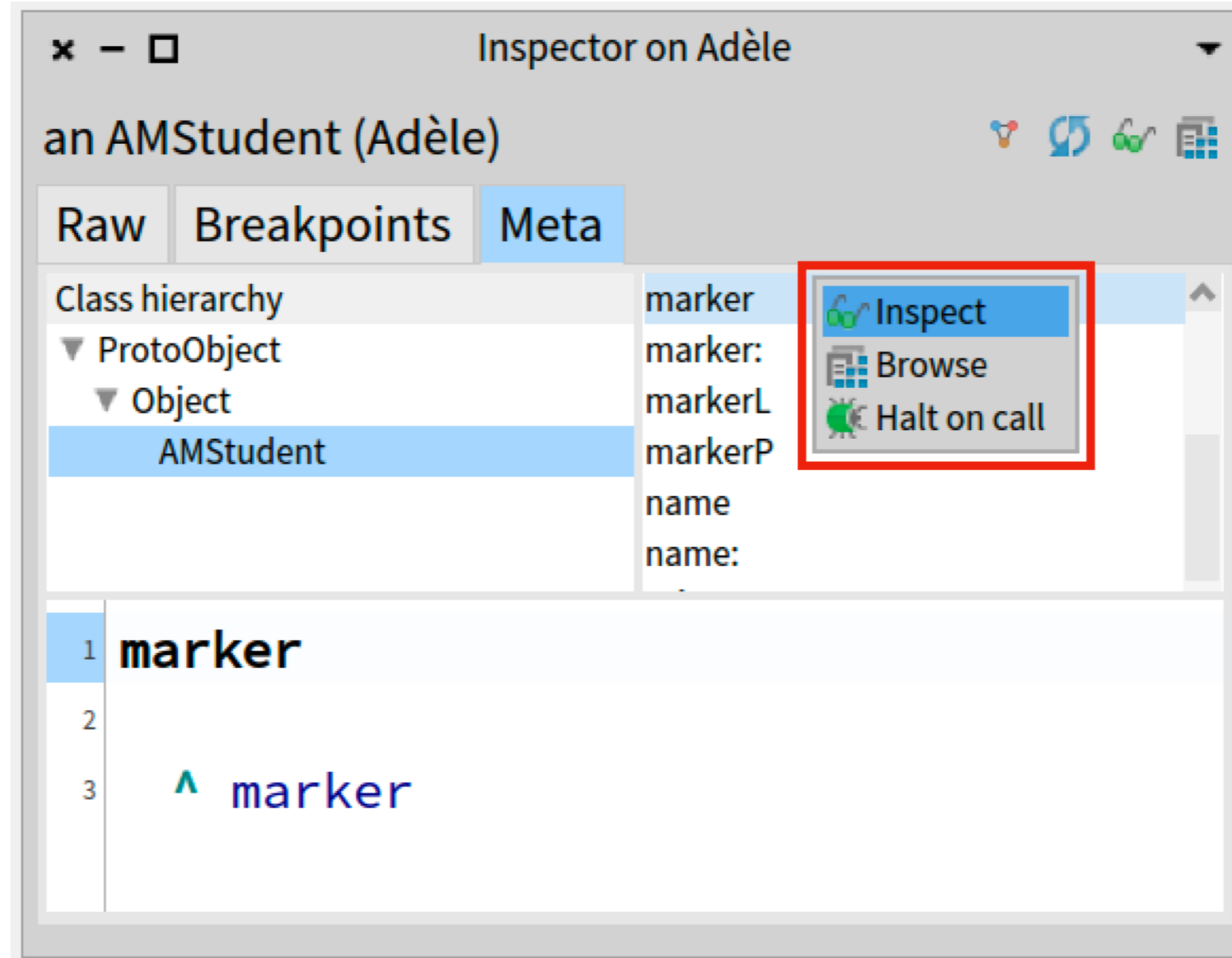
- Inspect
- Browse
- Browse pointers to
- Halt on read
- Halt on write
- Halt on state access

At the bottom of the inspector, the following code is visible:

```
1 "Adèle"  
2 self
```

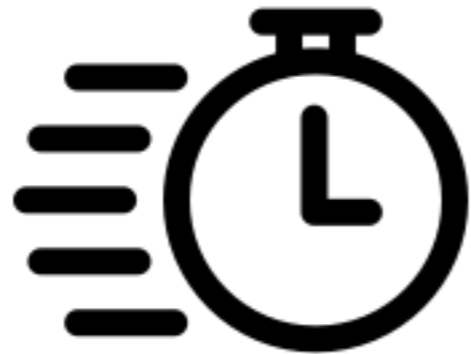
What is object-centric debugging?

Object-centric breakpoints in Pharo



Object-centric debugging

The hypotheses



- **Faster** debugging
- **Fewer** actions

Ressia. *Object-centric debugging*

- ✓ Insights, examples
- ✗ Empirical evaluations

Empirical evaluation: object-centric debugging

The design



Ammolite



Lights Out

Empirical evaluation: object-centric debugging

The design



Ammolite



Lights Out

Ammolite Magenta

Class	Number of students	Student	Level
OCRE xp	35	<input checked="" type="checkbox"/> Henri	+
		<input checked="" type="checkbox"/> Jules	-
		<input checked="" type="checkbox"/> Dorothée	
		<input checked="" type="checkbox"/> Alexandria	
		<input checked="" type="checkbox"/> Jacques	
		<input checked="" type="checkbox"/> Adèle	+
		<input checked="" type="checkbox"/> Catherine	

Groups: [1] Adèle + Alex + Alix + Guy - [2] Frédérique Henri + Jules - Thibault - [3] Adèle + Alex + Margaud - Nath - [4] Adèle Charles - Charles-Thibault + Élisabeth + [5] Constance + Danielle Julie Marguerite [6] Jean + Raymond-Tristan William - [7] Diane Thomas + Victoire - [8] Alexandria Isaac-Guillaume + Jacques [9] Inès-Hélène Margot + Valérie [10] Catherine Dorothée Philippine

A 10x10 grid of lights. Yellow lights are located at (row, column): (1,1), (1,2), (1,10), (2,10), (3,10), (4,5), (4,6), (4,7), (5,5), (5,6), (5,7), (6,5), (6,6), (6,7), (7,5), (7,6), (7,7), (8,5), (8,6), (8,7), (9,9), (9,10), (10,9), (10,10). A red question mark is in the top right corner (1,10).

Empirical evaluation: object-centric debugging

The design



Ammolite



Lights Out

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OCRE xp	35	<input checked="" type="checkbox"/> Henri	+
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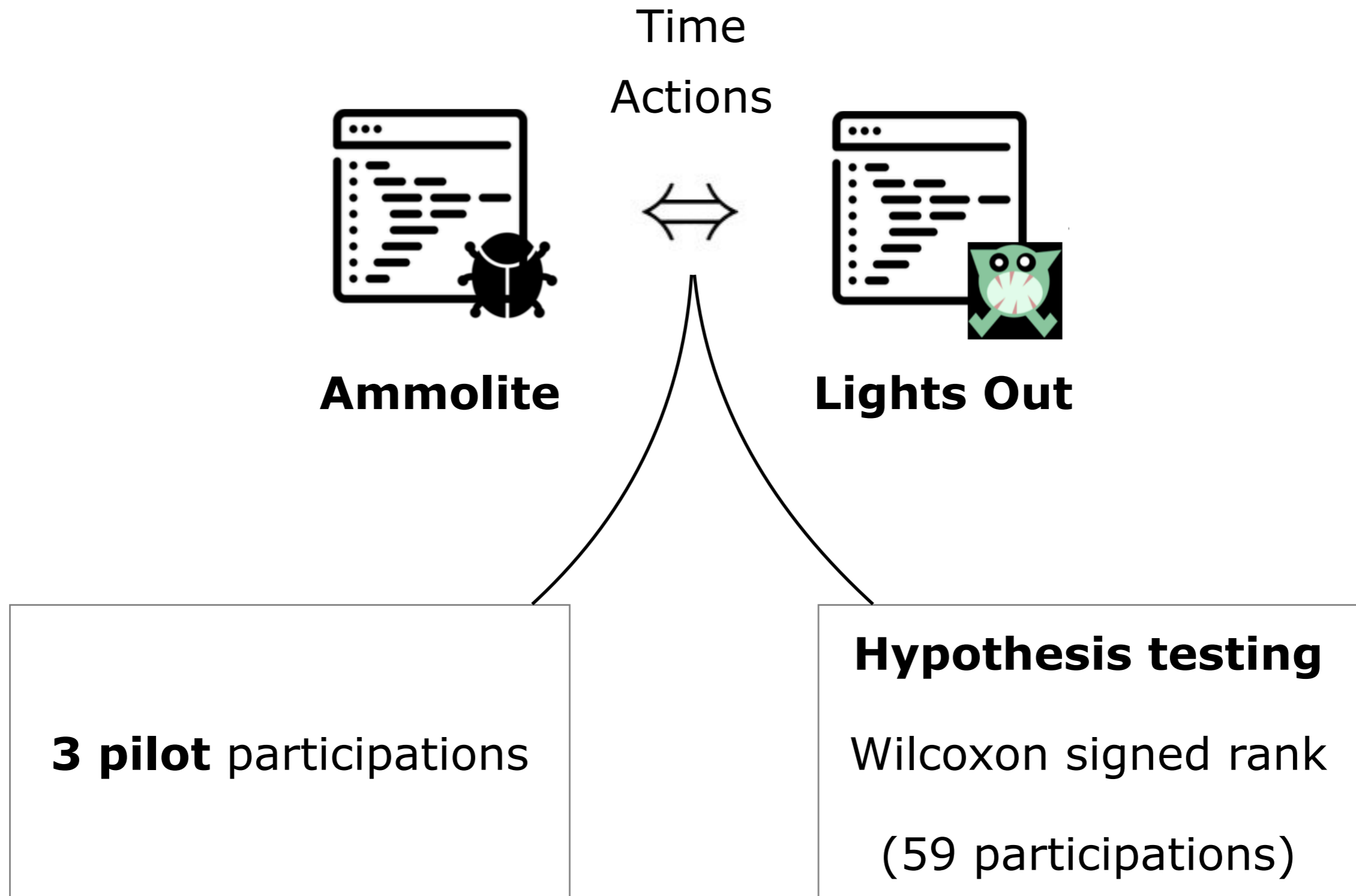
Groups

[1] Adèle + Alex + Alix + Guy -	[2] Frédérique Henri + Jules - Thibault -	[3] Adèle + Alex + Margaud - Nath -	[4] Adèle Charles - Charles-Thibault + Élisabeth +
[5] Constance + Danielle Julie Marguerite	[6] Jean + Raymond-Tristan William -	[7] Diane Thomas + Victoire -	[8] Alexandria Isaac-Guillaume + Jacques
[9] Inès-Hélène Margot + Valérie	[10] Catherine Dorothée Philippine		

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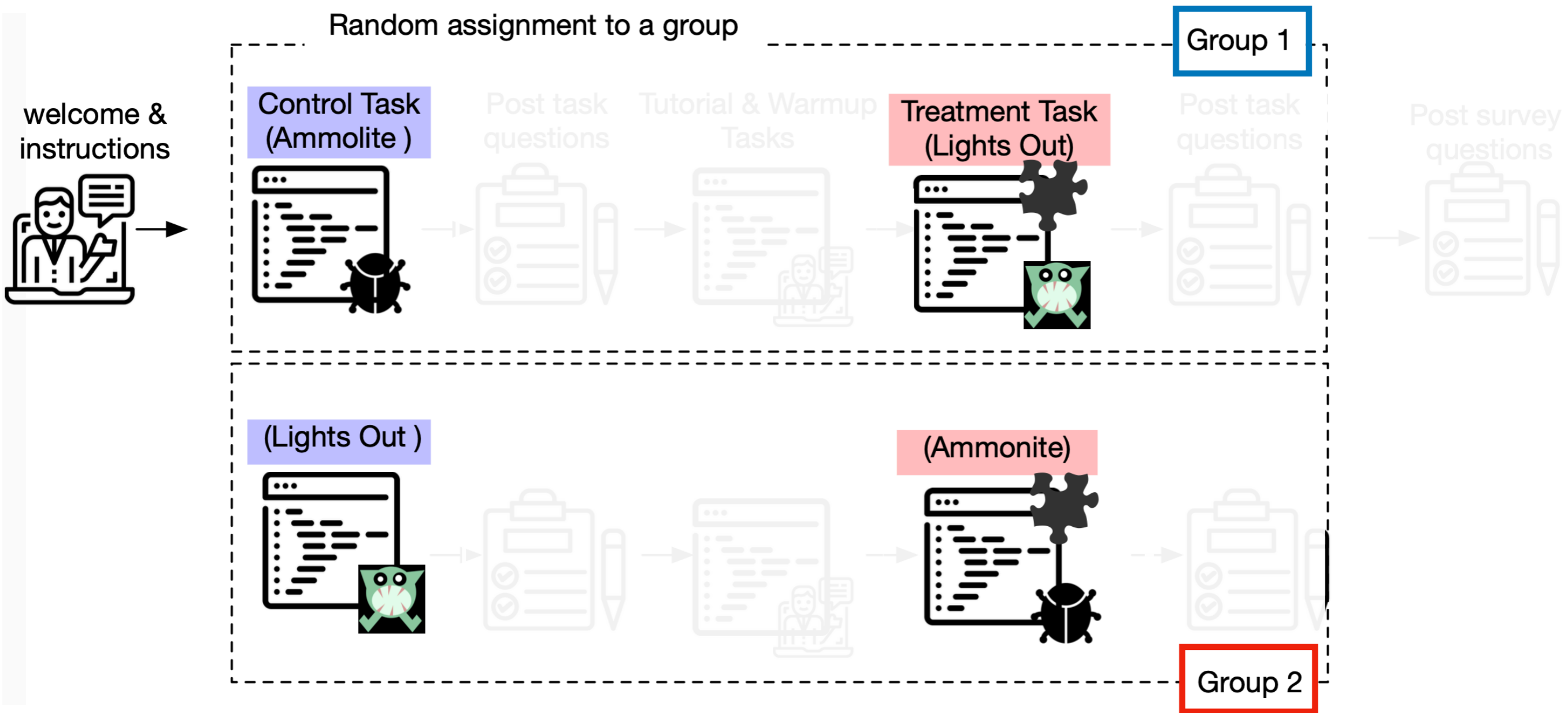
Empirical evaluation: object-centric debugging

The design



Empirical evaluation: object-centric debugging

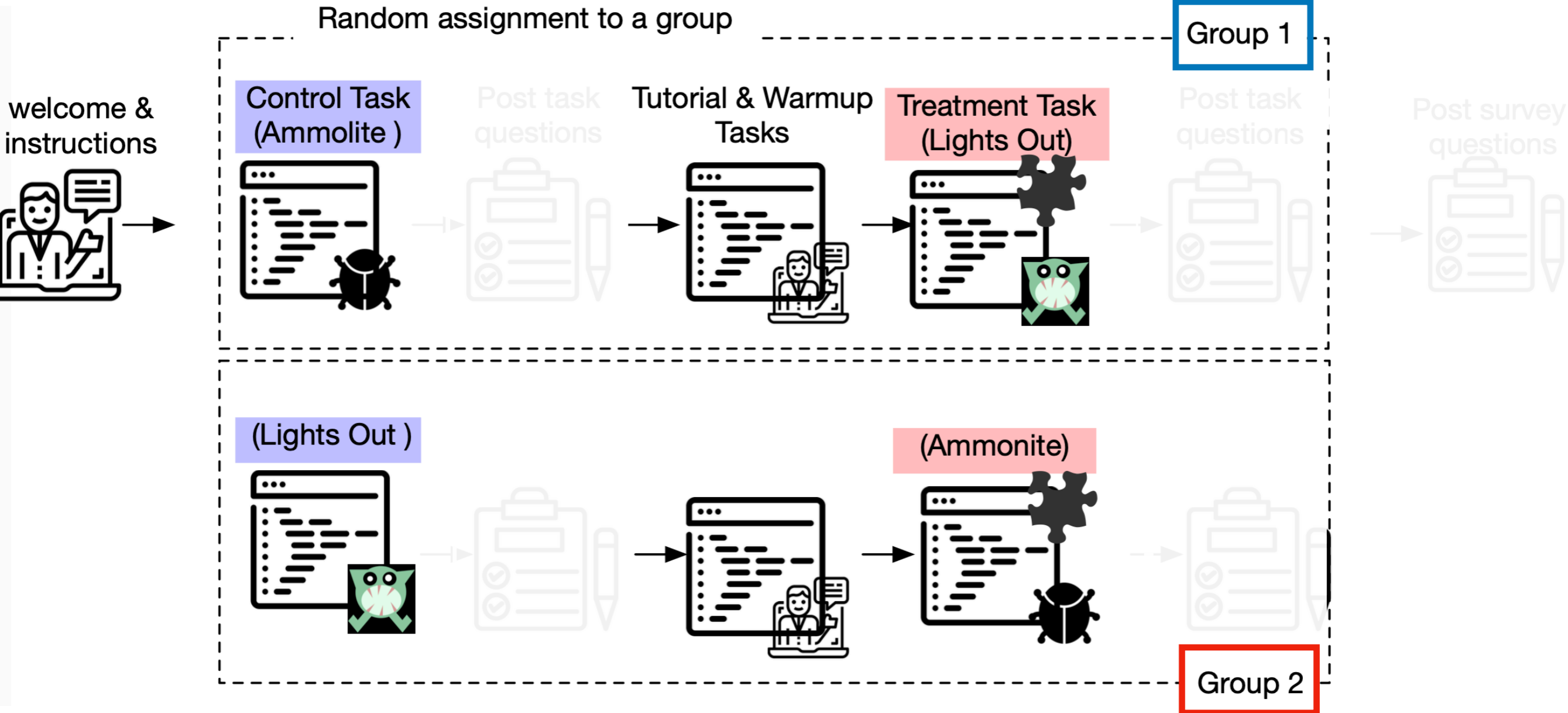
The design



 *Object-centric breakpoints*

Empirical evaluation: object-centric debugging

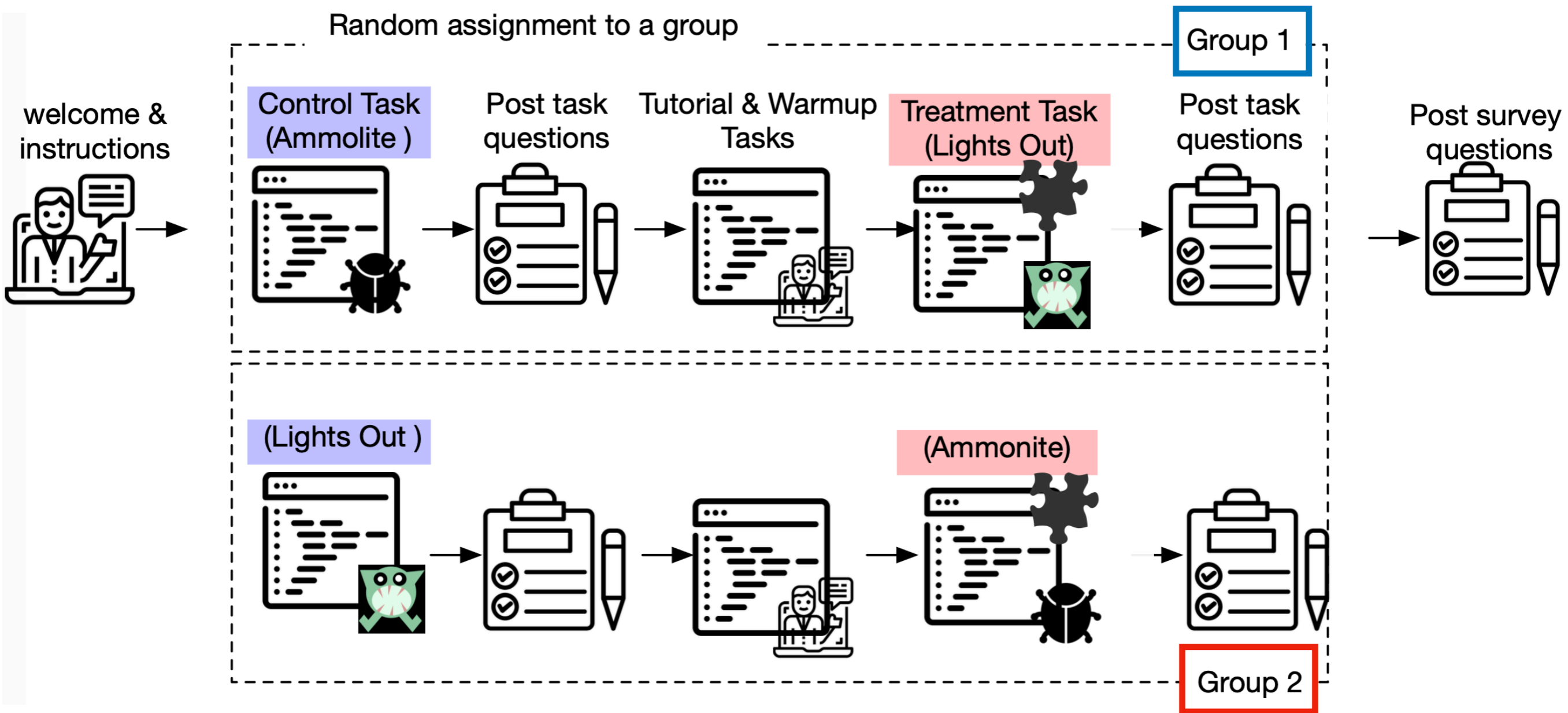
The design



 *Object-centric breakpoints*

Empirical evaluation: object-centric debugging

The design



Empirical evaluation: object-centric debugging

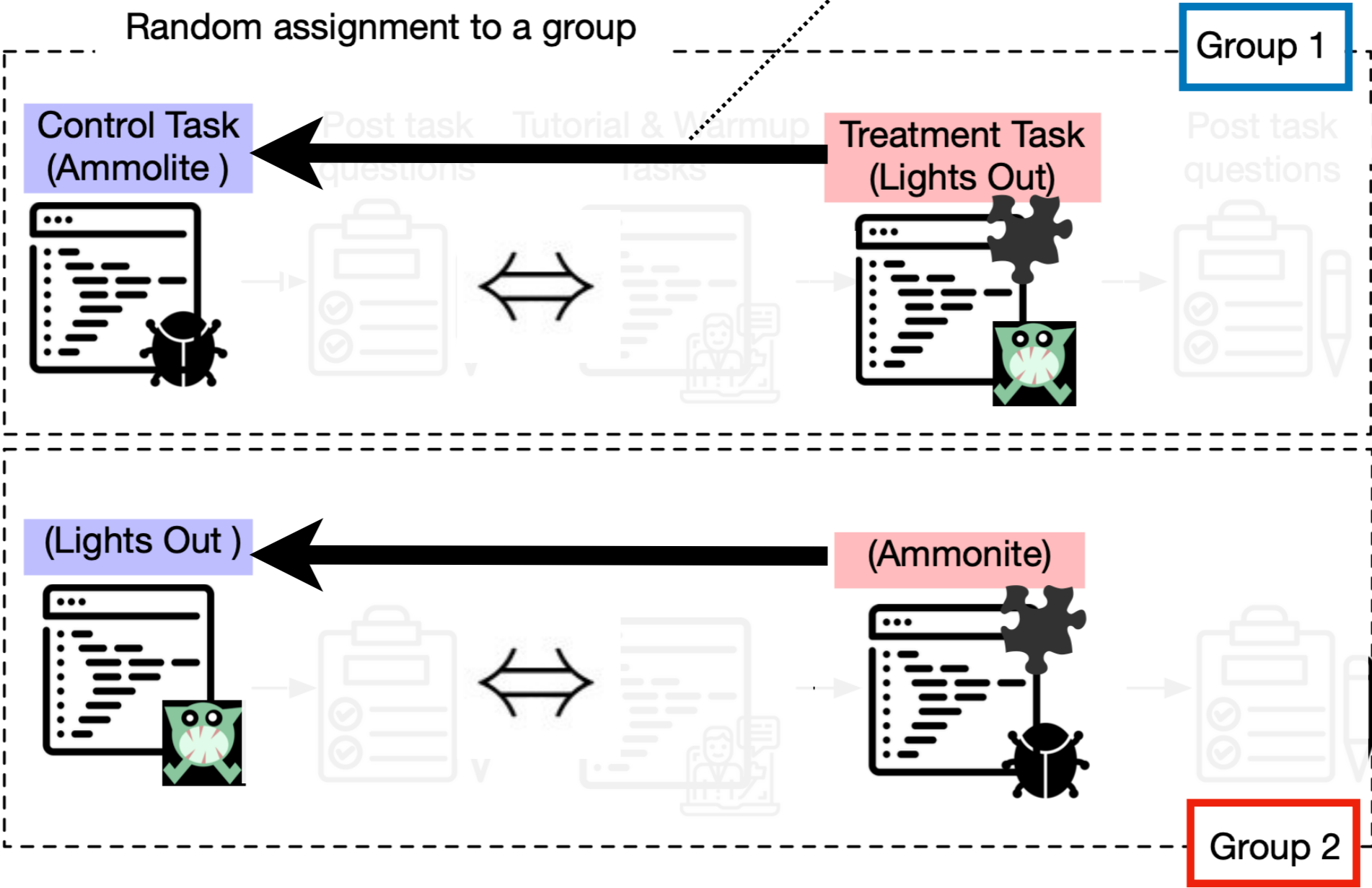
APPLAUSE!



Empirical evaluation: object-centric debugging

The design

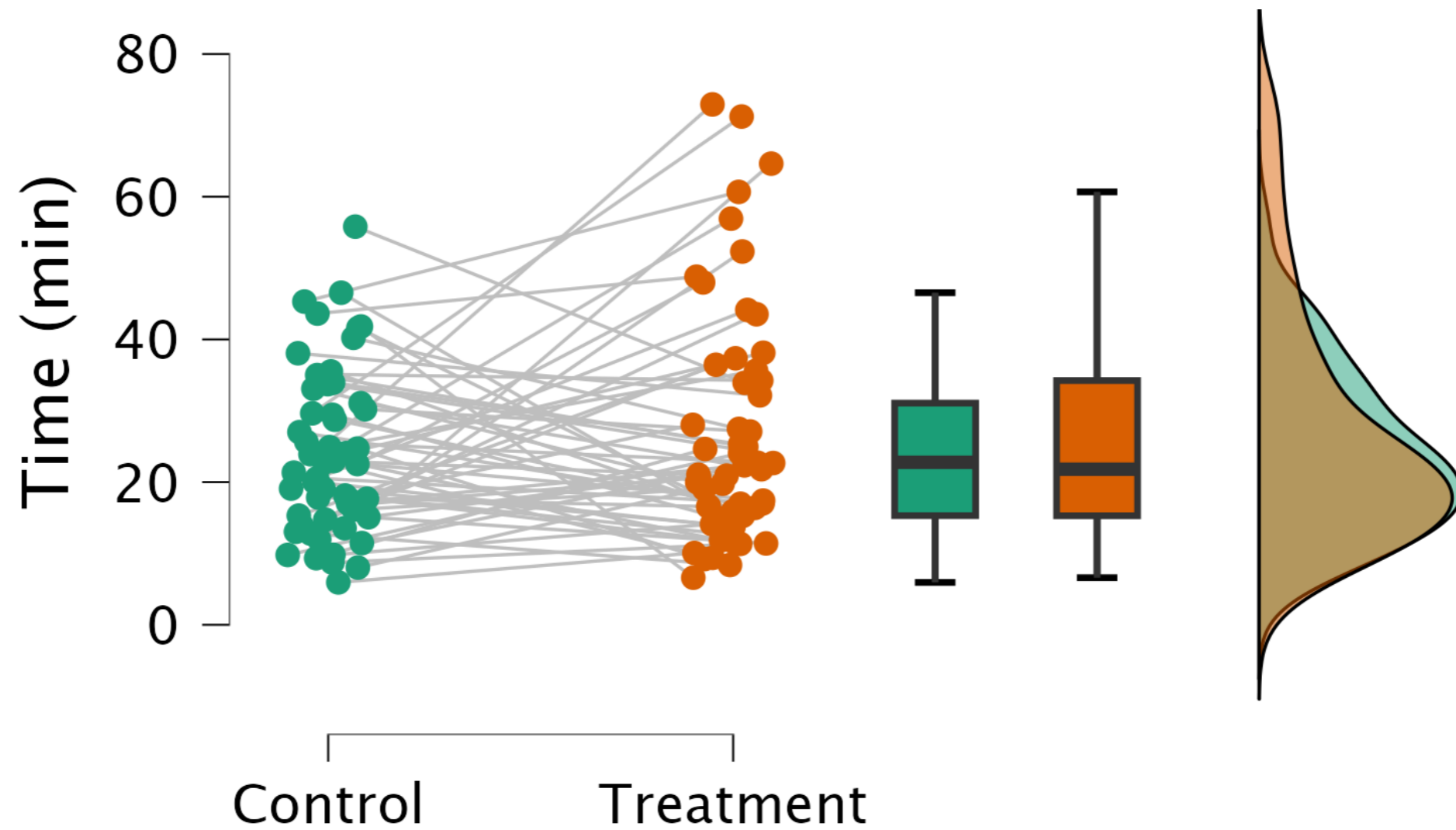
Per-participant analysis



 *Object-centric breakpoints*

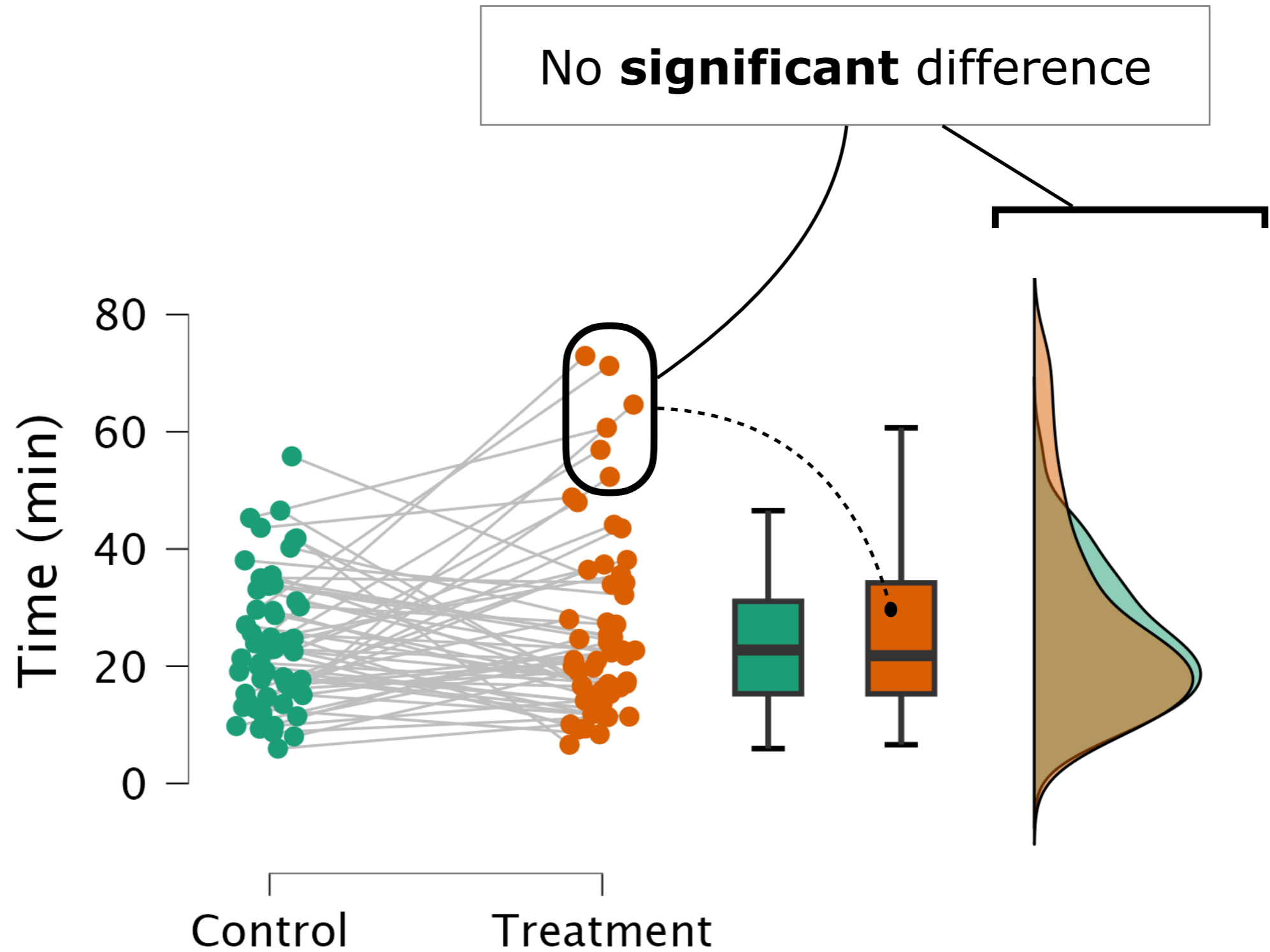
Empirical evaluation: object-centric debugging

Per-participant, N=59



Empirical evaluation: object-centric debugging

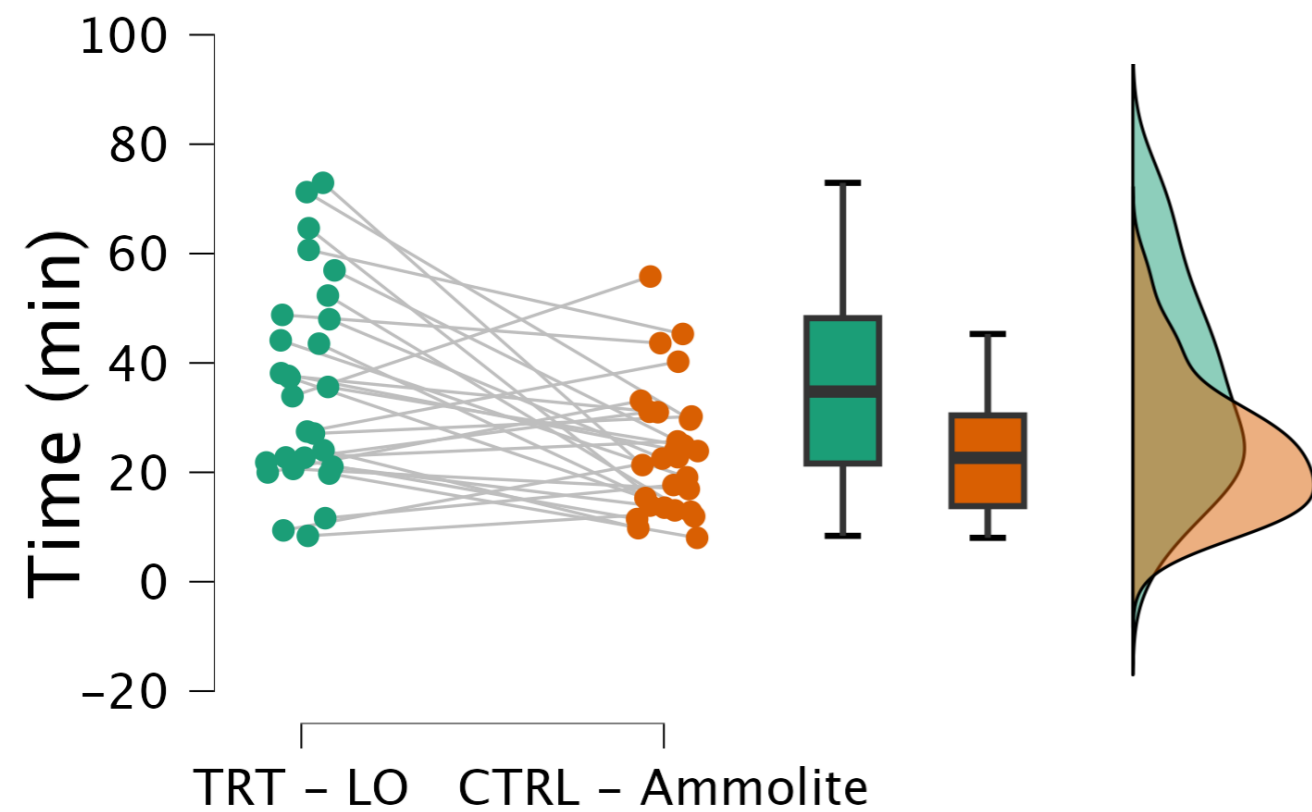
Per-participant, N=59



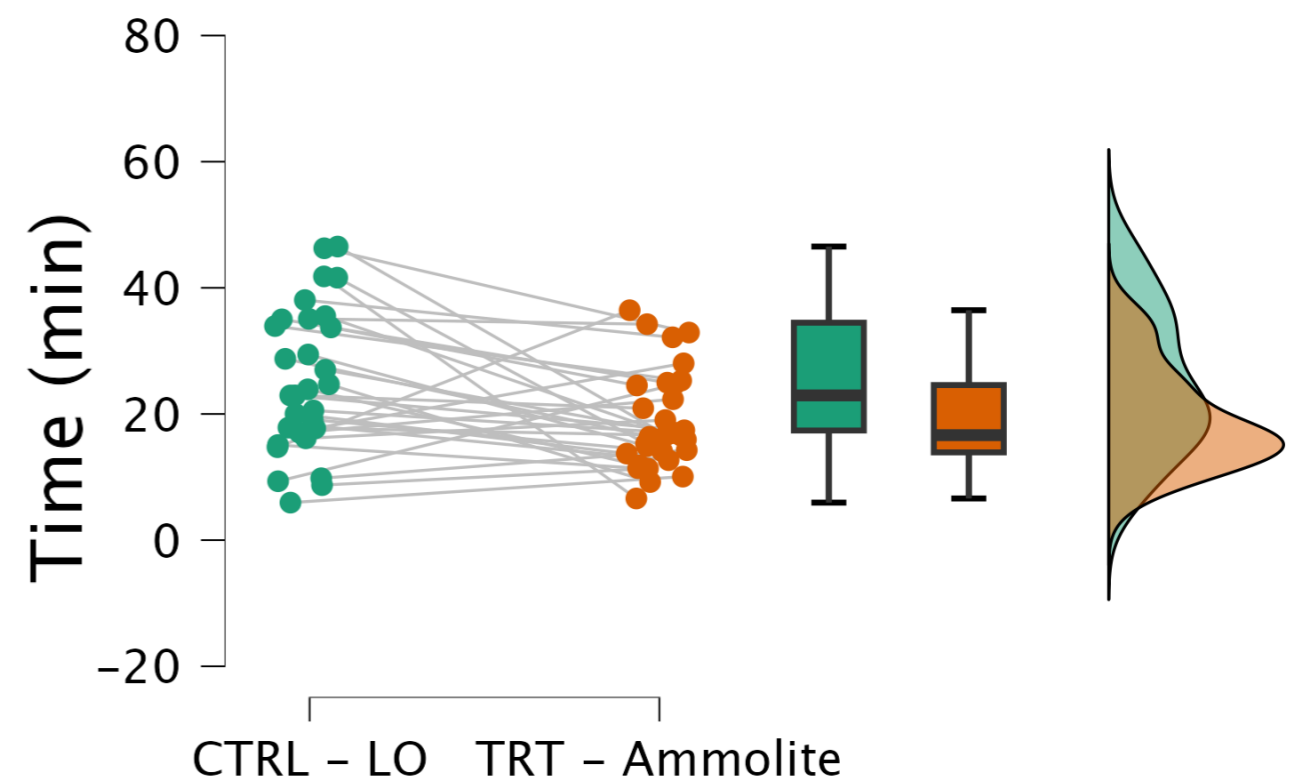
Empirical evaluation: object-centric debugging

Per-group, task-sequence analysis

GROUP 1



GROUP 2

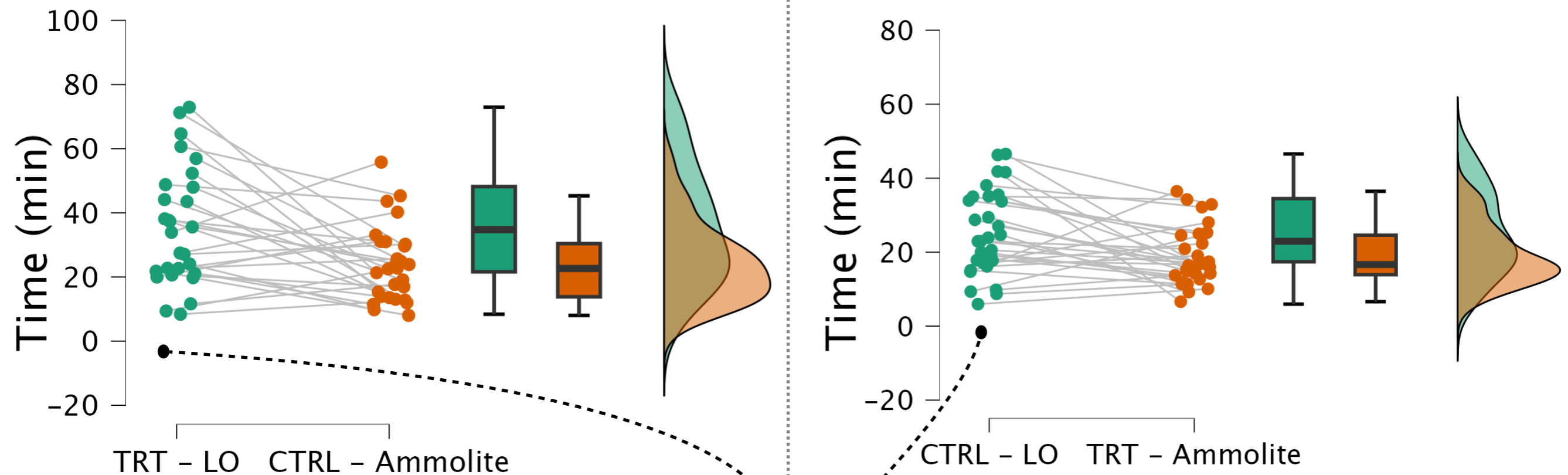


Empirical evaluation: object-centric debugging

Per-group, task-sequence analysis

GROUP 1

GROUP 2



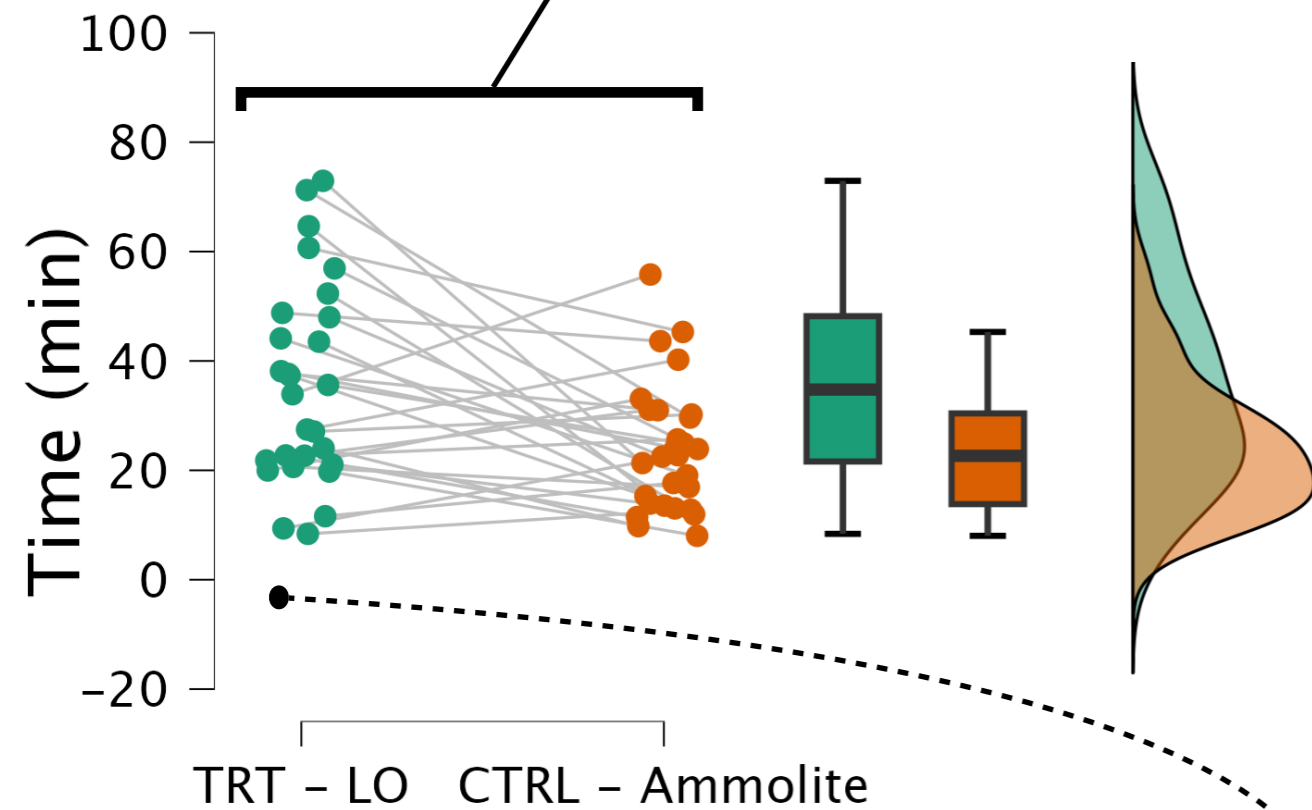
Higher values on the left side

Empirical evaluation: object-centric debugging

Per-group, task-sequence analysis

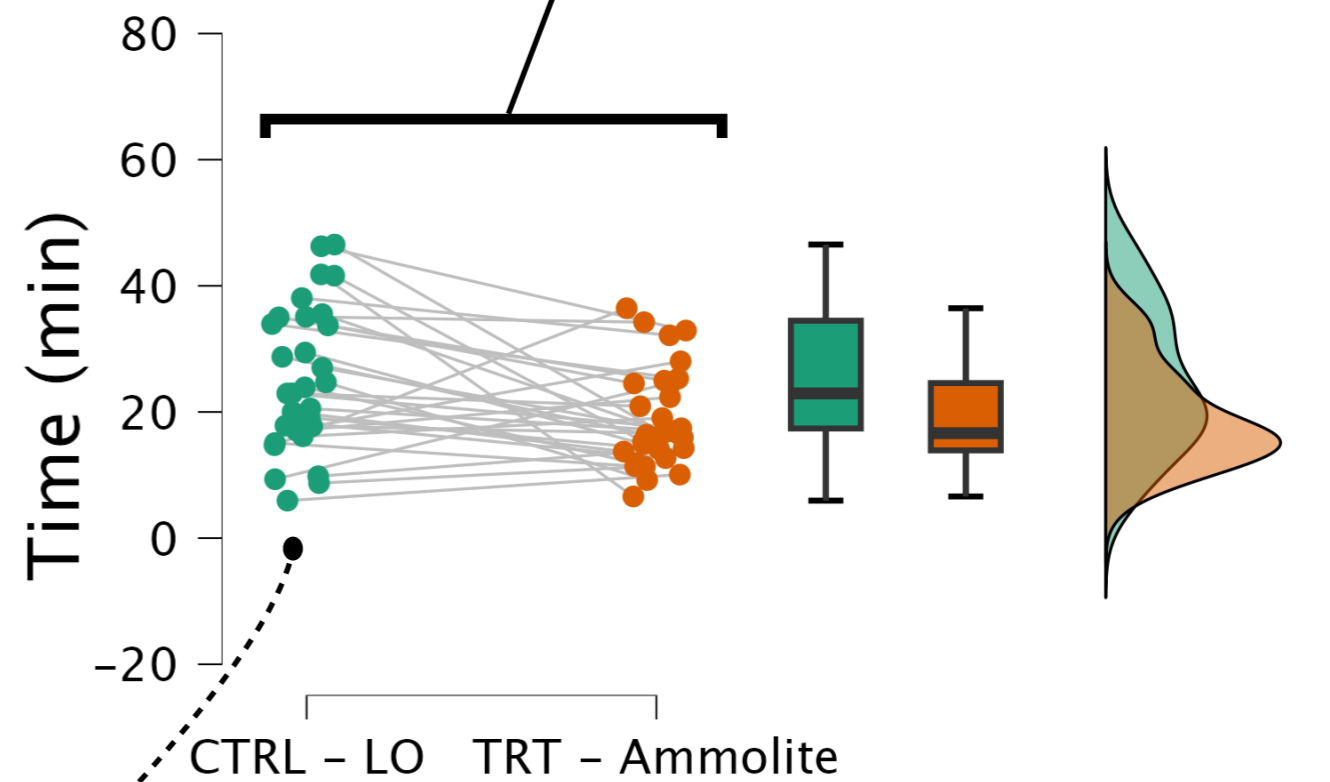
GROUP 1

Negative difference



GROUP 2

Positive difference



Higher values on the **left** side

Empirical evaluation: object-centric debugging

Per-group, task-sequence analysis

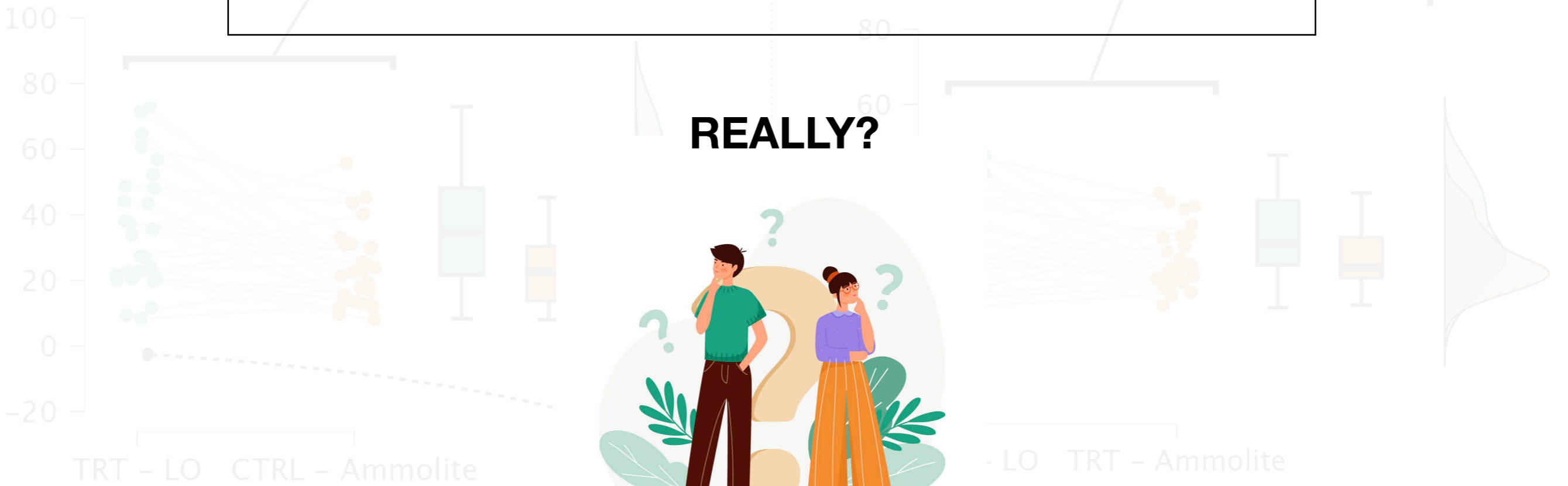
GROUP 1

GROUP 2

Negative difference

Positive difference

Object-centric debugging seems to help with Ammolite, but NOT Lights Out



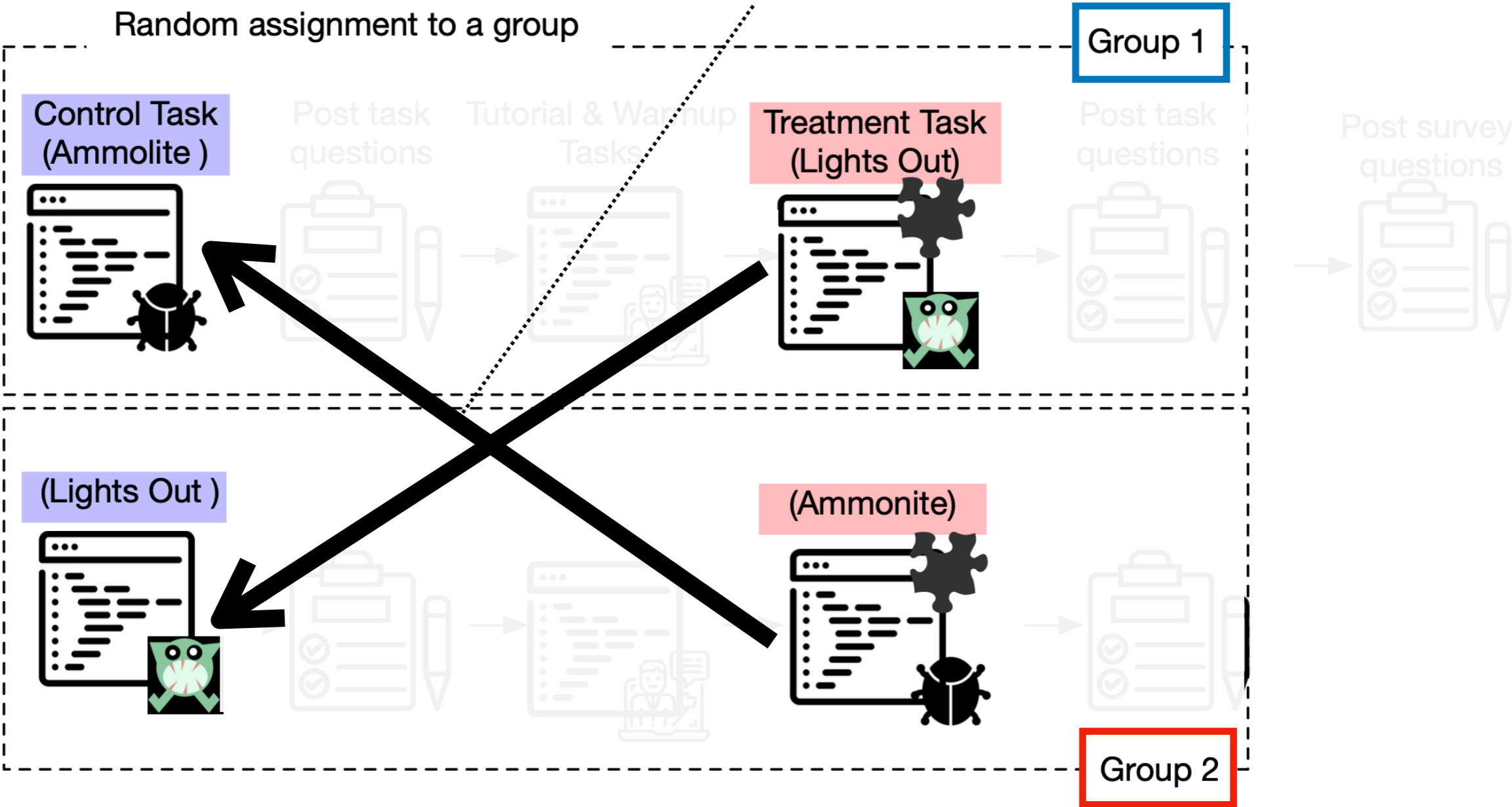
REALLY?

Higher values on the left side

Empirical evaluation: object-centric debugging

Work-in-progress

Per-task analysis

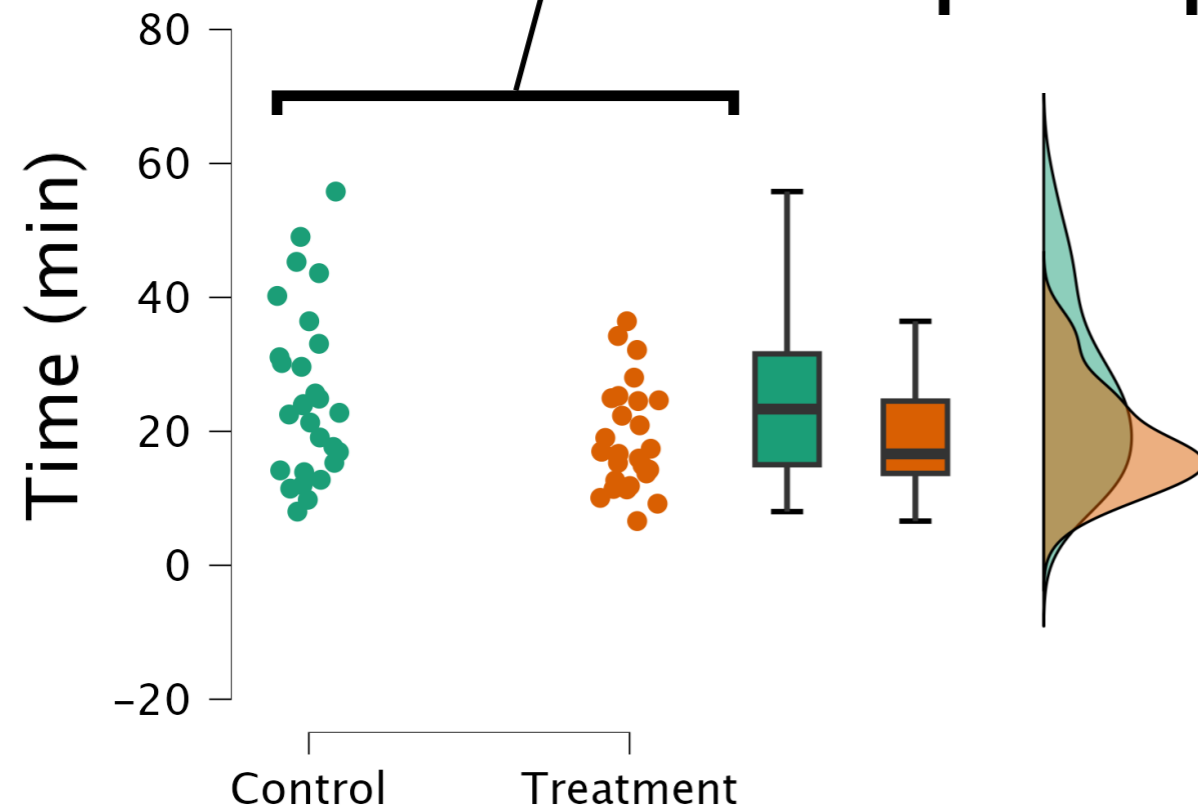


Empirical evaluation: object-centric debugging

Per-task analysis

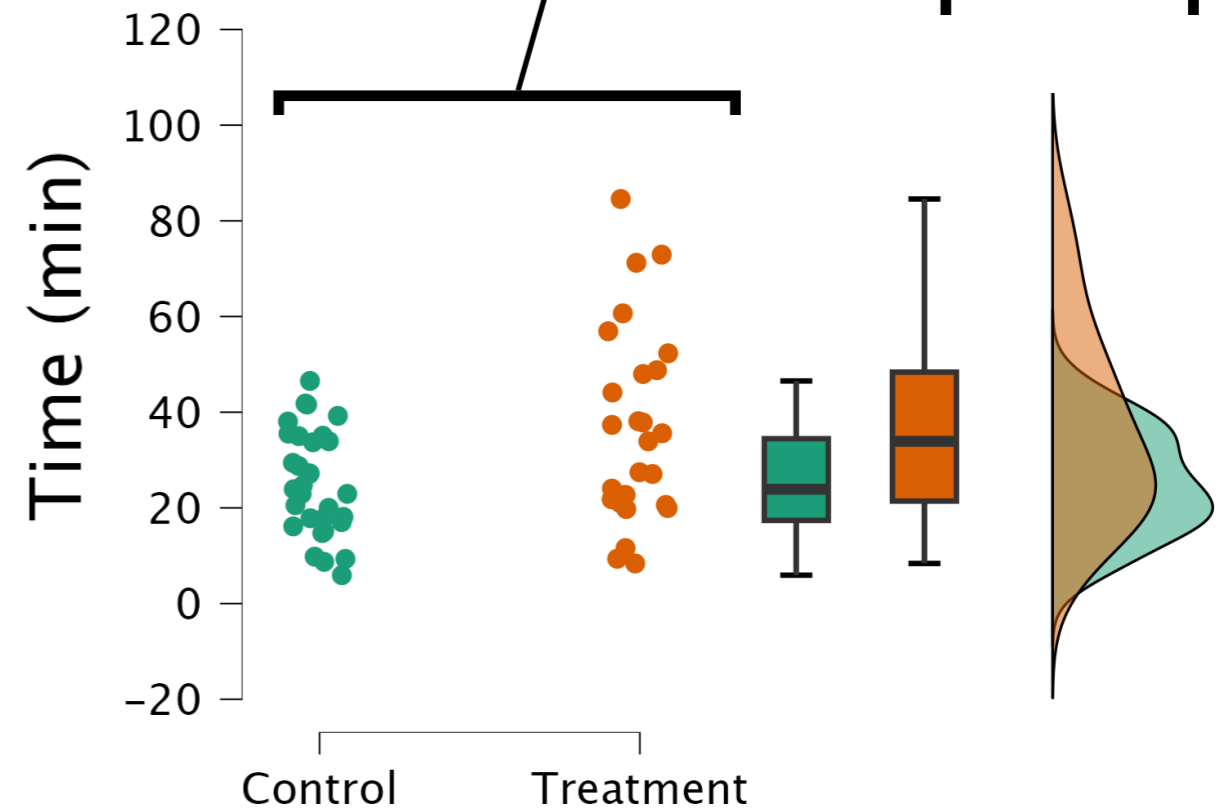
AMMOLITE

Positive difference



LIGHTS OUT

Negative difference

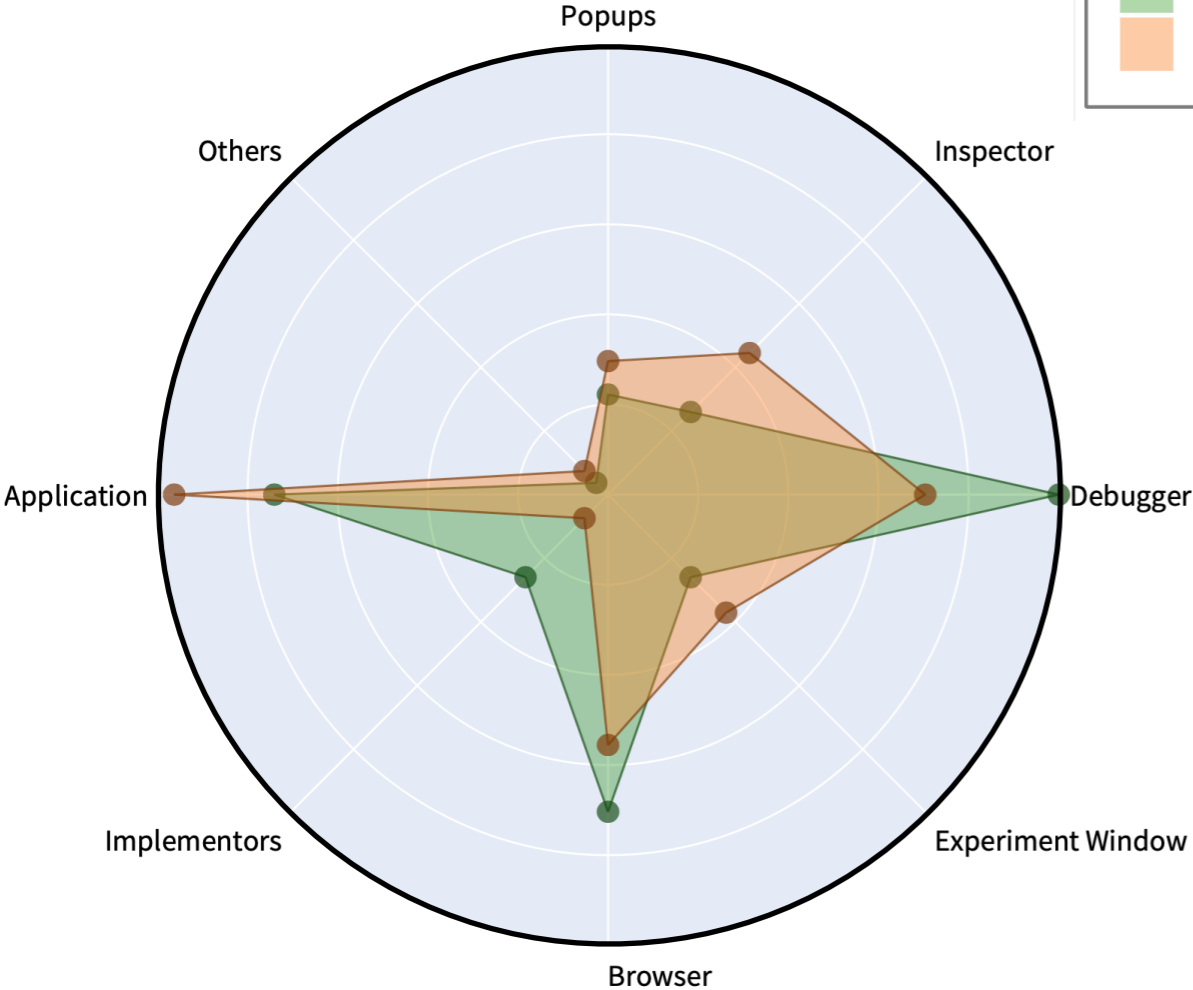


Empirical evaluation: object-centric debugging

What causes this difference?

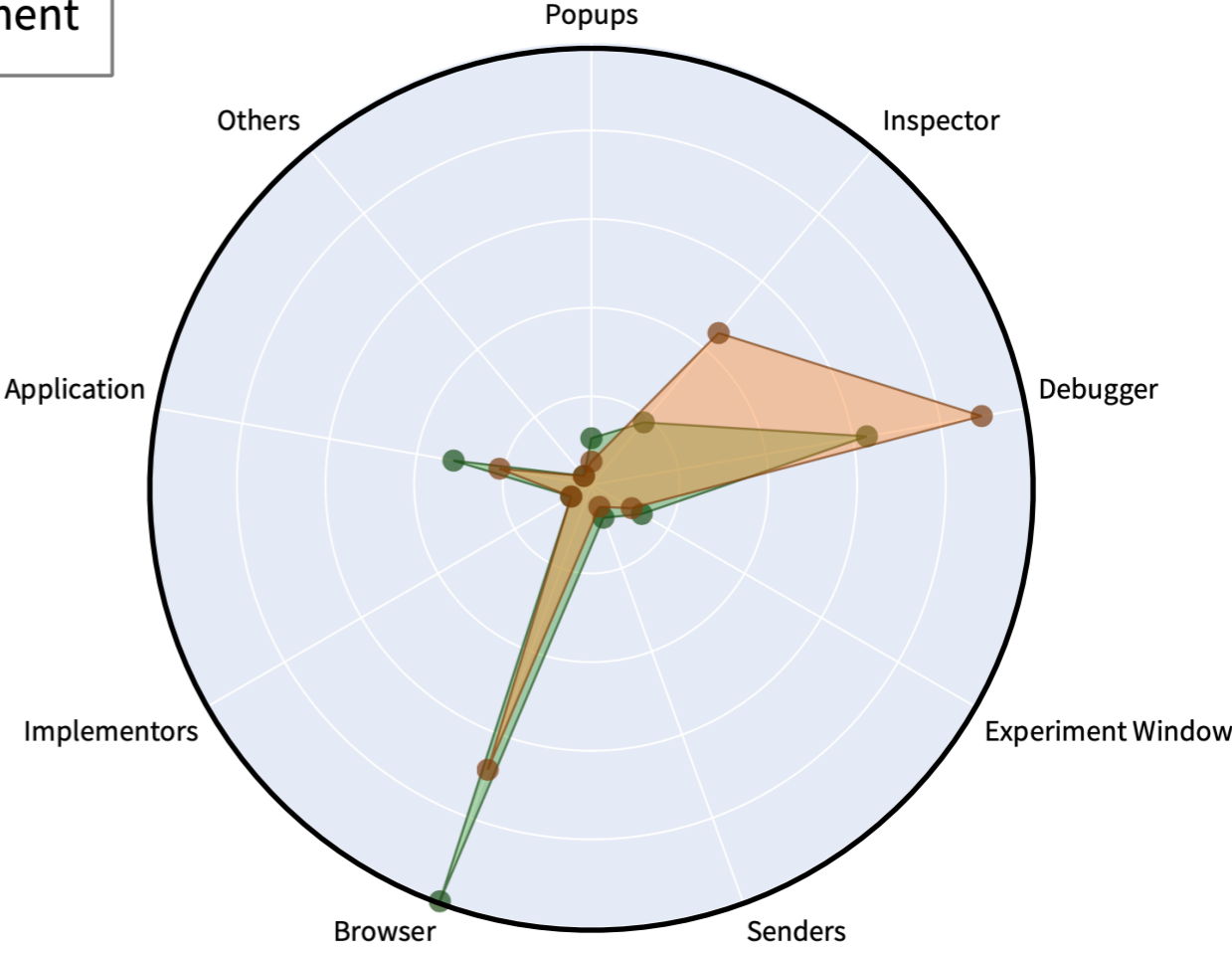
AMMOLITE

Positive difference



LIGHTS OUT

Negative difference

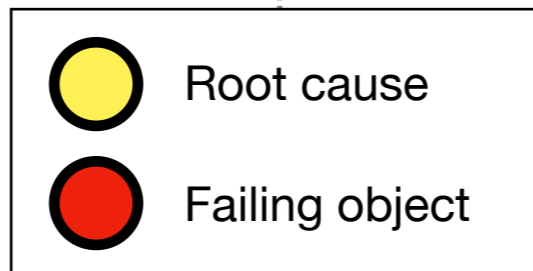
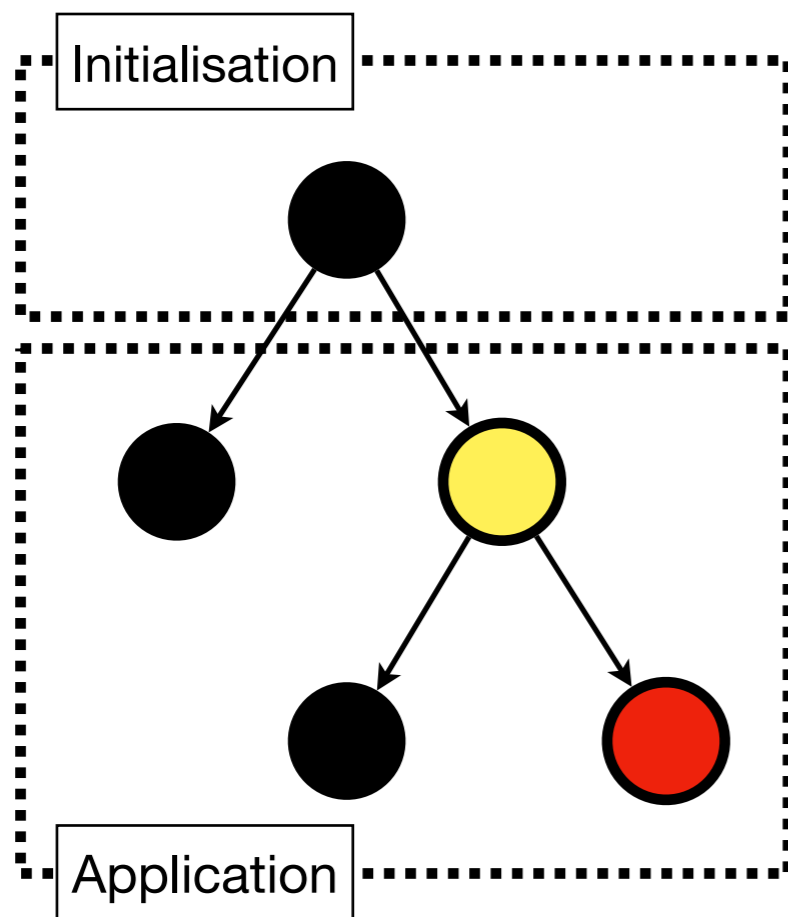


Code Browser more **efficient** than the **debugger** for Lights Out?

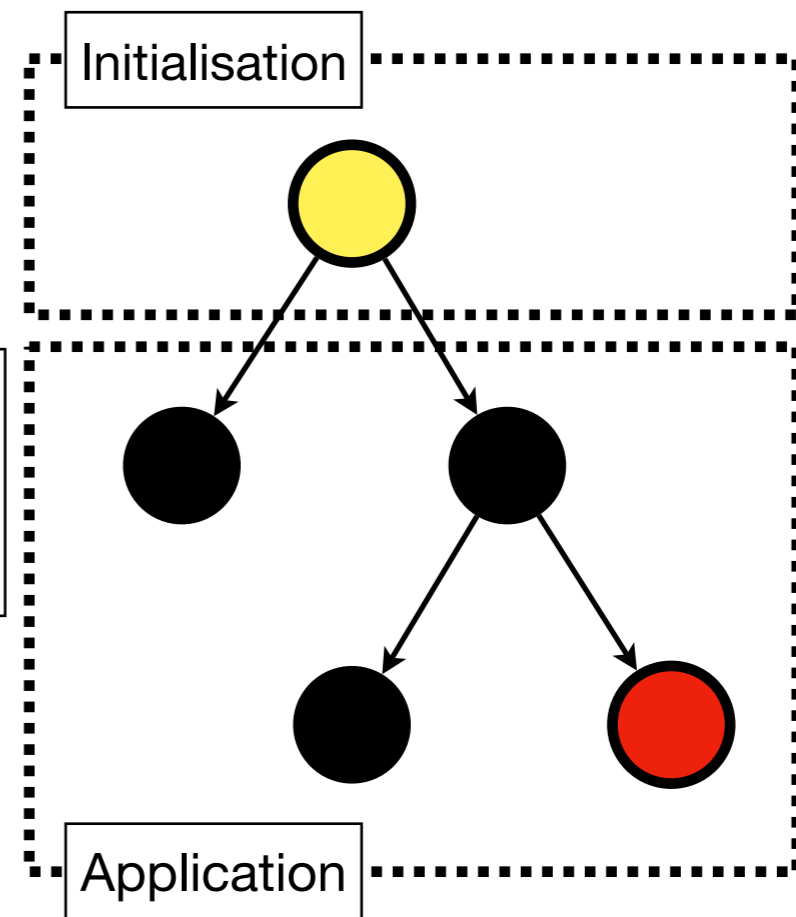
Empirical evaluation: object-centric debugging

What causes this difference?

AMMOLITE



LIGHTS OUT



Bugs with a **different nature**
(reported by a dozen participants)

What's next?

- A deep dive in the data:
- **Per-expertise** analysis
 - **Robustness** analysis



International **C**onference
on
Software **E**ngineering

New **object-centric** tools
&
New experiments

Object-Centric Debugging

Empirical experiment - preliminary results

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ESUG - 11 July 2024