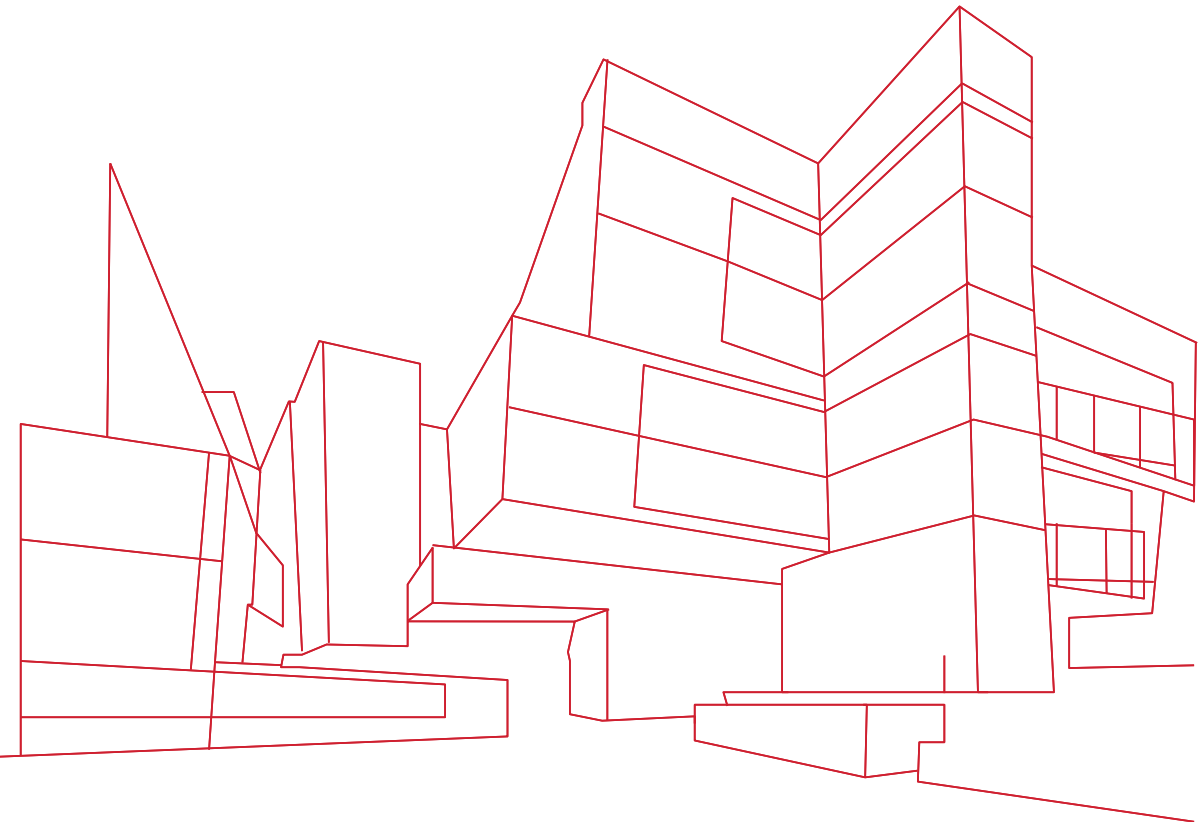


Daejeon, Korea

Feedforward in Interaction: A Case Study of Feedforward for a Glimpse of its Potential in Interaction Design

**Richard Chulwoo Park,
Woohun Lee**

ID KAIST WonderLab



Mental Model?



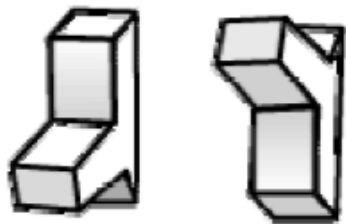
Seriously, which one is a switch for the restroom?

Problem of Affordance

Breaking Affordance: Culture as Context

Oshlyansky Lidia, Thimbleby Harold, Cairns Paul

US style switch



	On	Off	Total
UK	28	12	40
US	2	43	45

UK style switch



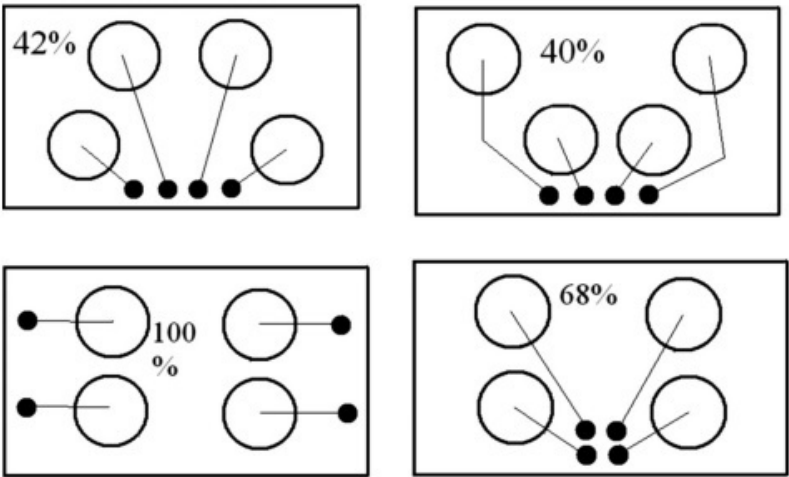
	On	Off	Total
UK	36	4	40
US	12	33	45

Contrast tendency in Western culture
between US and UK

Alternative Approaches to the design of four-burner stoves

Errol R. Hoffmann, Alan H.S. Chan

Four most nominated designs



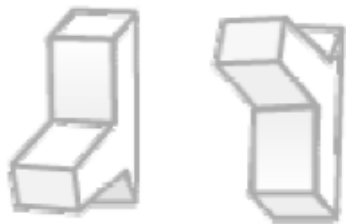
No stereotypical mappings

Problem of Affordance

Breaking Affordance: Culture as Context

Oshlyansky Lidia, Thimbleby Harold, Cairns Paul

US style switch



	On	Off	Total
UK	28	12	40
US	2	43	45

UK style switch

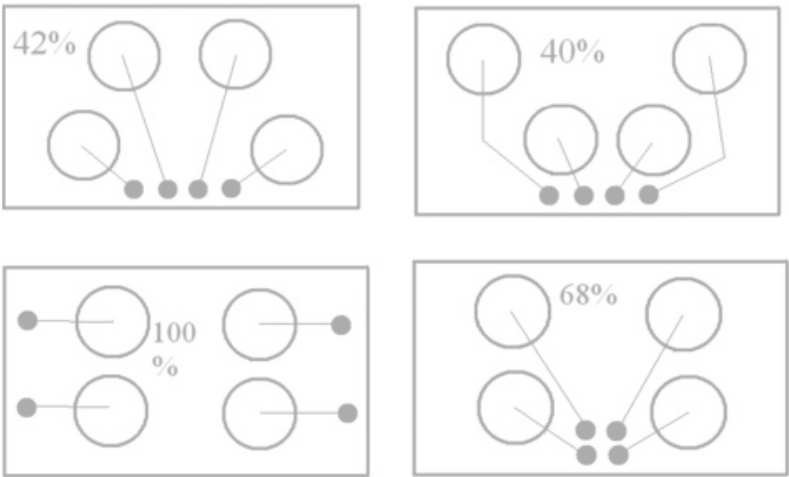


	On	Off	Total
UK	36	4	40
US	12	33	45

Alternative Approaches to the design of four-burner stoves

Errol R. Hoffmann, Alan H.S. Chan

Four most nominated designs



In this circumstances, how can designers possibly afford people?

Feedforward

What if we provide a clue to the user?

Feedforward, widely known as *Preview*



Feedforward

Crossing the Bridge over Norman's Gulf of Execution: Revealing Feedforward's True Identity

Jo Vermeulen, Kris Luyten, Elise van den Hoven, Karin Coninx (CHI 2013)



Feedforward provides clear and instant information that tells users what the result of their action will be.

OctoPocus: A Dynamic Guide for Learning Gesture-Based Command Sets

Olivier Bau & Wendy E. Mackay (UIST 2008)

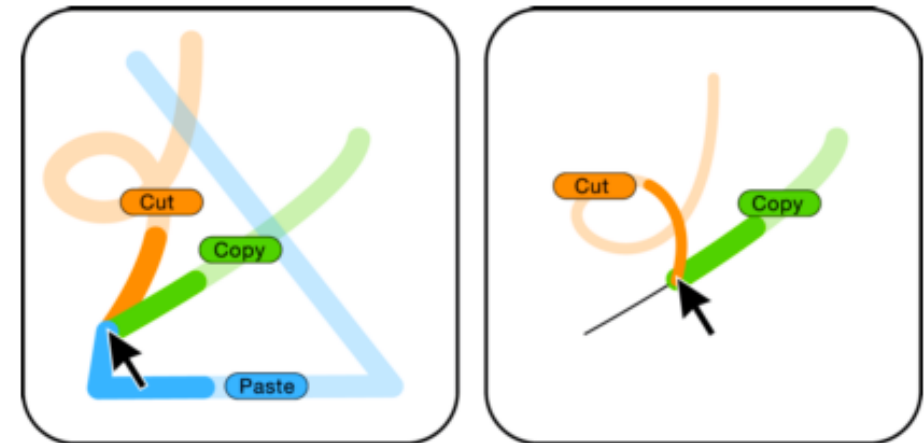


Fig. 3: OctoPocus displays three gestures and commands. Tracing **copy** causes **paste** to disappear and **cut** to get thinner.

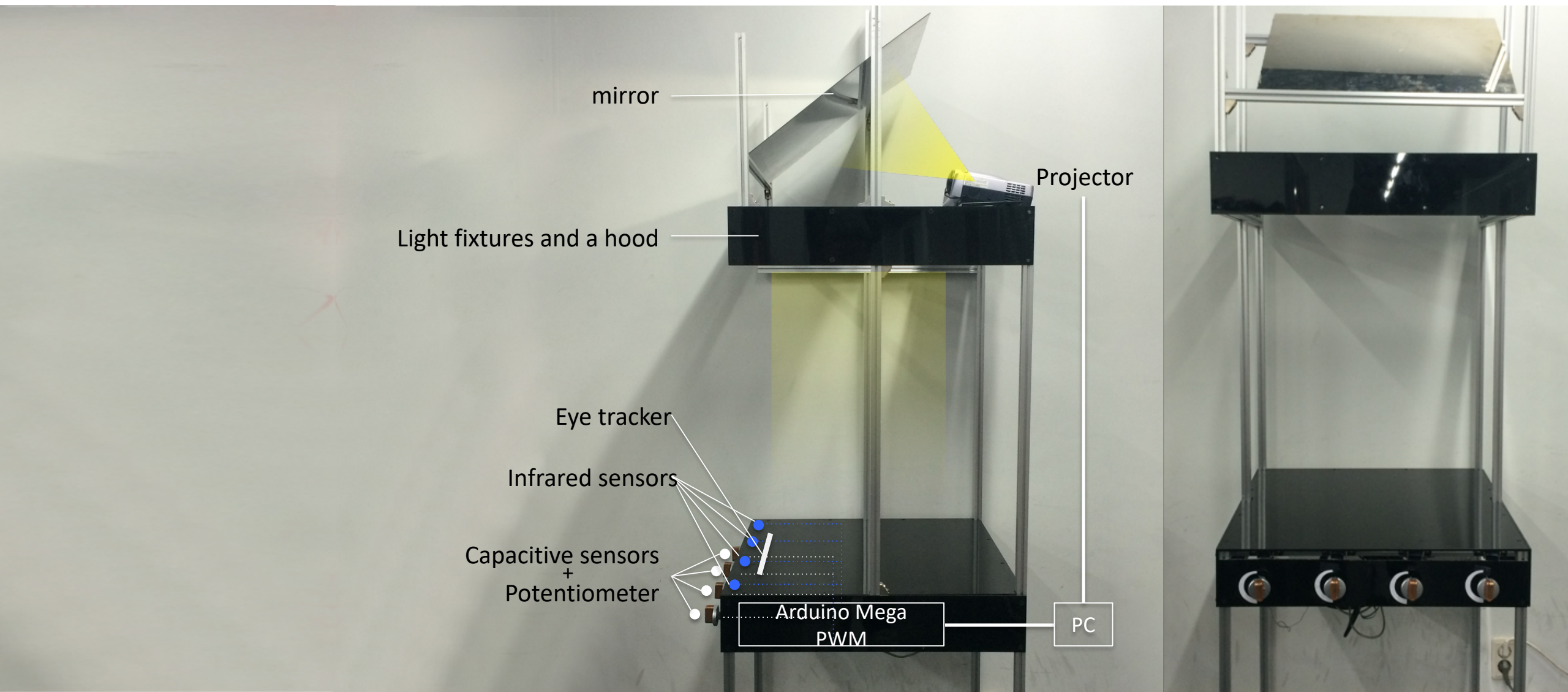
System Prototype Consideration

- A real scale human factor (Rinnai RSF-CA24G¹)
- Alters as little as possible. A light fixture in a gas stove hood uses as a guide of feedforward

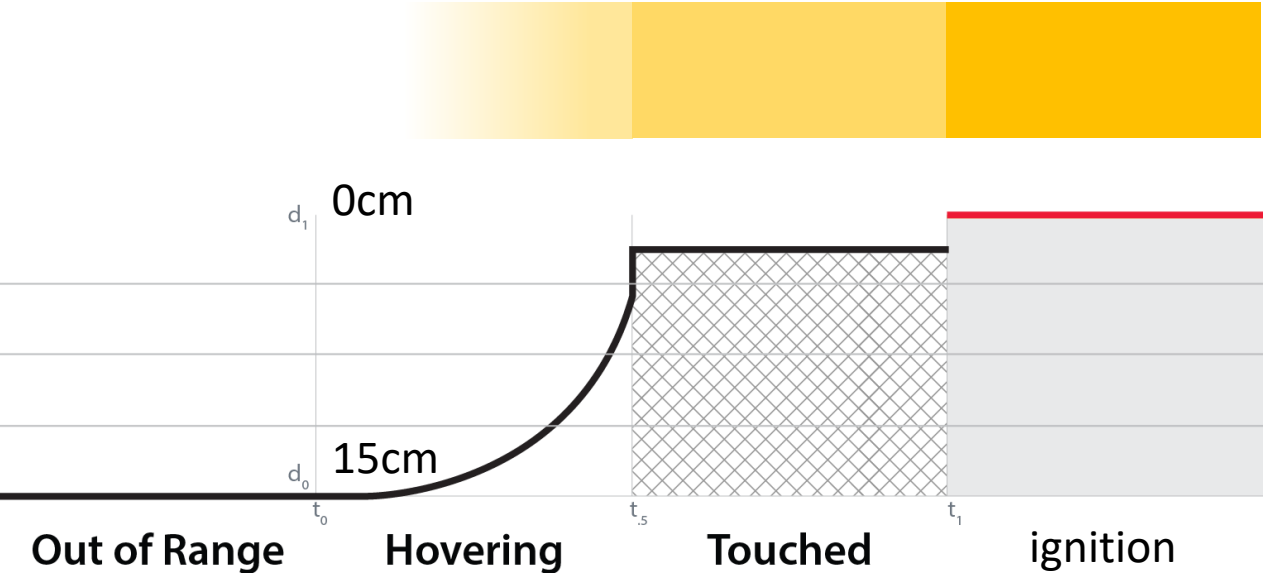


1. Rinnai RSF-CA24G <http://www.vatgia.com/5785/1610294/rinnai-rsf-ca24g.htm>
2. Gas stove image © <https://www.hometips.com/buying-guides/cooktop-ranges-ventilation.html> |

System Prototype

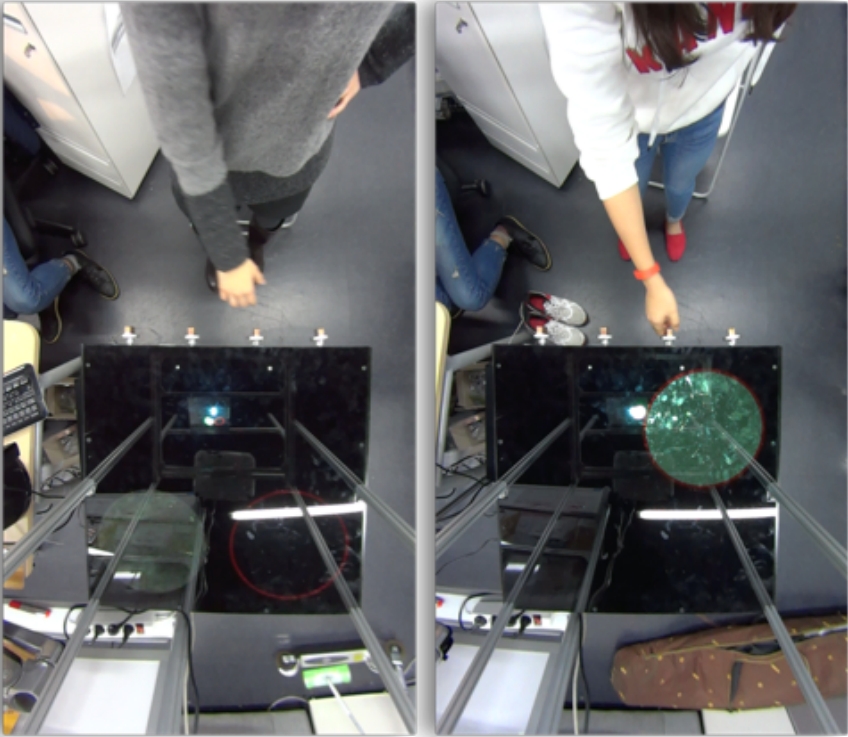


Gas Stove System



brightness

- t time
- $t \geq t_1$ after the action
- $t \leq t_0$ before the action
- $t_0 \leq t \leq t_1$ during the action
- d information details
- d₀ veiled
- d₁ unveil functionality



Experiment

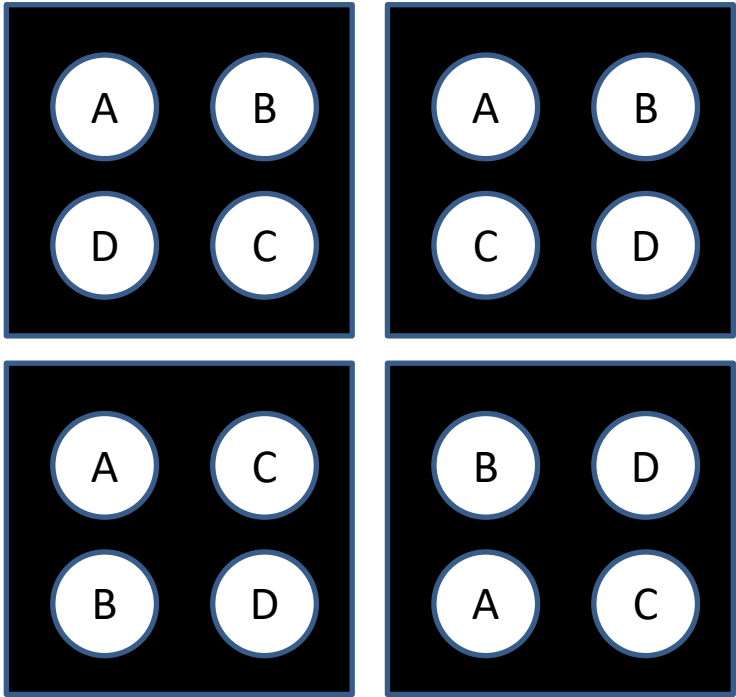
Primary user study

20 Participants

	Within Subject Test	
	TOUCH Session	HOVERING Session
Conventional gas stove	Conventional gas stove trial x 10	Conventional gas stove trial x 10
The Previewable Gas Stove	Touchable gas stove trial x 10	Hover-able gas stove trial x 10
(a) Primary test for exploring effectiveness of Nunchi		

Effectiveness (time, accuracy, comfort), Subjective user experience and intuitiveness

Randomized 4 types of mapping condition



*Minimum 3 hours intervals between session for learnability & effect of prior experience

Experiment

Primary user study	Additory user study with eye tracking																											
20 Participants	10 Participants																											
<table><tr><td></td><td colspan="2">Within Subject Test</td></tr><tr><td></td><td>TOUCH Session</td><td>HOVERING Session</td></tr><tr><td>Conventional gas stove</td><td>Conventional gas stove trial x 10</td><td>Conventional gas stove trial x 10</td></tr><tr><td>The Previewable Gas Stove</td><td>Touchable gas stove trial x 10</td><td>Hover-able gas stove trial x 10</td></tr><tr><td colspan="3">(a) Primary test for exploring effectiveness of Nunchi</td></tr></table>		Within Subject Test			TOUCH Session	HOVERING Session	Conventional gas stove	Conventional gas stove trial x 10	Conventional gas stove trial x 10	The Previewable Gas Stove	Touchable gas stove trial x 10	Hover-able gas stove trial x 10	(a) Primary test for exploring effectiveness of Nunchi			<table><tr><td colspan="3">Within Subject Test</td></tr><tr><td>Conventional gas stove</td><td>Touchable gas stove</td><td>Hover-able gas stove</td></tr><tr><td>Trial x 10</td><td>Trial x 10</td><td>Trial x 10</td></tr><tr><td colspan="3">(b) Eye tracking test for exploring user eye behavior</td></tr></table>	Within Subject Test			Conventional gas stove	Touchable gas stove	Hover-able gas stove	Trial x 10	Trial x 10	Trial x 10	(b) Eye tracking test for exploring user eye behavior		
	Within Subject Test																											
	TOUCH Session	HOVERING Session																										
Conventional gas stove	Conventional gas stove trial x 10	Conventional gas stove trial x 10																										
The Previewable Gas Stove	Touchable gas stove trial x 10	Hover-able gas stove trial x 10																										
(a) Primary test for exploring effectiveness of Nunchi																												
Within Subject Test																												
Conventional gas stove	Touchable gas stove	Hover-able gas stove																										
Trial x 10	Trial x 10	Trial x 10																										
(b) Eye tracking test for exploring user eye behavior																												
Effectiveness (time, accuracy, comfort), Subjective user experience and intuitiveness	Concentration and dispersed attention in relation with mental demand																											

*Minimum 3 hours intervals between session for learnability & effect of prior experience

User Study

Quantitative Experience

QUESI

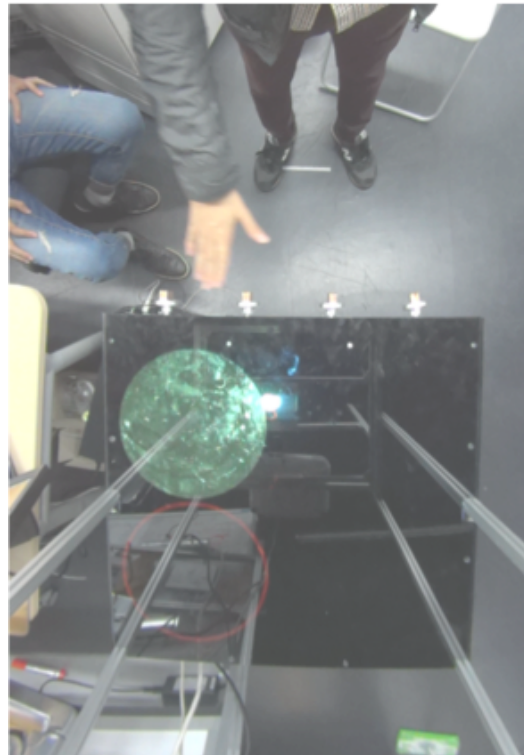
(questionnaire for measuring the subjective consequences of intuitive use)
-Hurtienne & Naumann 2010-

QUESI subscales

- Subjective **mental workload**
- Perceived **achievement of goals**
- Perceived effort of **learning**
- **Familiarity**
- Perceived **error rate**

Gesture & Behavior

Camera observation



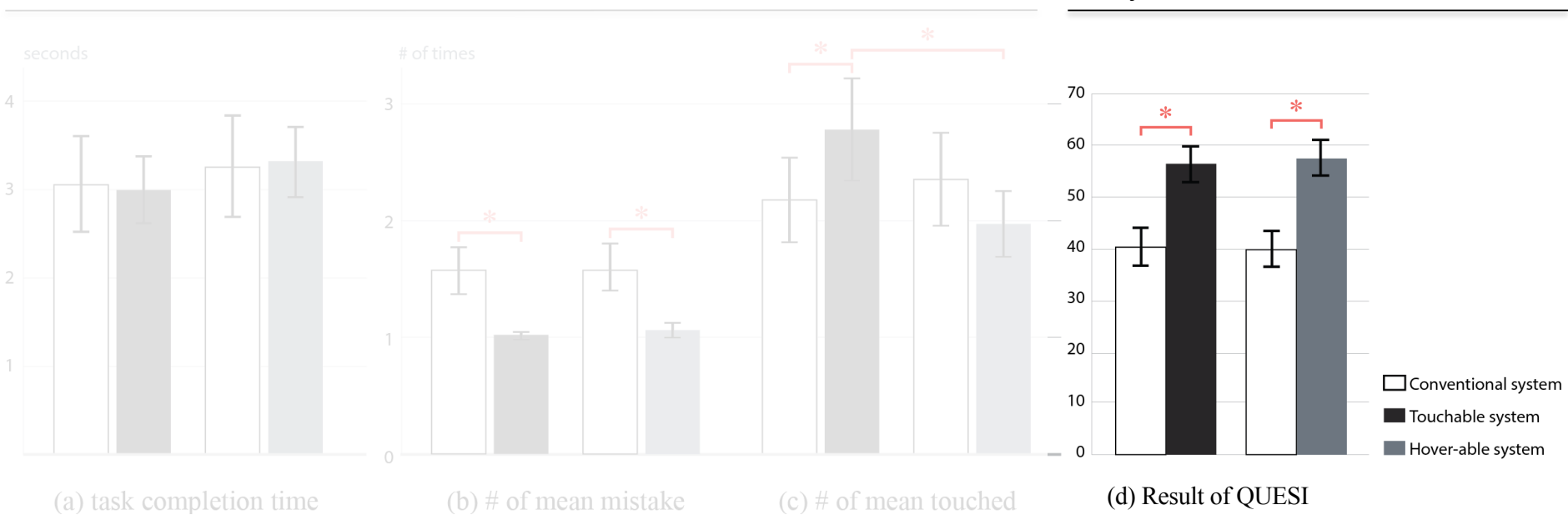
Subjective Experience

Interview



Performance and Satisfaction

Mean of first 3 trials



<Result of task completion time and error by mean of mistakenly control and accidentally touched, and QUESI>

*Task performance: $t_{(124)} = 5.462, p < .05$; $t_{(124)} = 5.145, p < .05$; QUESI: $t_{(40)} = -8.13, p < .05$; $t_{(40)} = -6.47, p < .05$.

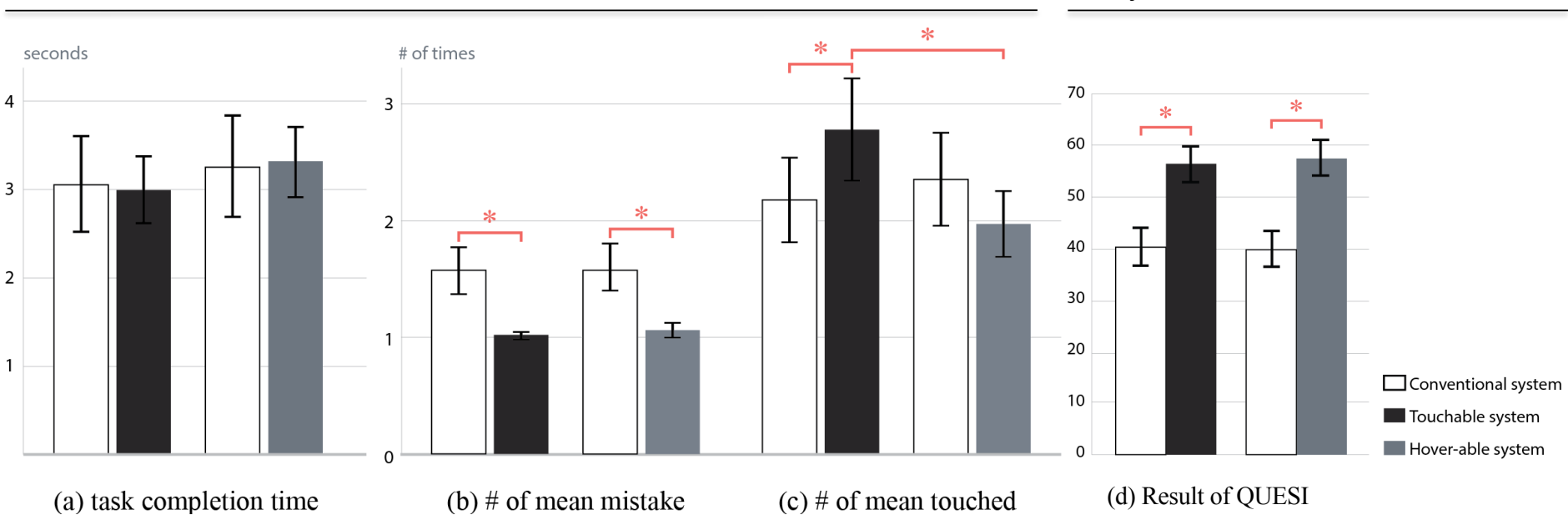
Results of Performance

Results of User Experience

- The prototype was not significant improve performance.
- But satisfaction of subjective user experience was significantly better.

Performance and Satisfaction

Mean of first 3 trials



<Result of task completion time and error by mean of mistakenly control and accidentally touched, and QUESI>

*Task performance: $t_{(124)} = 5.462, p < .05$; $t_{(124)} = 5.145, p < .05$; QUESI: $t_{(40)} = -8.13, p < .05$; $t_{(40)} = -6.47, p < .05$.

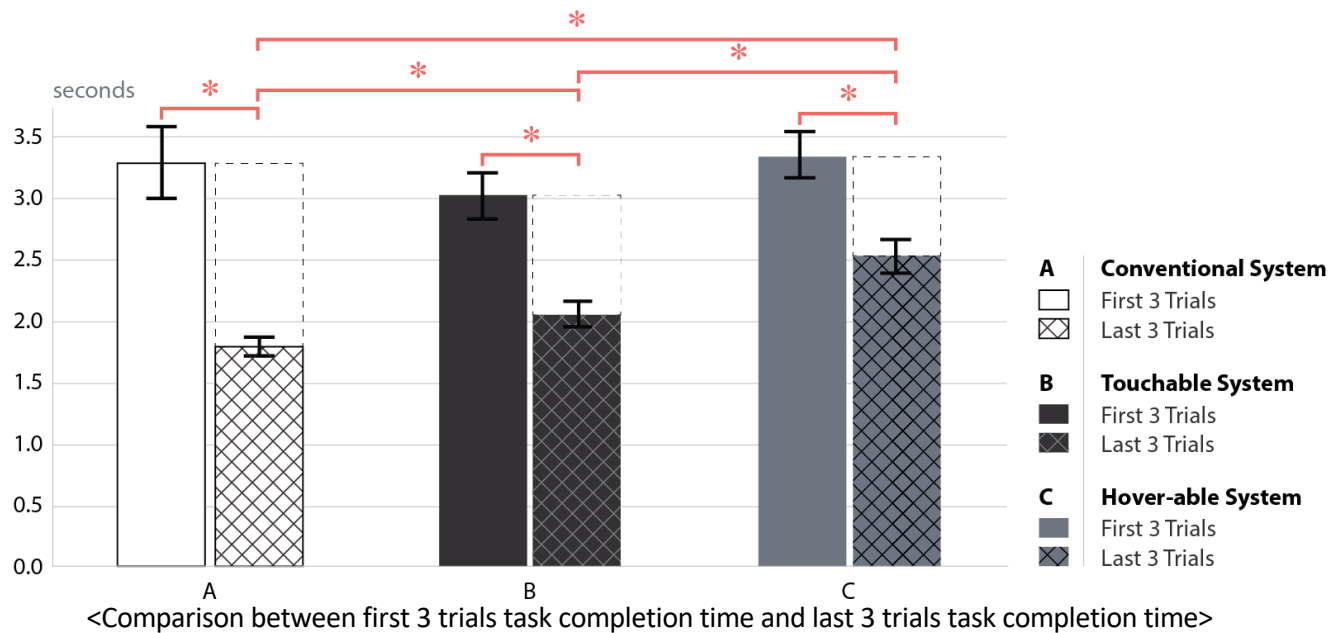
Results of Performance

Results of User Experience

- The prototype was not significant improve performance.
- But satisfaction of subjective user experience was significantly better.

Unfamiliar vs Familiar stage of interface

Unfamiliar (cognitive stage) vs Familiar (autonomous stage)



User's performance improved when they memorized the mapping

The users tended to **rely more on the system with the prototype**

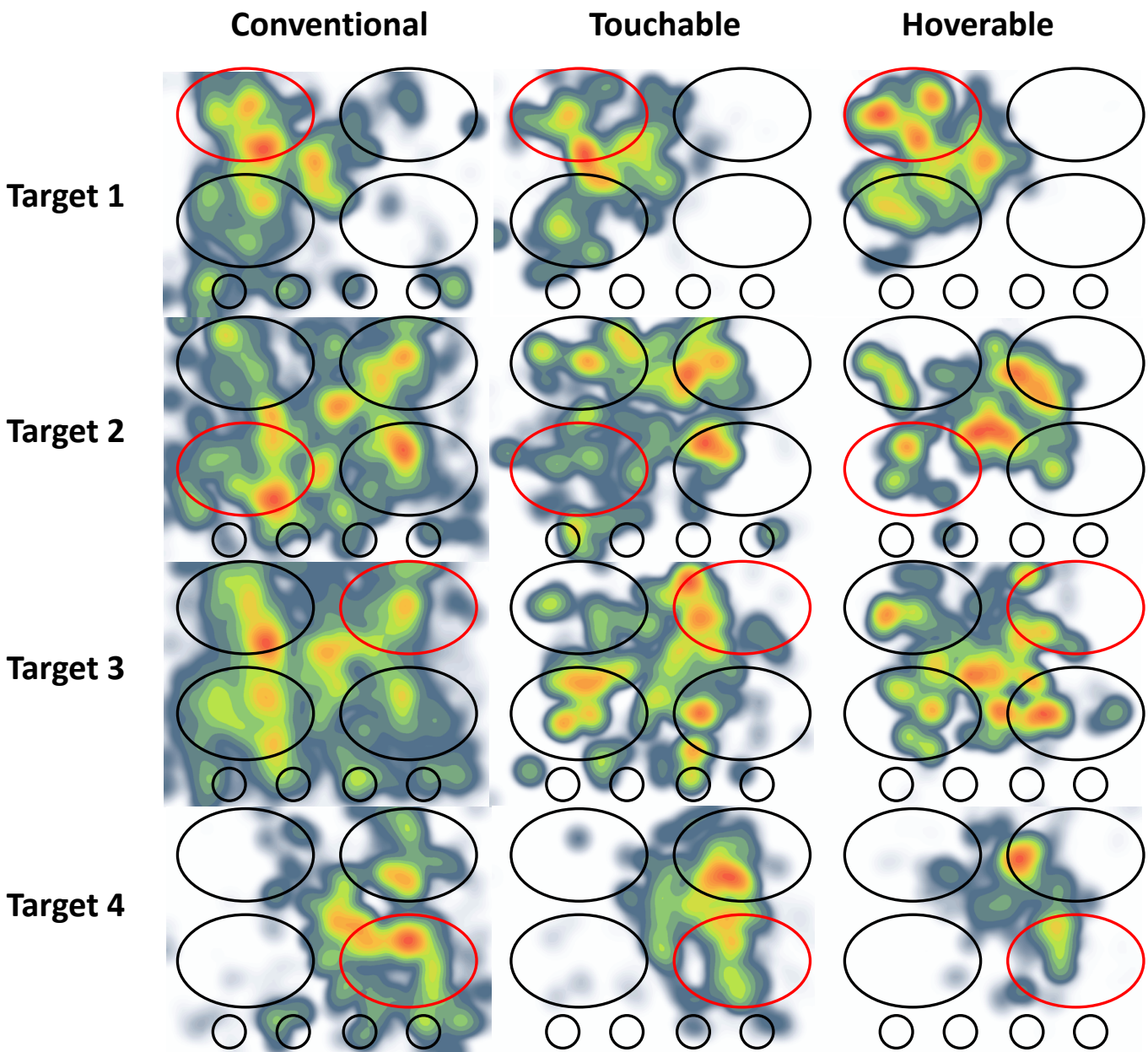
- Enhancement rate: Conventional(14.9%) > Touchable(9.7%) > Hover-able(8.0%)
- Subjective mental workload scores: **conventional(8.24) < touchable(11.76) < hover-able(12.00).**

Eye movement and attention

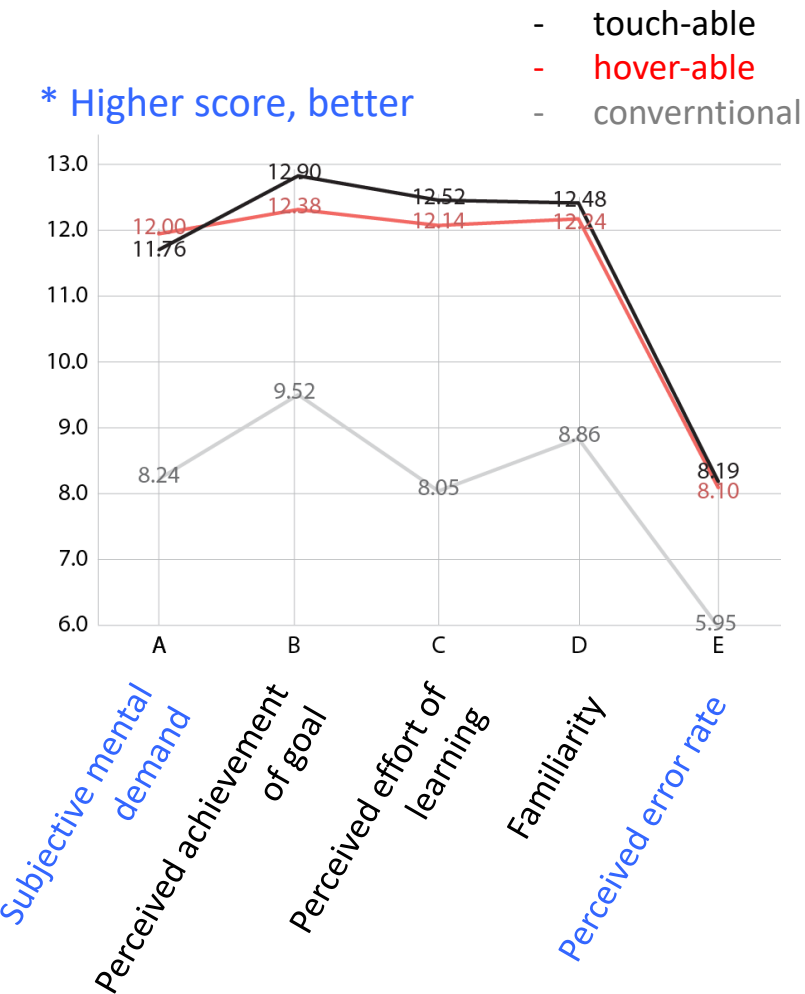
Scattered ————— focused

Conventional > Touchable > Hoverable

**due to dimensional differences and inconsistent eye tracker calibration, the result may seem distorted and inaccurate, but it is reasonably valid for comprehending the tendency differences*



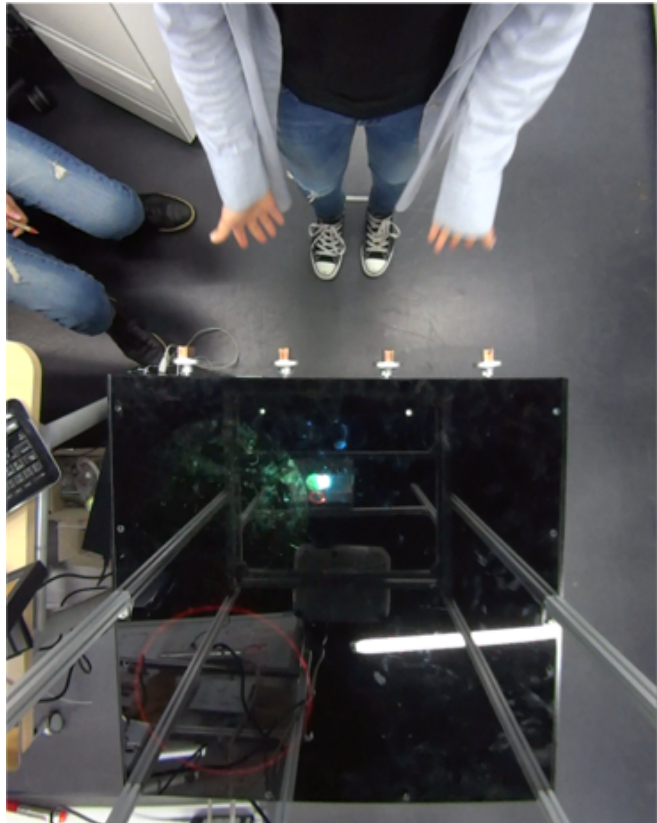
Interview & QUESI



- **Support natural behavior**
Users perceive the systems as a familiar interface, not as new manipulation technique
- **Perceived mistake and confidence**
"I have tried to remember (mapping of the system) but I have failed and I was confused. But with feedforward, when I miss-grabbed the knob, I didn't feel as a mistake." P4
- **Perceived task completion time, mental demand, and action state**
Hover-able < Touchable < Conventional system
- **Typical mid-air gesture drawbacks**
"it takes time to get used to hovering... I prefer haptic interface because it feels secure." P6

Interaction Technique

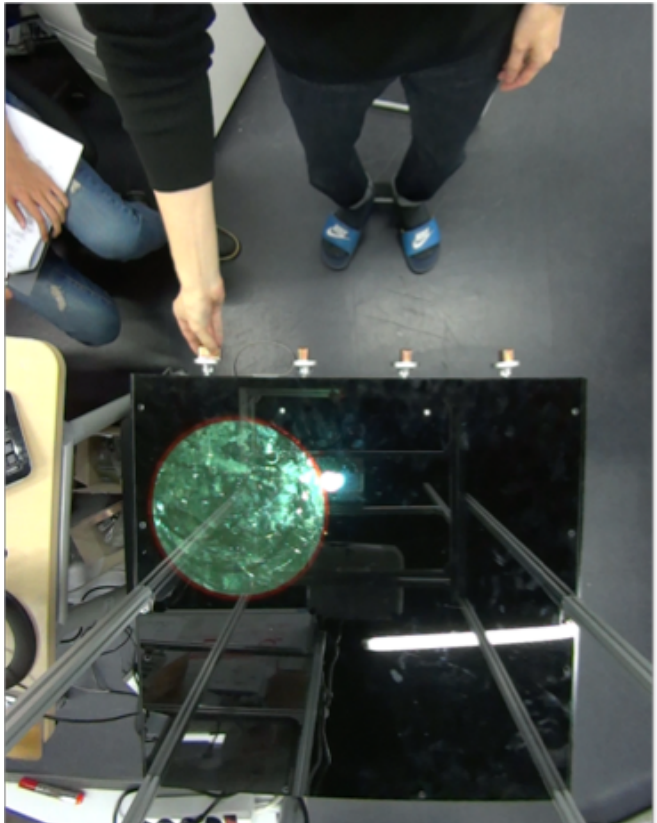
First few trials (avg. 1-3)
Cognitive stage



Exploring

Foreground Interaction
Searching technique

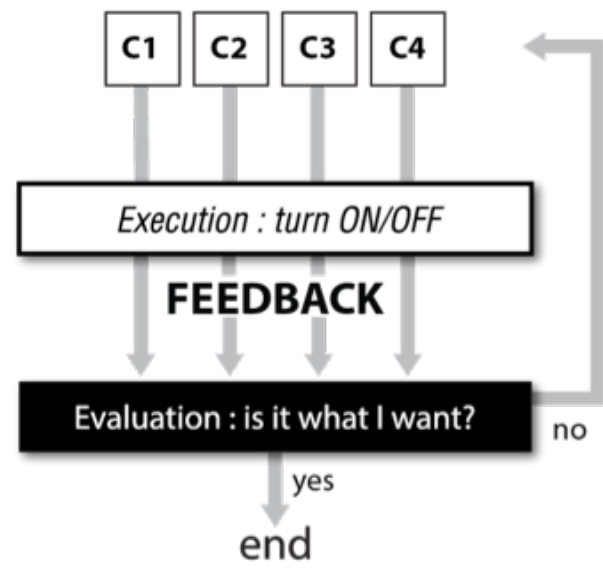
After adaption
Autonomous stage



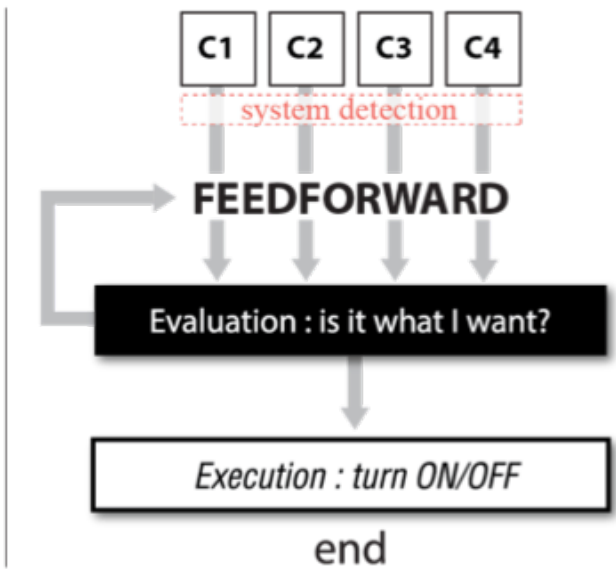
Assuring

Background Interaction
Building confidence

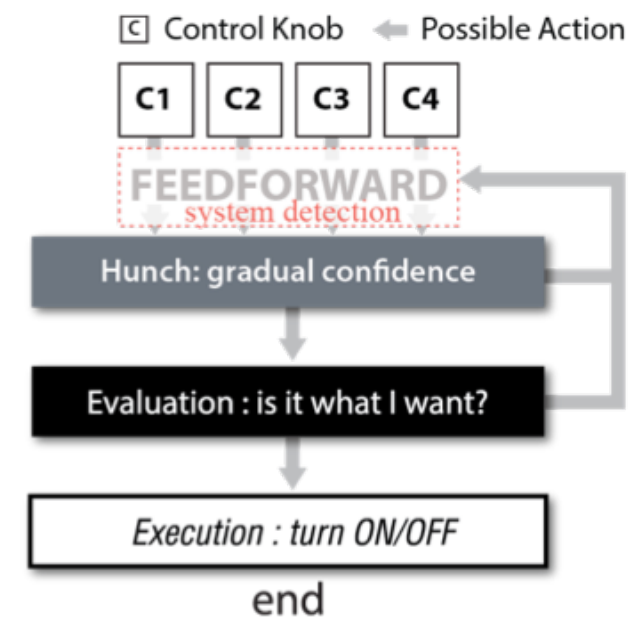
Interaction States



(a) Conventional System



(b) Touchable System



(c) Hove-able System



Power relation

Confidence versus inability of control less

How much power the system should take control, and in what way designers can balance between, comfort of automation and security of total control?

Csikszentmihalyi, M., 1990.
Flow: The psychology of optimal performance



Complexity of interactivity

“how do we lead them to less stressful way to learn and adapt to things?”

Feedforward as a guide in complex life

Janlert, L.-E. & Stolterman, E., 2010. Complex interaction.

Carroll, J.M. & Rosson, M.B., 1987. Paradox of the active user



Interpersonal Interaction



Interpersonal aspect in interaction design

Erikson, E.H., 1993. *Childhood and society*

“it (technology) didn’t make much of difference (between conventional and the prototype), but I felt that I can manipulate it entirely dependent to the system by trust.” P3

Daejeon, Korea

Feedforward in Interaction: A Case Study of Feedforward for a Glimpse of its Potential in Interaction Design

**Richard Chulwoo Park,
Woohun Lee**

ID KAIST WonderLab

