mouse tracking technique

UXlady

Patterns of cursor movement for different devices

Comparative study of *cursor movement pattern* between a touchpad and a mouse devices.

Keywords: mouse tracking, web interaction, user mouse activity, user mouse behavior, mouse movements, touchpad movements, patterns of mouse movement, pointer behavior, pointer pattern.

trackme

http://trackme.ux-lady.com/

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Tracking user's mouse
Mousetracking & Web navigation

Mouse tracking is a **technique for monitoring and visualizing mouse movement** and activity of the users. Allows us to understand how users interact, for example with a web site, find out where they click, which is the route that follows the mouse, including the time between each action. Unlike other tracking technologies, it is very simple to implement, and can be applied to large numbers of users in a non-invasive manner.

Most mouse tracking technologies allow us to:

- **Record mouse activity.** Path movements, clicks, pauses, scrolling...
- **Playback the user sessions**. replay the recorded activity either in real time or as a static representation.
- Select different **visual representations** of data as needed.
- Can be combined with other tracking technologies to provide a fuller picture...

Some commercial solutions based on mouse-tracking: none of them offer mouse trace visualization, that's why I finally use (smt) Simple Mouse Tracking (http://smt.speedzinemedia.com/) a free tool from Luis Leiva.

CLICKTALE® crazyegg mouseflow.com Realtime web user studies

trackme
http://trackme.ux-lady.com/

more?

Uses of mouse tracking technique

- **Usability** Studies
  possibility of remote and massive studies

- Build **user segmentation**.
  optimize their website according to the specific browsing behavior of different user groups.

- **Infer users' behavior**.
  Collected data can be used to find **behavioral patterns**.

What for...?

I used mouse-tracking technique to study **cursor patterns behavior** on two different pointer devices: a mouse and a laptop touchpad.

trackme

Following users...

Currently there are many tools to monitor the behavior of users during web browsing:
Mouse tracking, web analytics, eye tracking, geolocalization tracking, are just some of them.

The common goal of all these technologies are:

- ✔ Achieve a **deeper understanding** of the user (eg. interests, resources)
- ✔ **Improve the user experience**.
- ✔ Deliver **relevant content** to the user.
- ✔ Create **dynamic web sites** adaptable to the needs, interests and resources of the user.

of them...

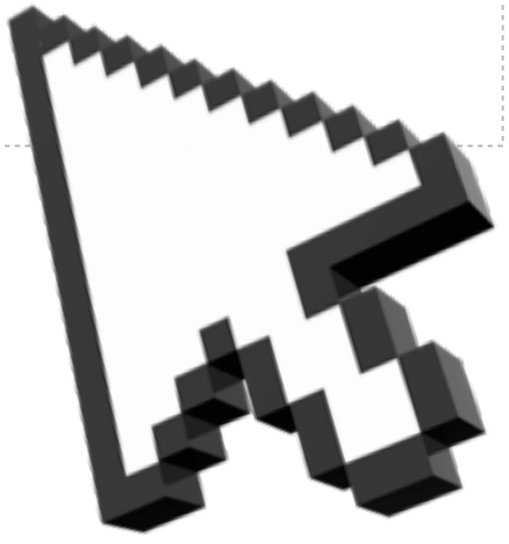
mouse tracking

Follow the movement of the cursor on the screen

(Path movements, clicks, pauses, scrolling...)

- ✔ **identify behavioral patterns**.
- ✔ infer the activities the user perform

- ✔ Deliver **relevant content** to the user.
- ✔ Create **dynamic web sites**.



In a first approach to the study of MouseTracking

we found two problems *and they are the origin of our research project.*

1

all studies were performed using a mouse.

but now people tend to use other tools with differents devices such as touchpad, touch screens, etc.

Performance and Kinematic studies comparing touchpad-mouse suggest that there may be differences in the behavior of the cursor. [11, 12]

2

Although there are common patterns identified...

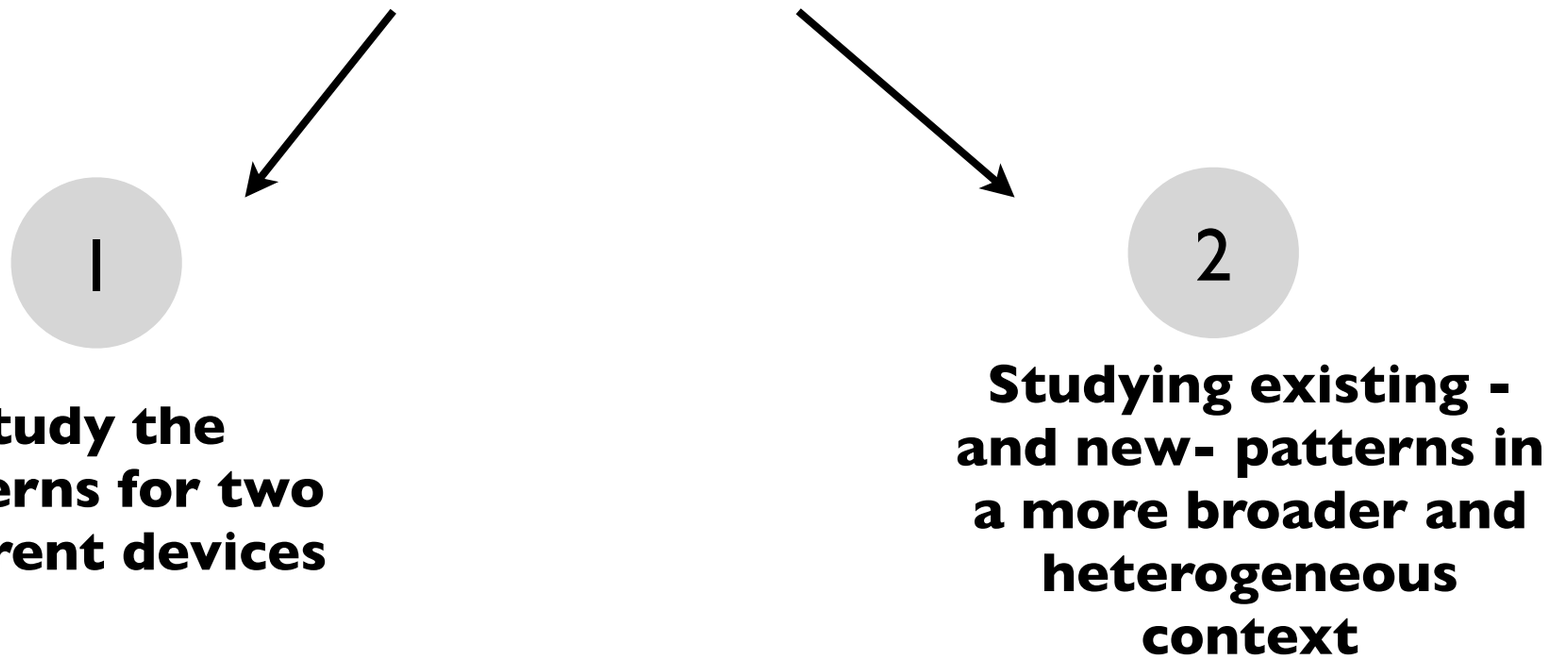
Defined too **broadly**.

Defined in very **specific contexts**.

In this context we decided to design an experiment to resolve *these shortcoming*

Each participant must:

→execute 3 common tasks on the web: *search for a content*, *reading* and *interact with a form*
→using two devices: mouse - touchpad.

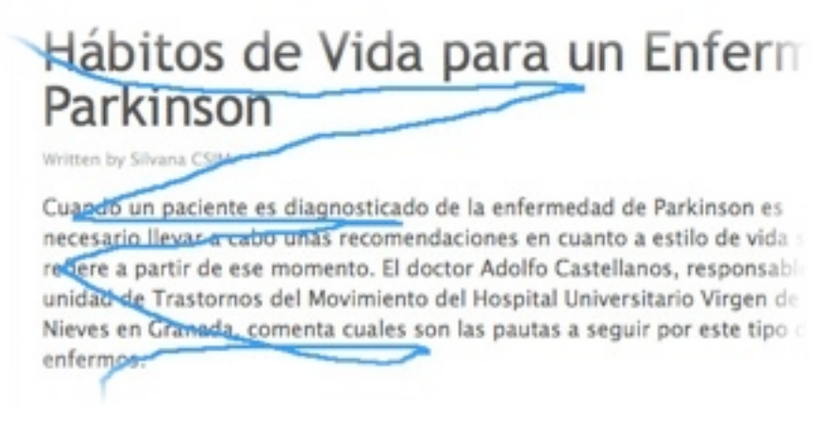


Use mouse-tracking technique to study **cursor patterns behavior** on two different pointer devices: a mouse and a laptop touchpad.

What is a mouse/cursor pattern

Have been identified some common patterns of behavior

These patterns are particular movements. Units of movement with a **meaning that is inferred**.



Follow a line of text with the cursor

→we *infer* that you are using the mouse as a "guide" to support reading.

→ Reading pattern

By looking **back and forth movements** between two targets (links checkboxs, etc)

→we *infer* that the user has doubts about which option to select.

→ Hesitation pattern

Currently, the patterns are generally identified from a visual analysis, but the ultimate goal is to identify patterns automatically

* *In the literature are called "mouse patterns"*

Problem Statement

Research objectives

Use a *touchpad* instead of a *mouse*, will affect the cursor behavior?
Will the cursor behavior patterns vary depending on the device and task?...

The following are our research objectives:

1. Define a common **taxonomy** for each cursor-pattern, as an approach for automatic classification of the patterns.

2. Determine whether the use of a particular pointer **device** affects average user **activity**.

3. Discover **patterns frequency for each task:** search-navigation, reading and fill-in questionnaire.

4. Find specific touchpad-patterns.

Problem Statement

Research questions

Does the **device** used **affect** the **activity** level of the cursor?

The **device** used influences the type and **frequency** of **patterns**?

Does the **task influence** the type and **frequency of patterns**?

Problem Statement

Hypothesis

Influence of the device on the level of activity

H1: The level of **activity** will be **different** between the groups using **touchpad** and those who use a **mouse**.

Frequency patterns in relation to the device

H2: The use of a touchpad reduce horizontal reading pattern (RH) compared to the mouse.

H3: The use of a touchpad reduces the movement of hesitation (H) compared to the mouse.

H4: The use of a touchpad reduce random movements (R) compared to the mouse.

H5: The use of a touchpad, causing an increase in direct movement (DM) compared to the mouse

Frequency patterns in relation to the task and device

H6: In the *fill-in form* task (questionnaire) will increase the presence of hesitation pattern (H) with respect to other tasks (search, reading)

H7: In the task of *reading* the patterns of reading (RV and RH) will increase.

State of the art

Mouse tracking technique

In the beginning was raised as an economic alternative to the eye-tracking technique
(*cheaper, simpler to implement...*)

Its use is validated because the correlation between both techniques,
some studies put close to 80% [10].

The mouse-tracking technique has been used for years to (since 2000):

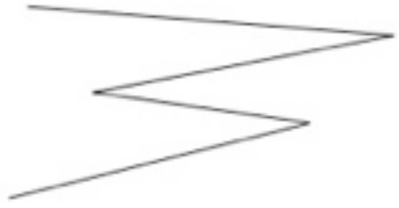
- ✔ usability studies, [1,2, 4, 8, 22]
- ✔ user modeling [1, 4, 7, 8, 9, 14]
- ✔ web analytics [15, 21]

The investigations focus on:

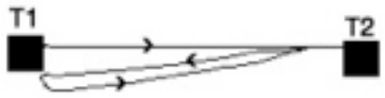
- ✔ development of new technology
- ✔ identification of patterns and user modeling
- ✔ correlation studies with eye tracking
- ✔ as input to dynamic web (machine learning [6]).

State of the art

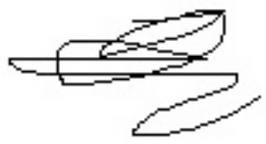
cursor/Mouse patterns



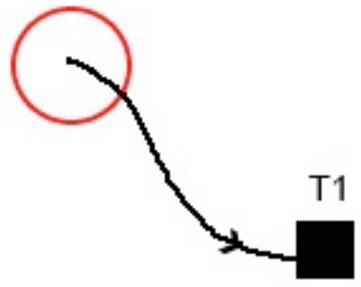
Reading



Hesitation



Random



Direct movement

Fixed Patterns

Guide Patterns

Discarded for this study

State of the art

Mouse patterns Reading | Hesitation | Random | Direct movement

Reading pattern

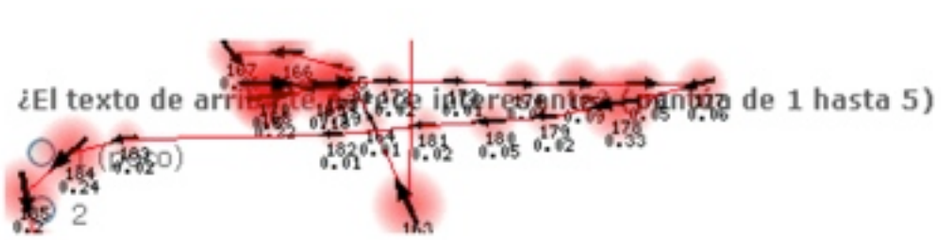
It can be subdivided into two types:

- ✔ Horizontal reading
  clear but not so common among users [5]
- ✔ Vertical reading
  where the trace left by the cursor is a vertical line, with small or long pauses.

inferred →

Reading activity

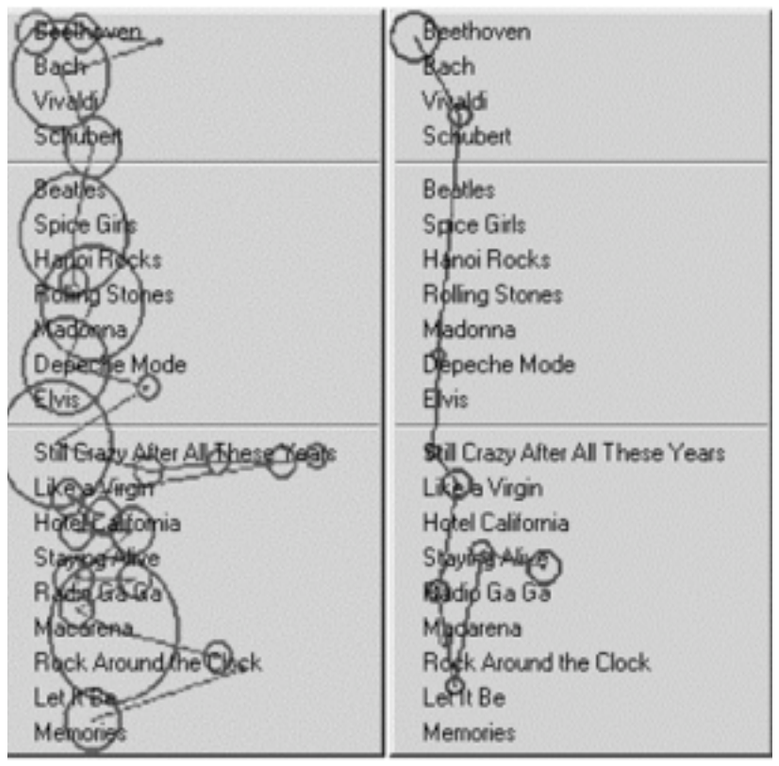
scanning activity



4 Ferreira, S.; Arroyo, E.; Tarrago, R.; Blat, J. Applying Mouse Tracking to Investigate Patterns of Mouse Movements in Web Forms.

5 Rodden, Kerry, Xin Fu, Anne Aula, and Ian Spiro. "Eye-Mouse Coordination Patterns on Web Search Results Pages."

5



5 Aaltonen, A. Hyrskykari, A. Räihä, Kari-jouko. 101 Spots, or How Do Users Read Menus?.

State of the art

Mouse patterns Reading | Hesitation | Random | Direct movement

Hesitation pattern

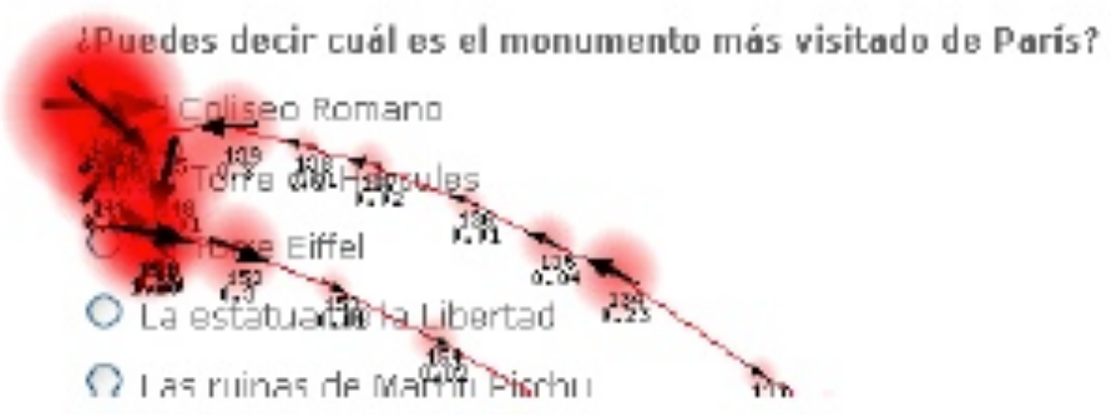
Has been defined in two ways:

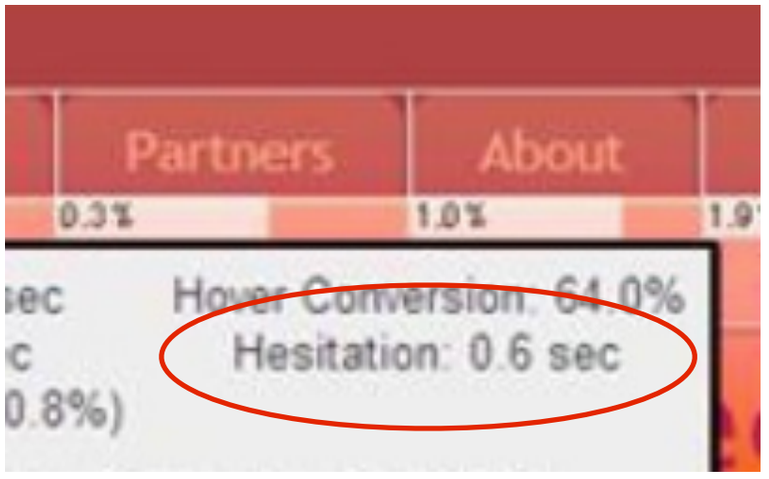
- ✔ between options
  between 2 or more targets [4]
- ✔ Hover-time before click
  on a single target [15]

inferred →

doubt | difficulty

decision-making activity





4 Ferreira, S.; Arroyo, E.; Tarrago, R.; Blat, J. Applying Mouse Tracking to Investigate Patterns of Mouse Movements in Web Forms.

15 ClickTale User Manual. V0.5 May 2010. www.clicktale.com

State of the art

Mouse patterns Reading | Hesitation | **Random** | Direct movement

Random pattern

Defined as movement:

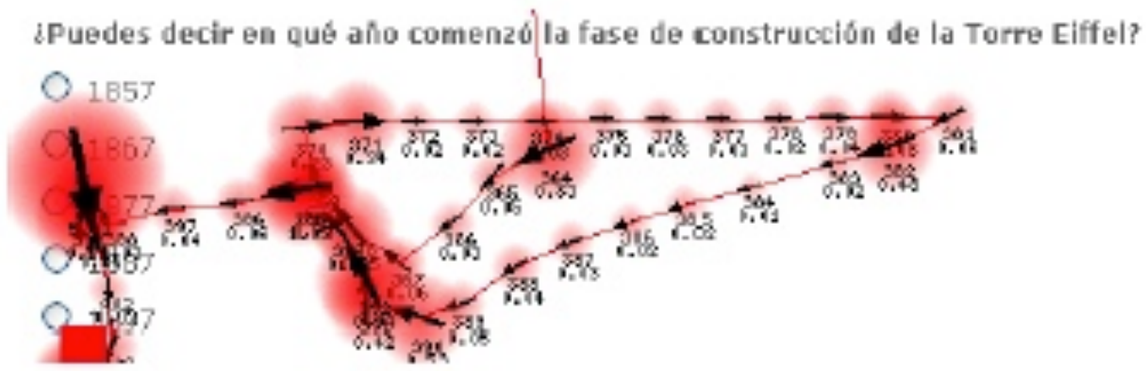
> *"without **any specific intention**, just playing around and doing random movements whit short pauses or not"* [4].

inferred →

doubt

difficulty

Anxiety



Ferreira, S.; Arroyo, E.; Tarrago, R.; Blat, J. Applying Mouse Tracking to Investigate Patterns of Mouse Movements in Web Forms.

State of the art

Mouse patterns Reading | Hesitation | Random | **Direct movement**

Direct movement

Also called "straight pattern" [13]:

is characterized by a pause prior to a direct movement towards a target [13]

(in forms context) is "a direct movement whit no big pauses" [4].

inferred →

- Earlier decision
- Ease
- simplicity
- passive user

Very common pattern among the passive users (incidental use of mouse):

Direct movements that occur once the user has decided which action to take. *[5]*

4 Ferreira, S.; Arroyo, E.; Tarrago, R.; Blat, J. Applying Mouse Tracking to Investigate Patterns of Mouse Movements in Web Forms.

13 Griffiths, L. Cheng, Z., Aykin, N. Investigating the Differences in Web Browsing Behaviour of Chinese and European User Using Mouse Tracking

State of the art

Mouse - touchpad

Research comparing the performance between these devices suggest us that it is possible to find different patterns of mouse behavior between them.

Study on the differences in pointing performance

suggest:

differences on

- speed -velocity-
- errors -accuracy-
- cursor trajectories
- reaction time

kinematic Analysis of touchpad

Touchpad: more finger movement -excessive submovements-
Mouse: more wrist movement. Easier to use than topuchpad

11 Hertzum, M., Hornbaek, K. (2010) How Age Affects Pointing with Mouse and Touchpad: A Comparison of Young, Adult, and Elderly Users

12 Dillen, H., Phillips, J.G., and Meehan, J.W. (2005). Kinematic analysis of cursor trajectories controlled with a touchpad.

Method

Experimental Design

Our experiment follows two purposes: Exploratory and Correlational

Correlational

→establish a correlation between *activity* level and the *device* used.

Exploratory

→explore patterns in different *devices* (mouse and touchpad) and different *situations* (task).

- **Repeated measures**.
  Each participant repeated the test 2 twice (mouse - touchpad)

  → **Group A: MOUSE**
  Group performing tasks with a mouse.

  Group B: TOUCHPAD
  Group performing tasks with a touchpad

- The experiment included three common tasks on a website:
  1-search content.
  2-reading content.
  3-Fill in a questionnaire (web form)

- The experiment was administered individually and in person to each participant.

- The order of the *devices* and *article* have been rotated

Method

Initial test: 5p

Evaluate test procedures.
Evaluate the design and content of the tests.
Evaluate the identification and operationalization of patterns (first selection).
Evaluate the tool (SMT).
Evaluating the registration system.

Pilot test: 17p

define the final ***criteria for the operationalization of the variables****.*

operationalization criteria and preliminary results

Final test: 50p

Method

Experimental Design *Variables*

Independent Variables

Pointing device:
- mouse
- touchpad

Task:
- Search/Navigation (Search content)
- Reading
- Complete a questionnaire (web form)

Dependent Variables

Activity
Patterns of mouse movements:
- hesitation (H)
- direct movements (DM)
- random movements (RM)
- Reading horizontal (RH)
- Vertical Reading (VR)

Additional measurements:
- Short pauses
- Long pauses
- Clicks
- Time

Method

Experimental Design *Equipment*

Software

Mouse tracking tool (SMT2) *Simple Mouse Tracking tool* developed by Luis Leiva

Operating System OS X.
Browser Firefox

Hardware

We used a single laptop (Macbook pro) with touchpad and external mouse

(to avoid differences in the setup or the resolution that can affect the reading of data mousetracking)

Website: http://trackme.silvanachurruca.com

1 Blog News (dummy). [joomla]
2 articles (text + image)
2 forms/questionnaire relating to the articles.

Method

Experimental Design *PROCEDURES*

- The test is divided into 3 stages: *Searching*, *Reading*, *Fill in questionnaire*.
- Each participant performing the test 2 times: using a mouse (A) and using a touchpad (B).The order of the devices and article have been rotated

PAGE	Home	Section	Article	Form
TASK	*Search article*		*Reading article*	*Fill in the questionnaire*
STAGE	1		2	3

Method

Experimental Design: *PROCEDURES*

1 → 2 → 3 →

Search article

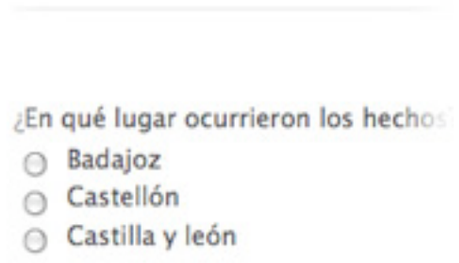
The participant should find an article on the website.

Reading article

The participant should read the article.

Fill in the questionnaire

The participant must complete a web form with questions about the previously read article.



Post-test questionnaire

Data:
age,
use and experience with computers and operating systems.

Preferred devices.

Educational level and profession.

The test is divided into 3 stages: Search, Reading, Fill in questionnaire (Common activities on a website).

Method

Experimental Design *Participants*

Sample: 17 p.
14 men / 3 women, aged between 18 and 39 years *(pilot-test)*
(Final experiment: 25 men / 25 women, aged between 18 and 50 years)

Participants must be frequently and fluently users of mouse and laptop touchpad.

Selection Process

Preliminary questionnaire
to establish their level of familiarity with both devices
(discarded users who have never used a touchpad)

Proficiency assessment by the test monitor
After the test, the participant is assessed depending on their use of mouse and touchpad on a scale:
Poor, *Good* and *Excellent*.
Poor users are discarded in the statistical analysis.

reward*

5' = 1 Donuts

**Very successful among students :-)*

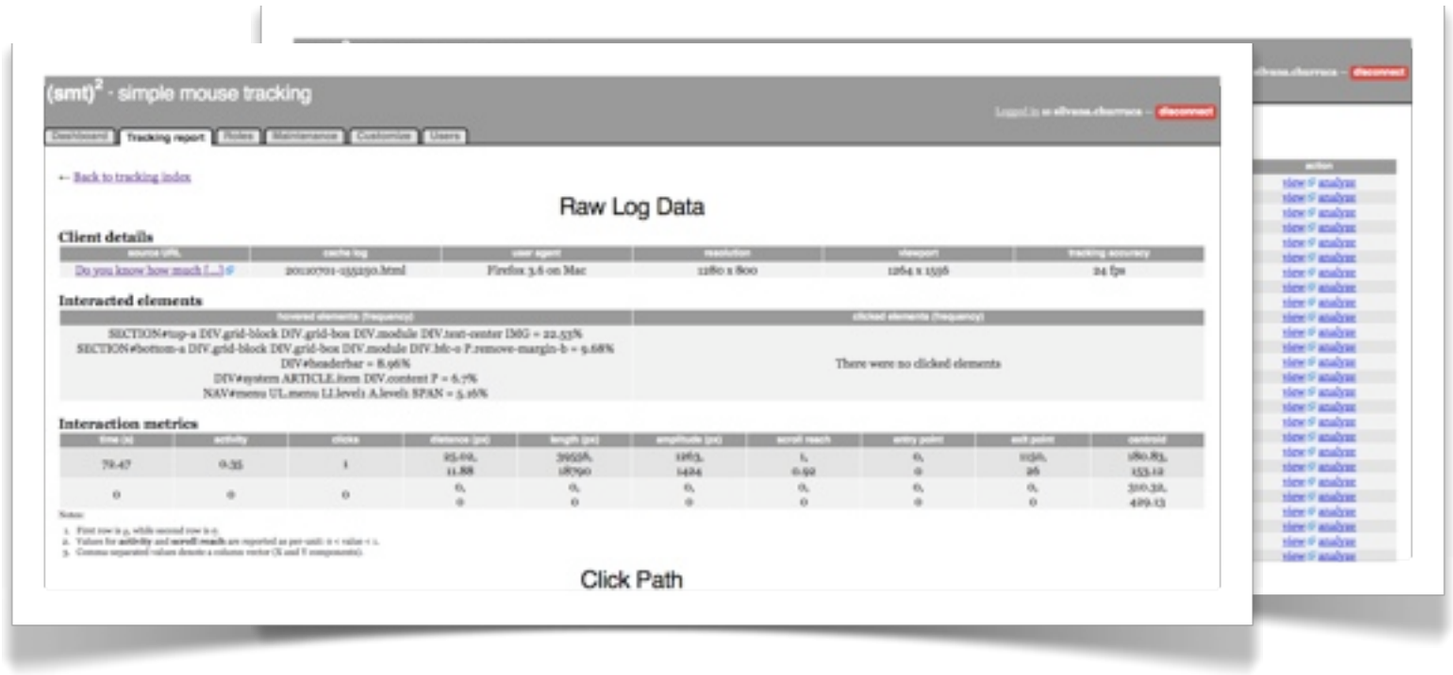
Method

Experimental Design *Operationalization of the variables*

✔ <u>Automatic recovery data:</u>

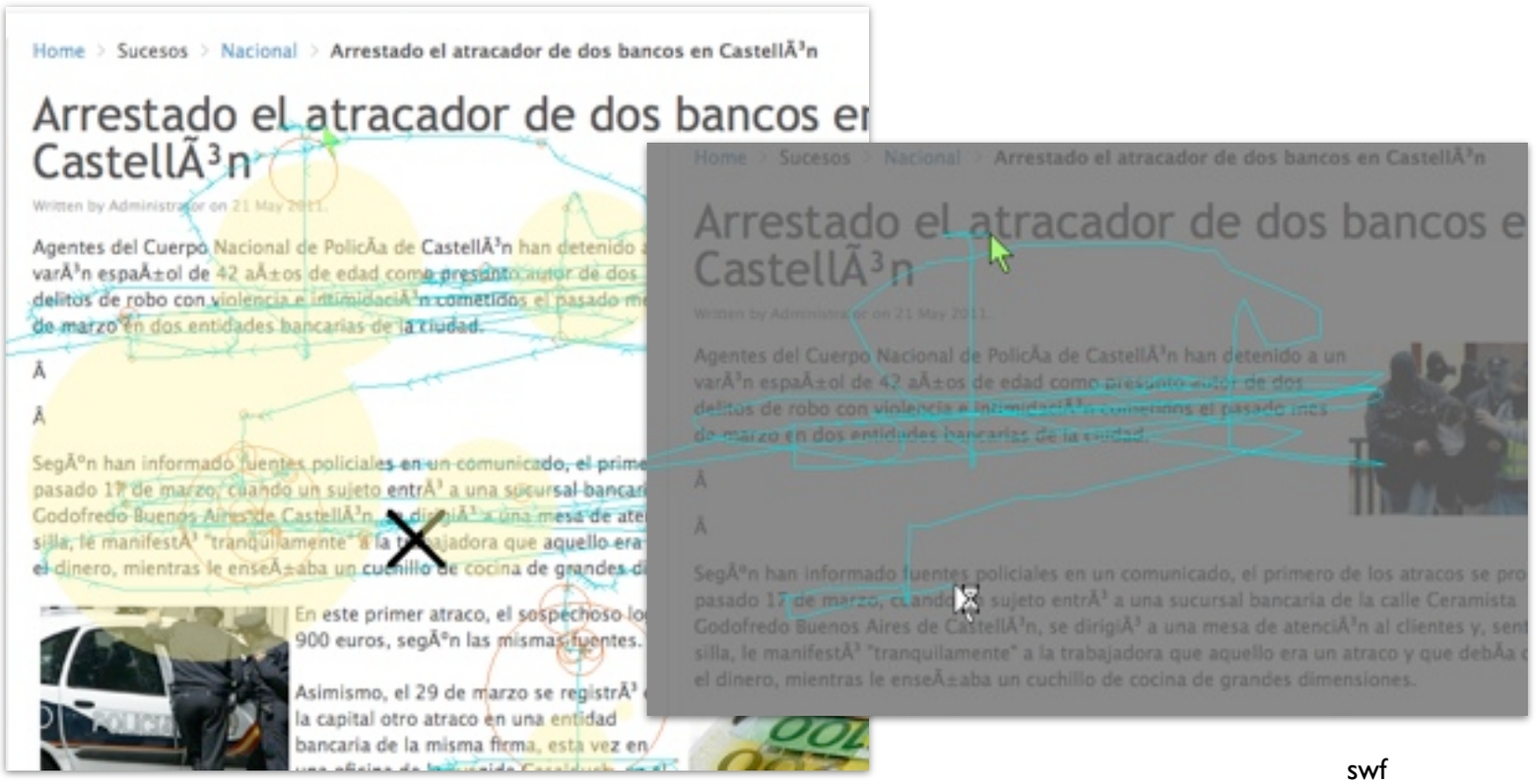
• Activity
It is the relationship between movement of the cursor and the time of the session.
[percentage 0-1]

Other data:
•Distance (x, y) *[pixeles]*
•Scrolling (x, y), *[percentage 0-1]*
•Clicks,
•Time *[seconds]*



✔ <u>Visual identification:</u> Patterns

General and specific criteria for each pattern



swf

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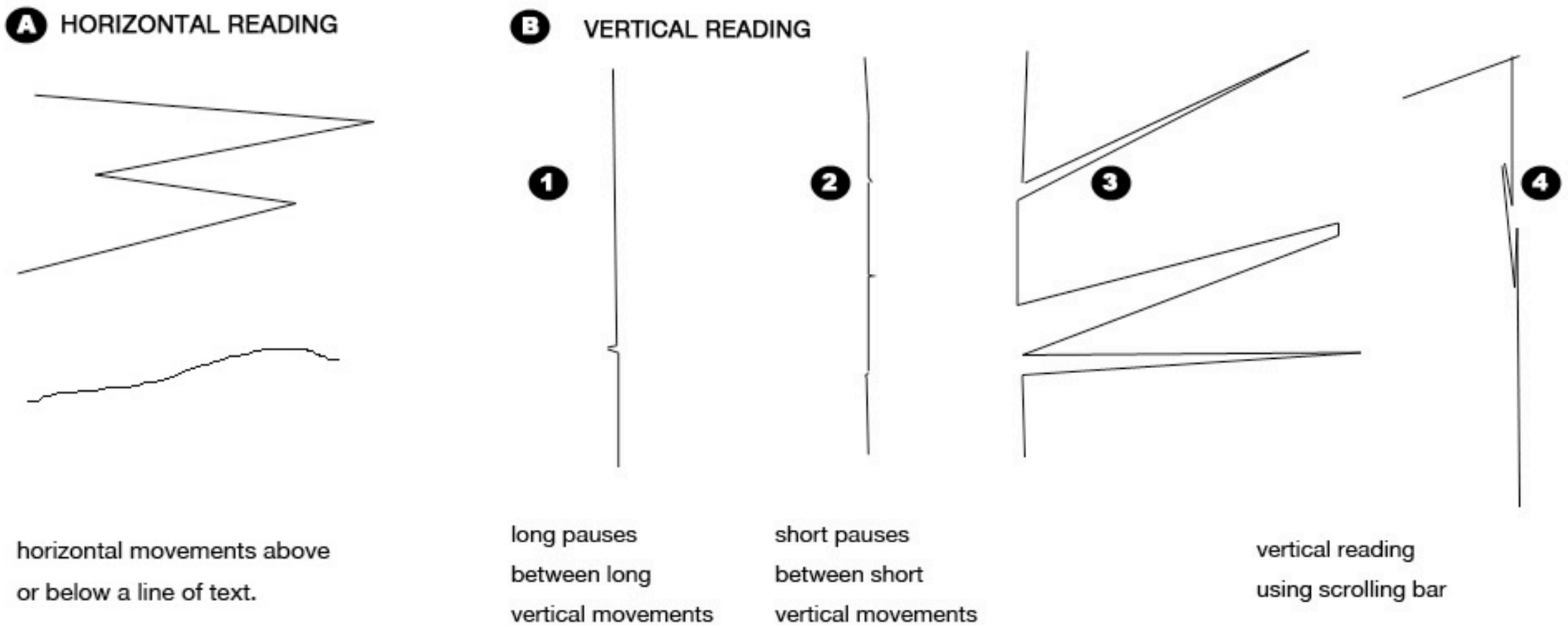
Method

Experimental Design: *Operationalization of the variables*

Pilot-test results

Reading pattern ✔ *Differentiate between vertical and horizontal reading reading.*



In our study **we differentiate between the HR and the VR**
because we believe that as suggested by a study comparing the performance touchpad and mouse [11,12] **certain movements**, such as that required for reading horizontal (left to right) **would be easier with a mouse over a touchpad**.

11 Hertzum and Hornbaek, 2010

12 Dillen, Phillips and Meehan, 2005

Method

Experimental Design: *Operationalization of the variables*

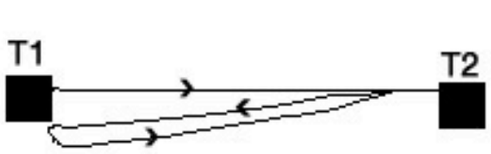
Pilot-test results

Hesitation pattern ✔ *Add a strong and weak dimension (different confidence level)*

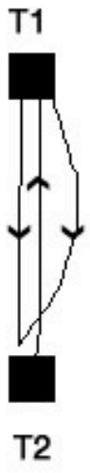
Hesitation pattern

STRONG-HESITATION

A HORIZONTAL



B VERTICAL

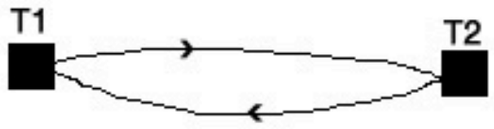


a movement is a **strong hesitation** when the cursor passes at least twice, for at least 2 targets (in the same sequence).

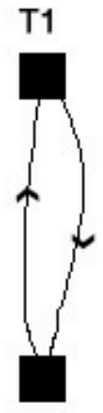
pilot test

WEAK-HESITATION

A HORIZONTAL



B VERTICAL



a movement is a **weak hesitation** when the cursor passes at least twice, for at least 1 targets (in the same sequence).

+ final test

Method

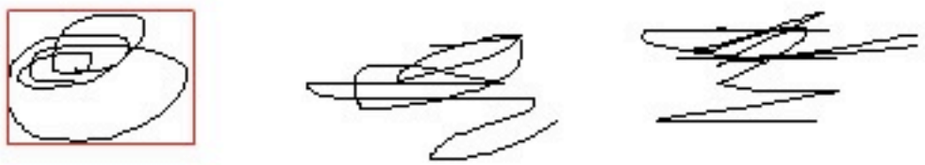
Experimental Design: *Operationalization of the variables*

Pilot-test results

Random pattern

✔ *Add a strong and weak dimension (different confidence level)*

STRONG-RANDOM



Occurs without apparent intention and the distance traveled exceeds at least 3 times, the perimeter that encloses the motion.

pilot test

WEAK-RANDOM

When the density of the movement is smaller, but we think it may be a random act (of "doubt" or "anxiety") and does not respond to a simple re-arrangement of the mouse to change direction.

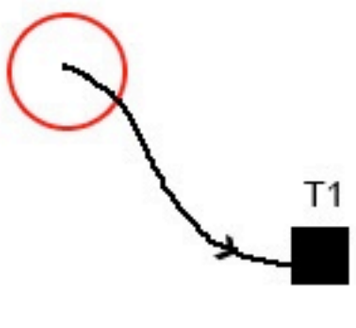
+ final test

Method

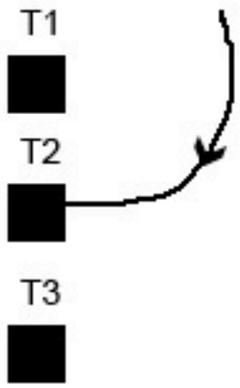
Experimental Design: *Operationalization of the variables*

Pilot-test results

Direct Movement ✔ *In contexts of form considering the absence of hesitation a DM*



A DM may include a pause before (or not).
But always in relation to a target (button, link)



In the context of a form, with multiple options
when the user goes directly to one of them (without hesitation)

pilot test

+ final test

Results

✔ **Pilot test**: 17p → *only* 7 sessions *have been fully completed without errors (on the record)*

↓

No statistically valid results, but so far **the general trend validates our H1**

- ✔ in all cases -without exception- using the touchpad reduced the level of **activity**
- ✔ observed a reduction in H and HR patterns for touchpad users (H2 y H3)

Results

Overall activity by Group (H1)

Activity

Sample: 7p,

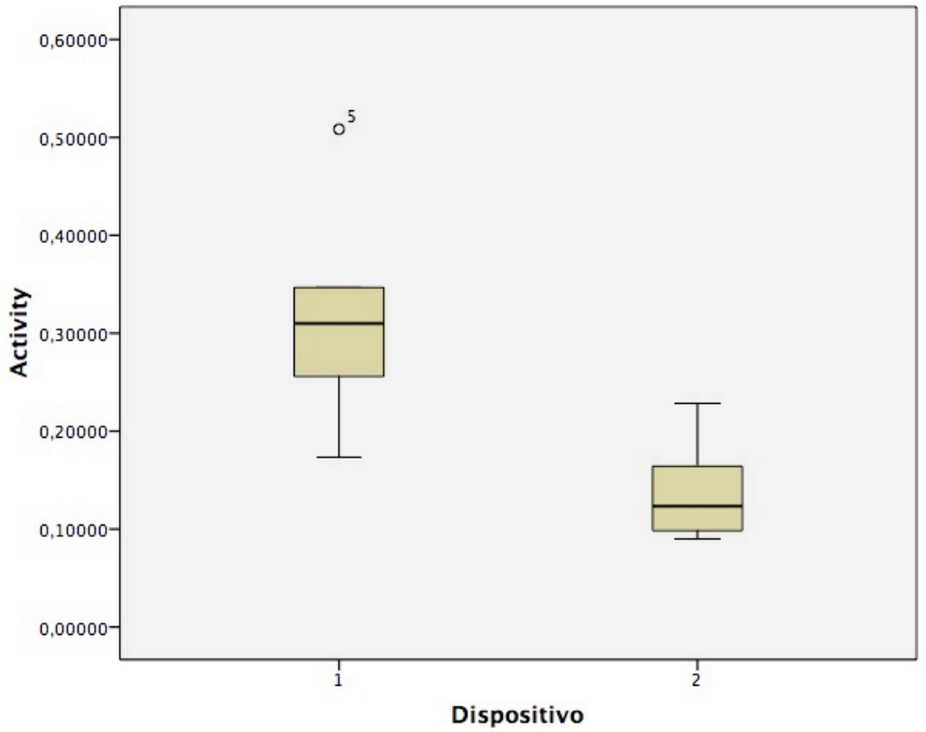
all the stages together.

Paired samples T-test for *Activity:*
Sig. .006 (reject null hypothesis)

As expected, there seems to be a significant difference in *activity* level between groups.

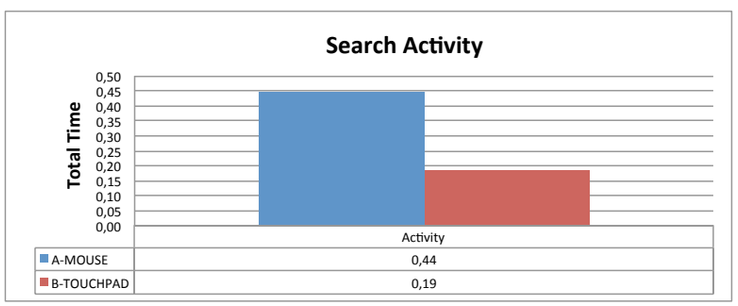
In all the users so far (17p.) shows a decrease in the level of activity when using a touchpad.

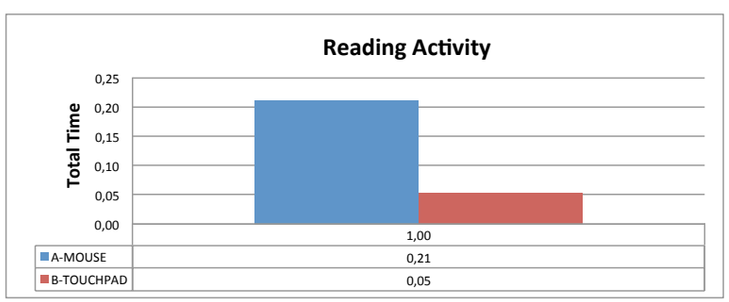
Differences in activity are higher on the reading task.

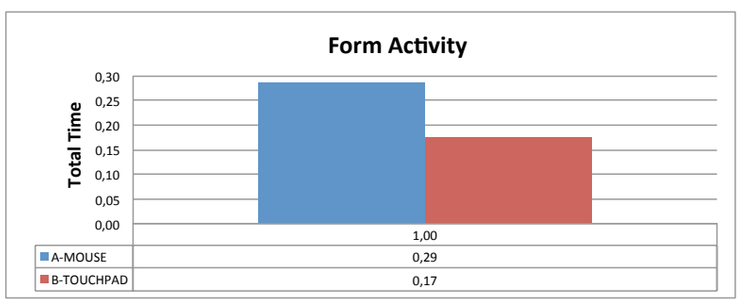


Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Activity_mouse - Activity_touchpad	,17571	,11287	,04266	,07133	,28010	4,119	6	,006







Results II

Patterns frequency by Group (H2 - H6)

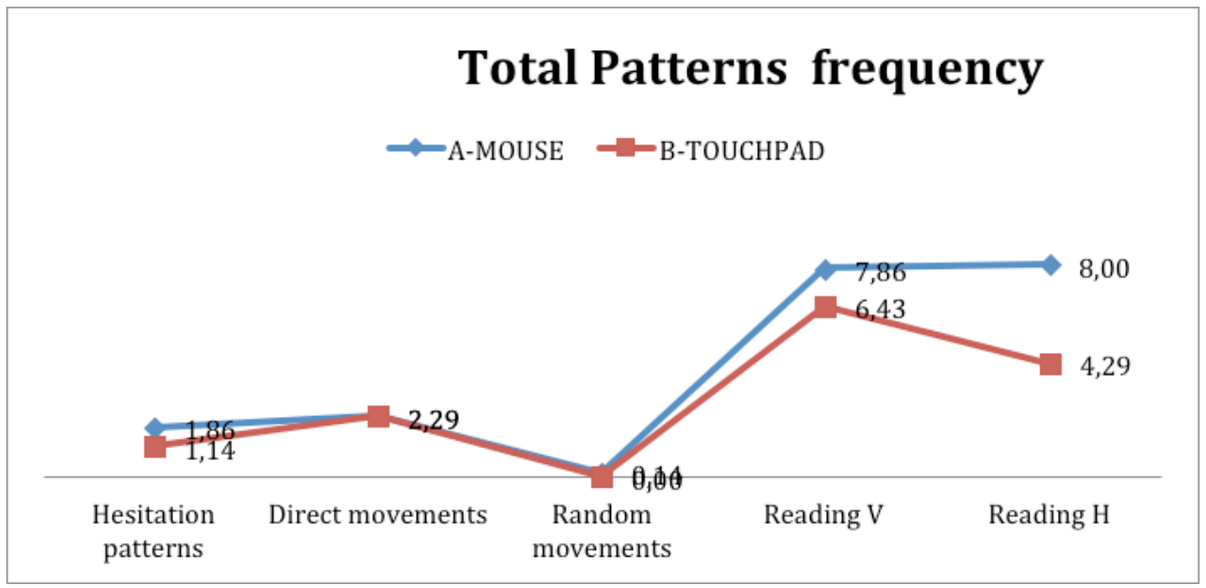
Patterns frequency

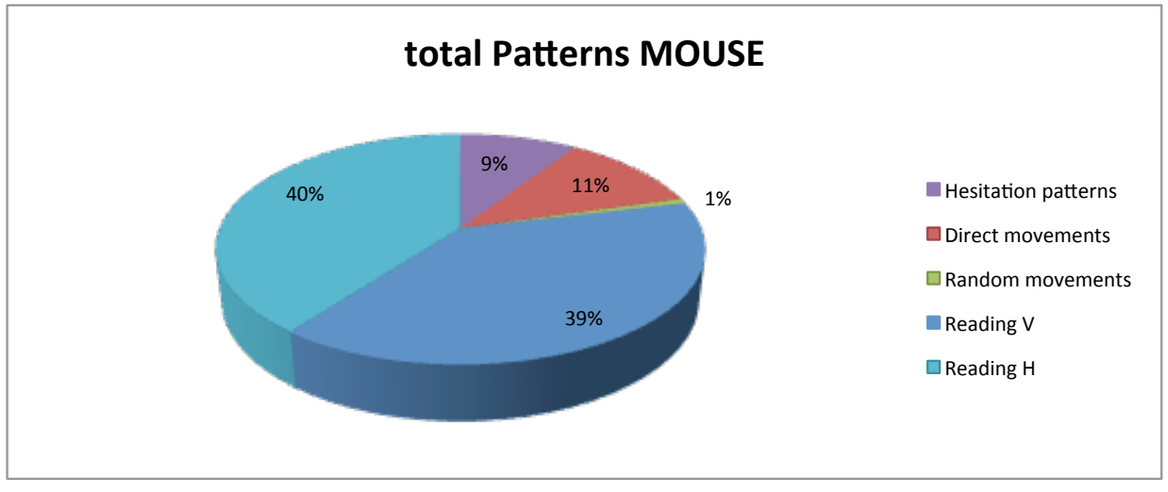
Sample: 7p,
all the stages together.

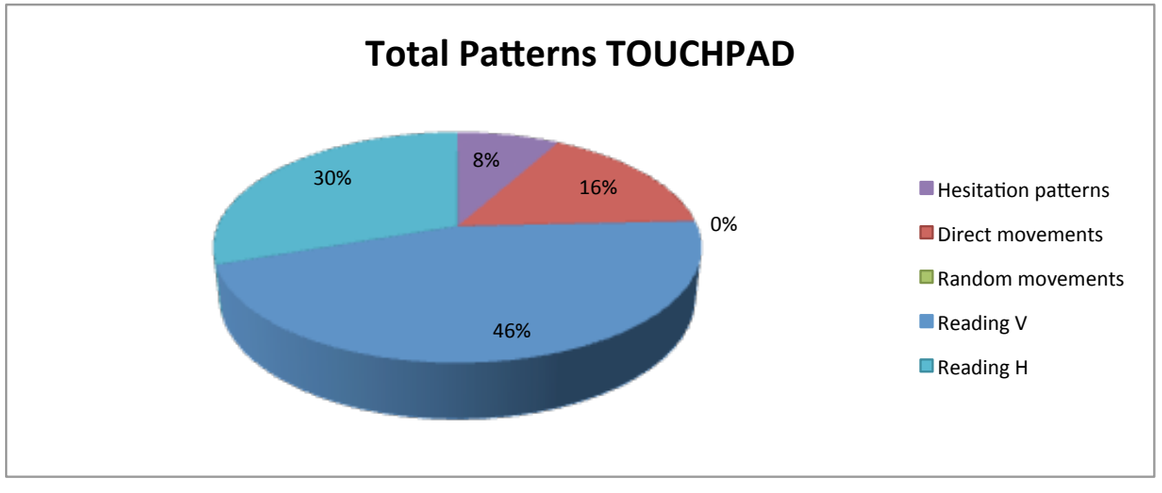
So far have only resulted in significant differences for the following variables:

H (hesitation): .047
HR (horizontal reading): .026

We expected a decrease (for group B) in the pattern of HR and we have confirmed (for Group B).
H, DM, R, should be redefined in the final tests.







Results II

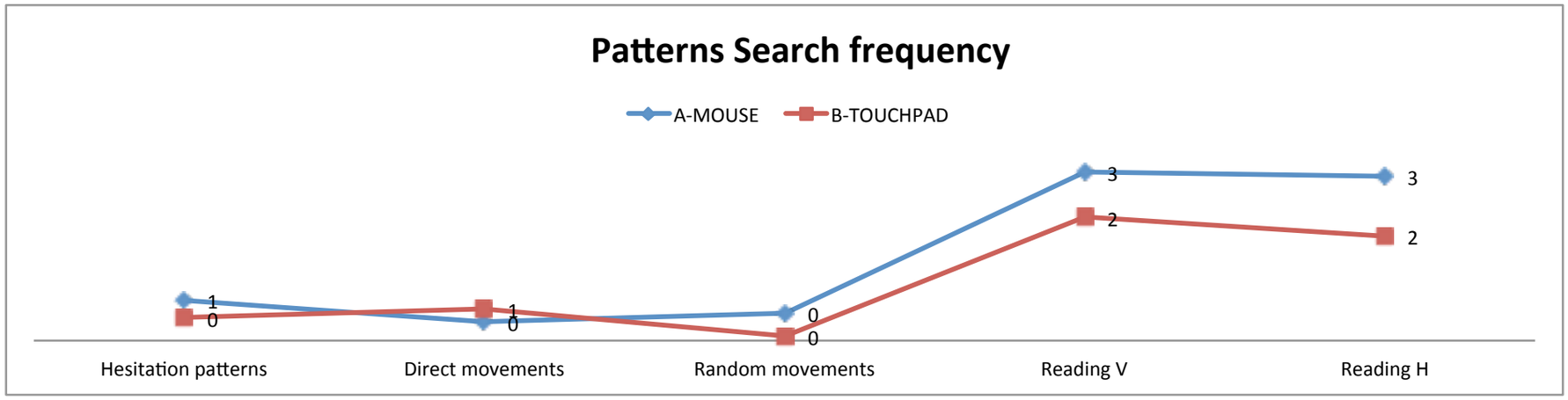
Patterns frequency by group and task (H7 - H8)

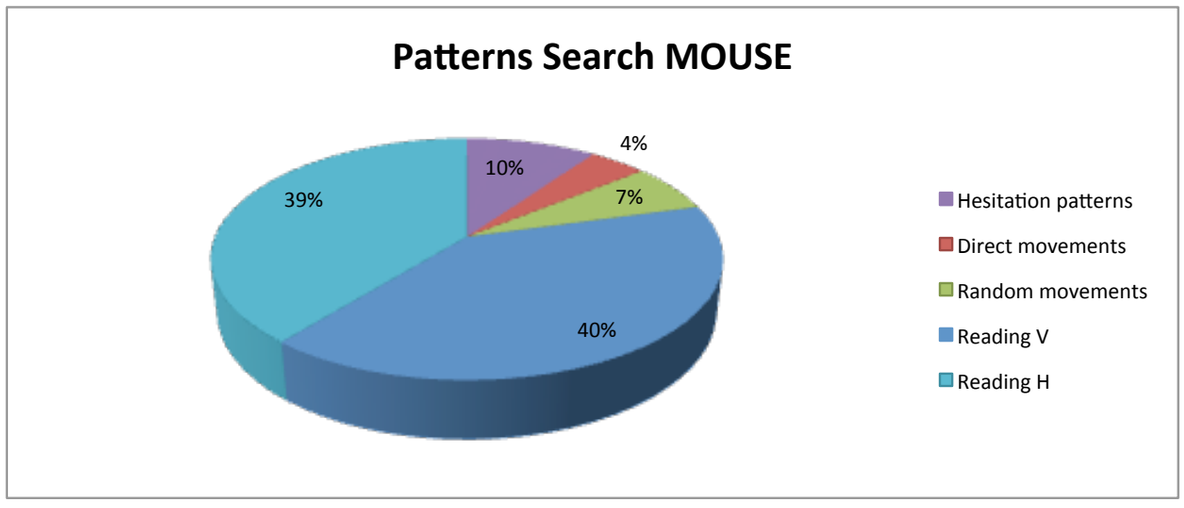
Search task

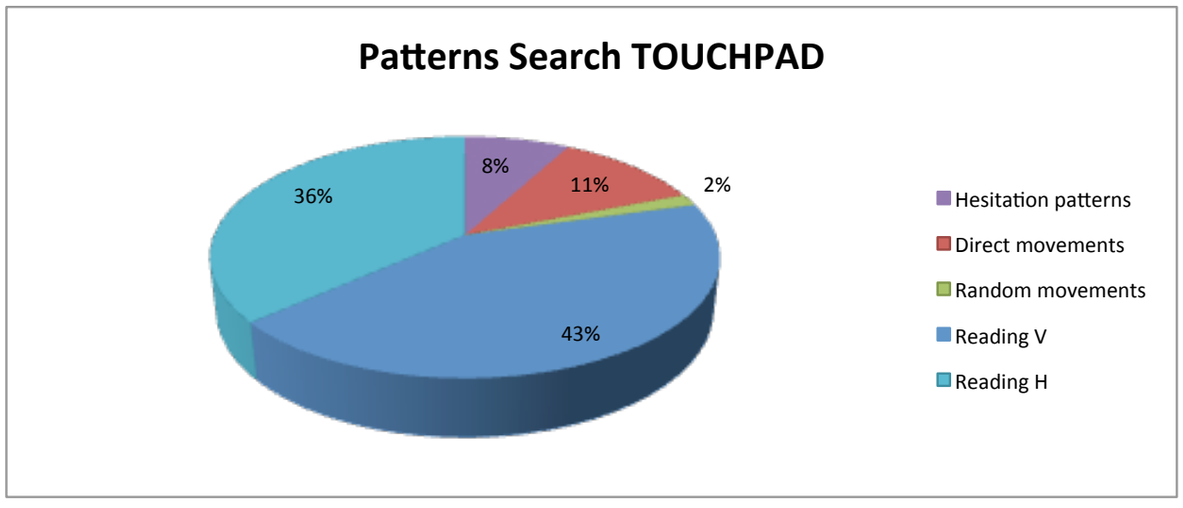
Sample: 13p,

For the *Searching* task have been significant differences for the following variables:

VR (Reading vertical): .022
Activity: .000







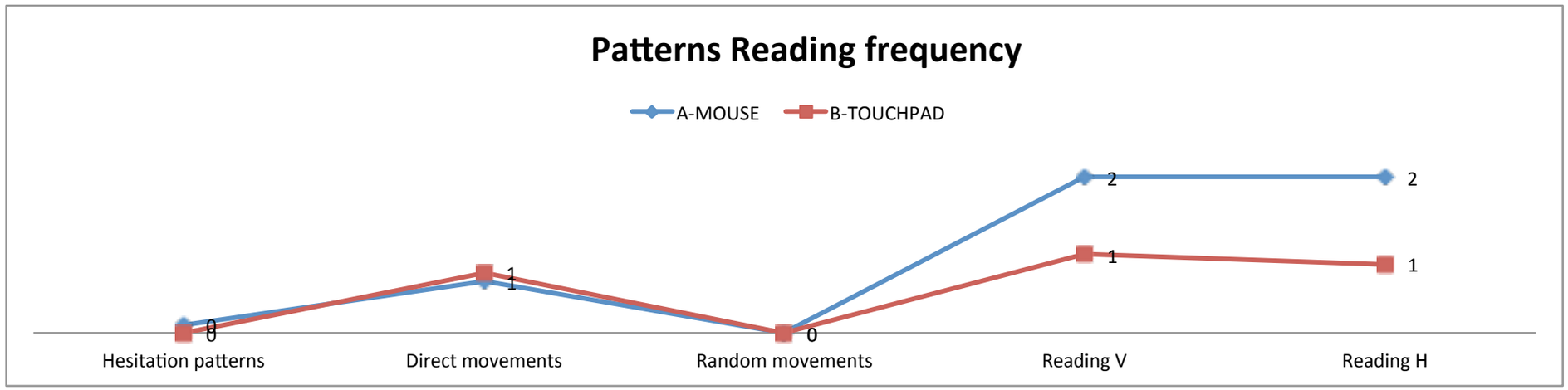
Results II

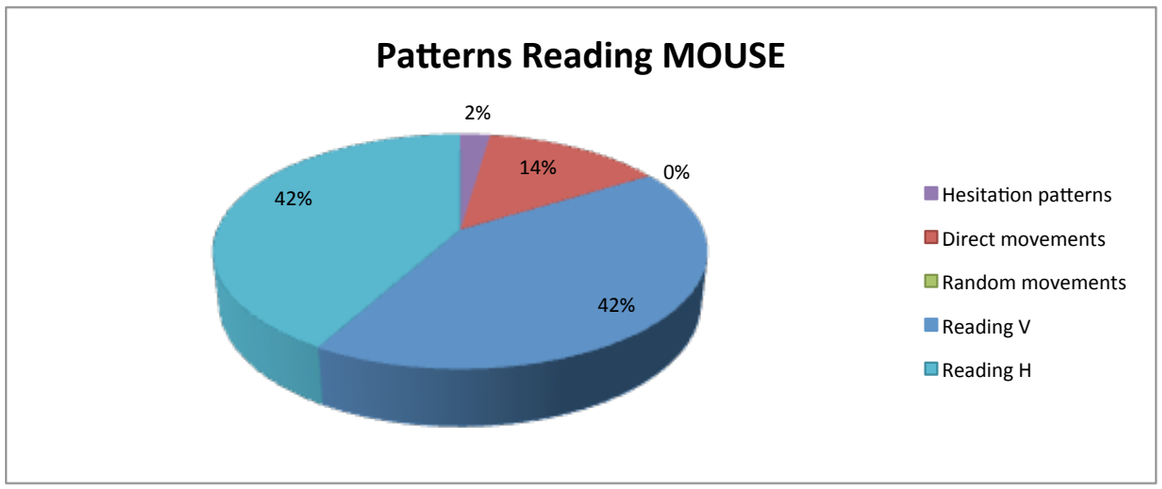
Patterns frequency by group and task

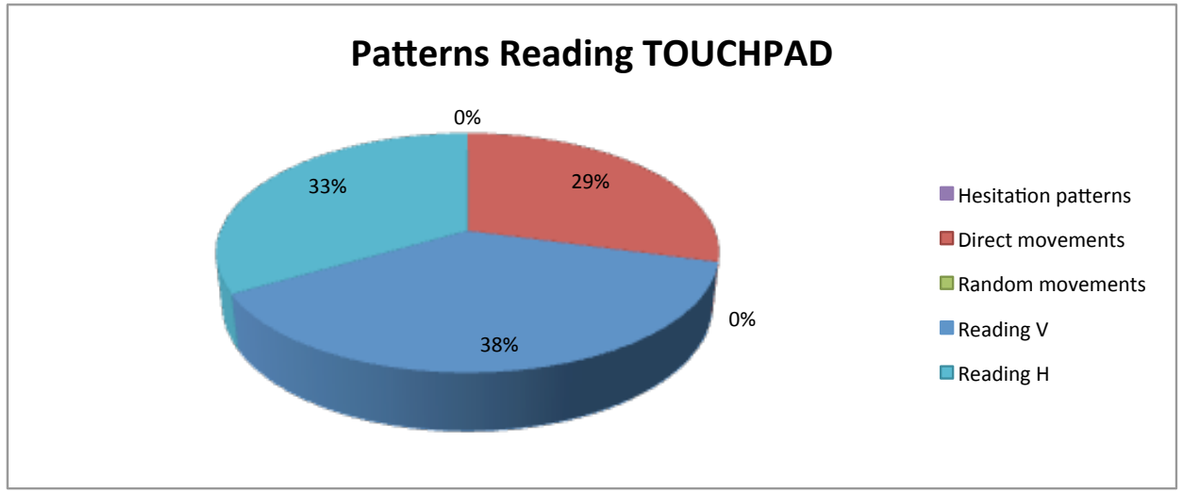
Reading task

Sample: 8p,

For the *Reading* task have been significant difference for the VR (vertical Reading) variable: .002







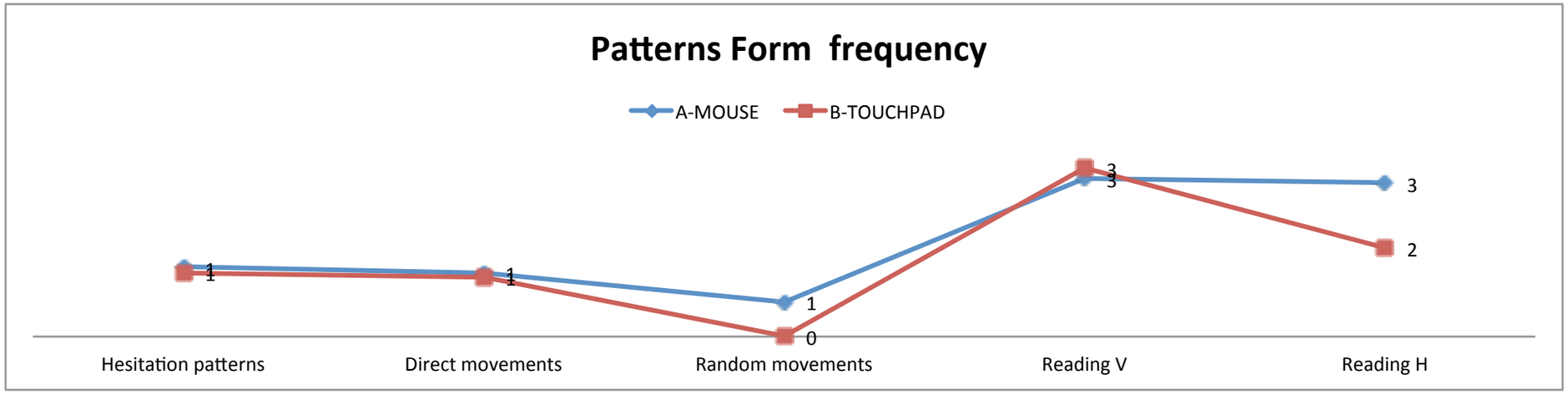
Results II

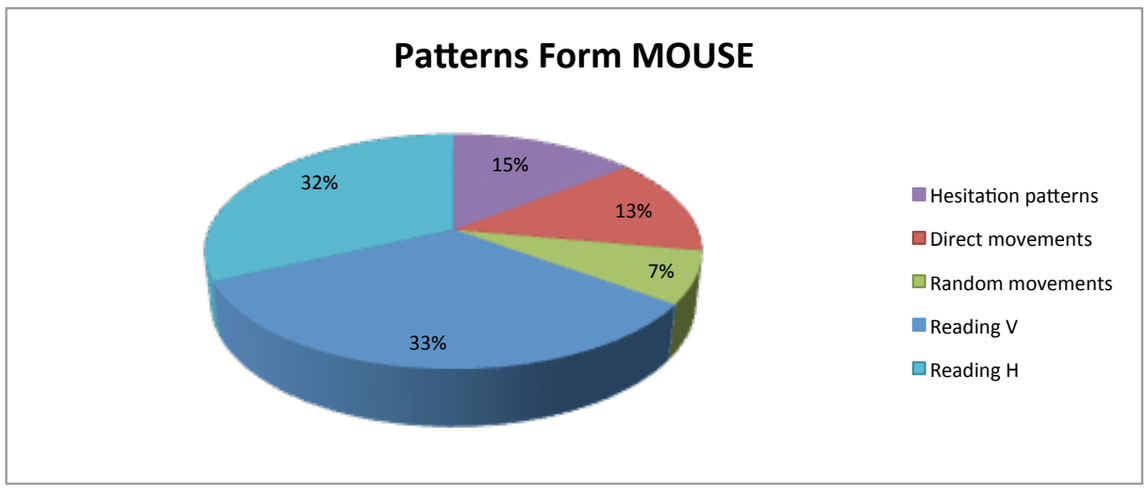
Patterns frequency by group and task

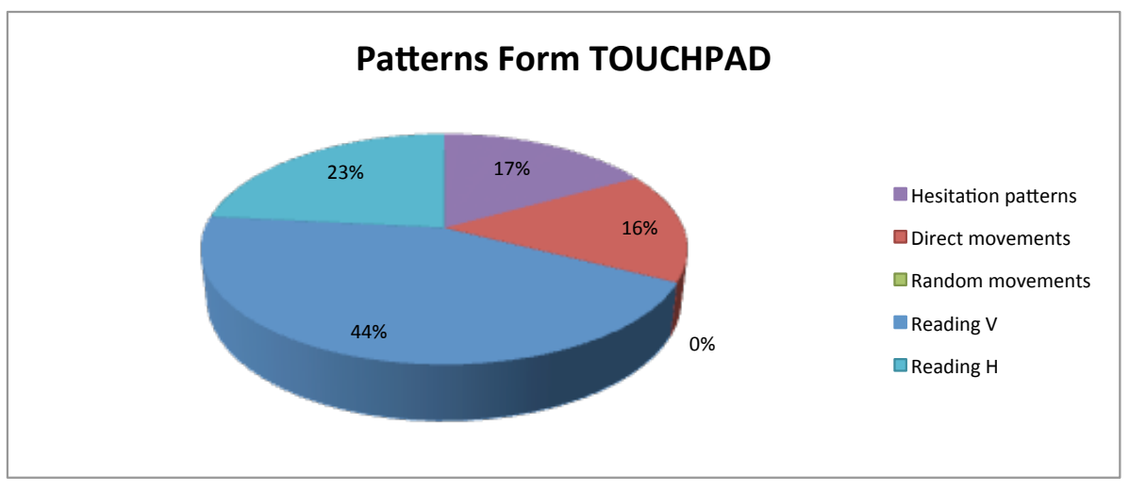
Fill in form task

Sample: 12p,

no significant differences have emerged







Conclusions

- User behaves differently when working with a mouse or touchpad. Suggests a more incidental use of the cursor for touchpad group (user tend to take decisions before make the move)
- **searching task** observed an increase in direct movement (DM) and decreased of Hesitation on touchpad group.
- **reading task** there is a decrease of Reading patterns (VR-HR), and increased DM on touchpad group.
- **Fill in form task** more random behavior observed among *mouse* users.
- In a sample of 17 users only 2 were **very active users** (over 40%). In both cases, were very active with the mouse, and showed an average activity for the touchpad.

future research lines

- outline more detailed taxonomies for patterns
- applying machine learning to identify patterns
- Specific tests can be designed to find features of each pattern:
  Reading pattern: test differences in the characteristics of the texts (length, complexity, font size, contrast ..)
  Hesitation (distance between targets, number of targets, length of items, etc)

...

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