

Research in the wild

Reflection on research and data collection in theory and practice

Lecture

Nico's research journey

- **Bachelor thesis**

interaction with large multi-touch displays; digital storytelling

- **Master thesis**

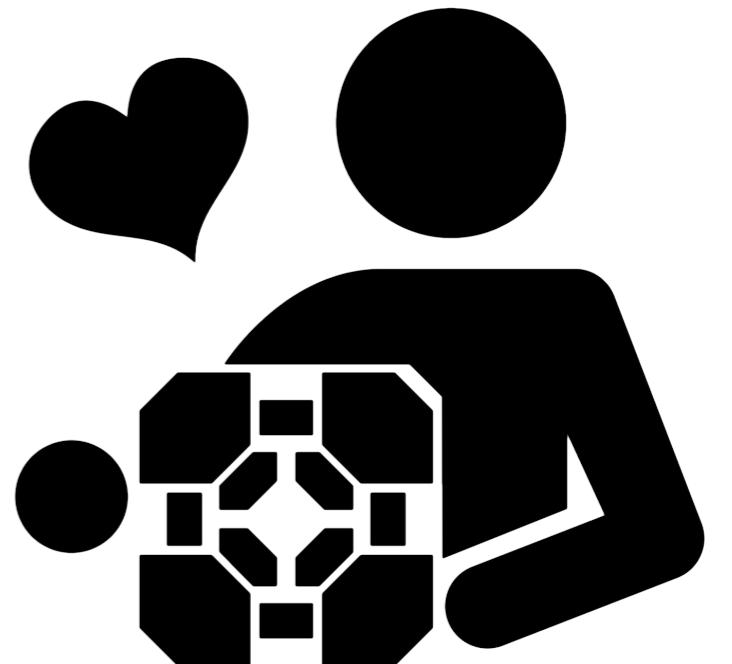
open data exploration; virtual reality;
vision-based motion controls

- **Early doctoral study (PhD) work**

open data exploration; virtual reality; gamepad; vision-based
motion controls; room-scale virtual reality

Bachelor thesis

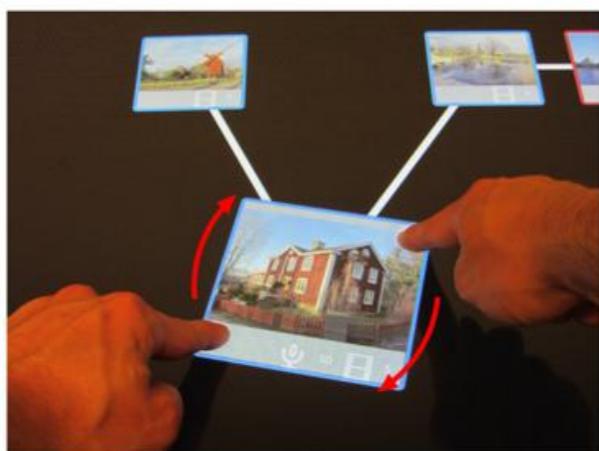
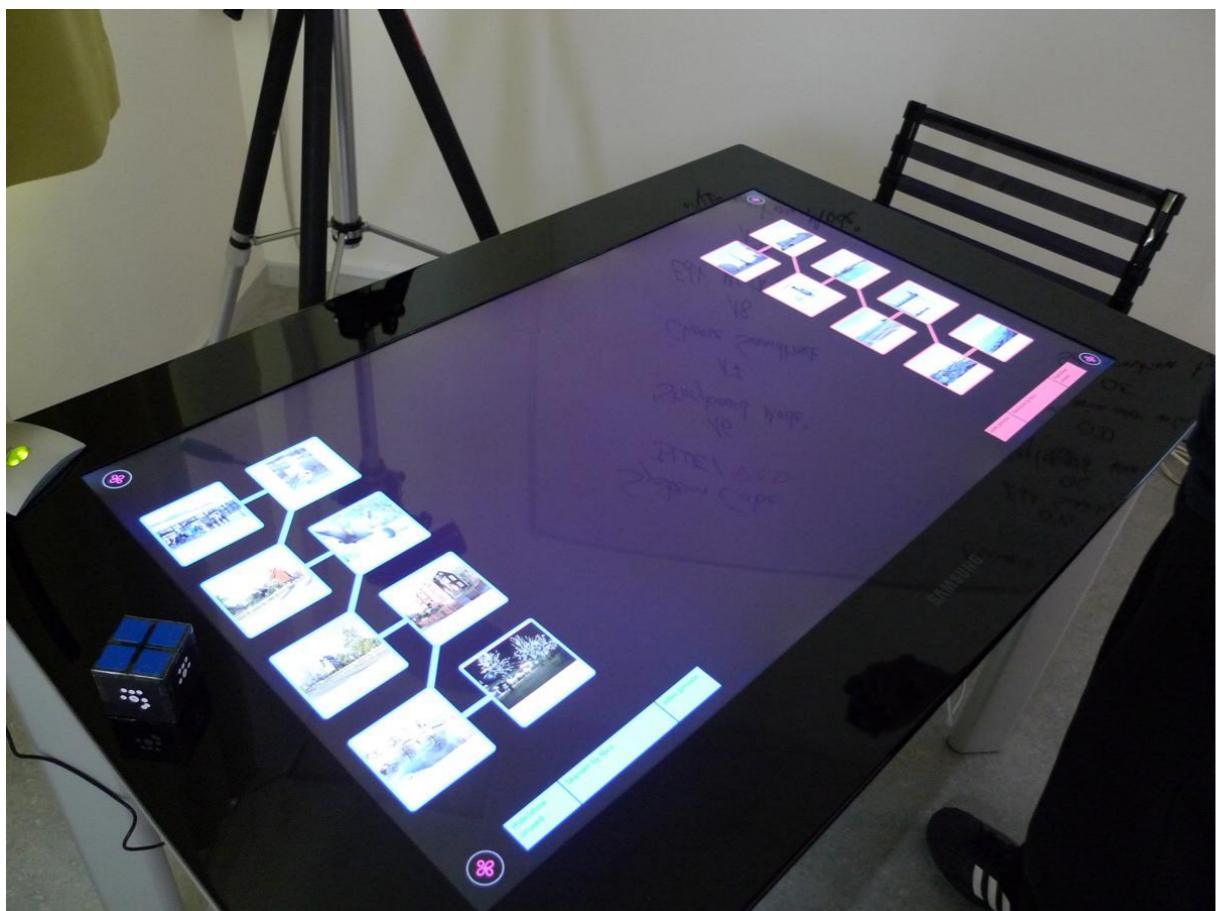
interaction with large multi-touch displays; digital storytelling



Scenario

- interaction with a large multi-touch display (SUR40)
 - natural user interface: touch
 - tangible user interface: tangible elements (cubes)
- digital storytelling
- support collaboration: two users at the same time
- information sharing

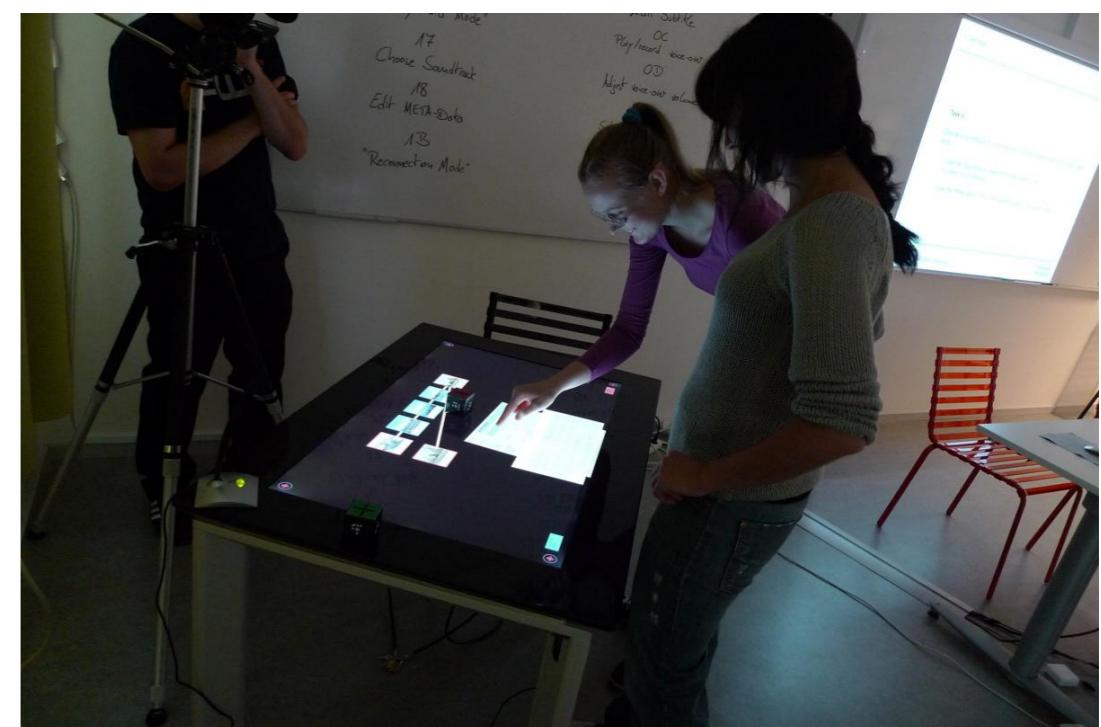
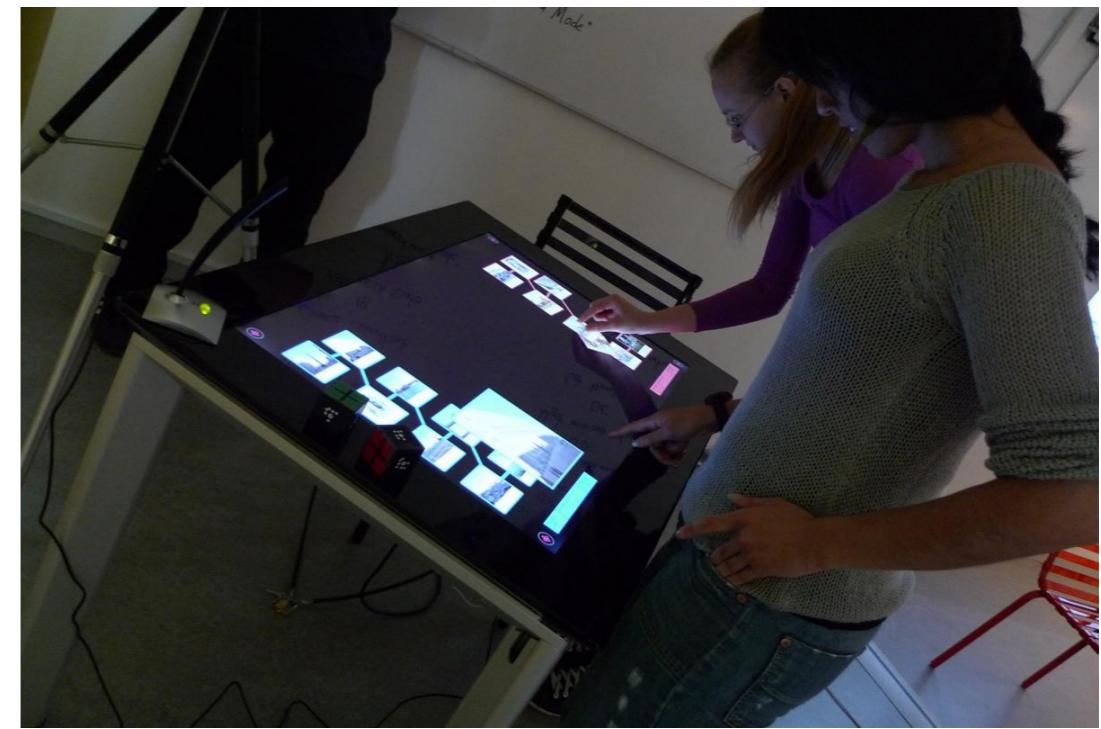
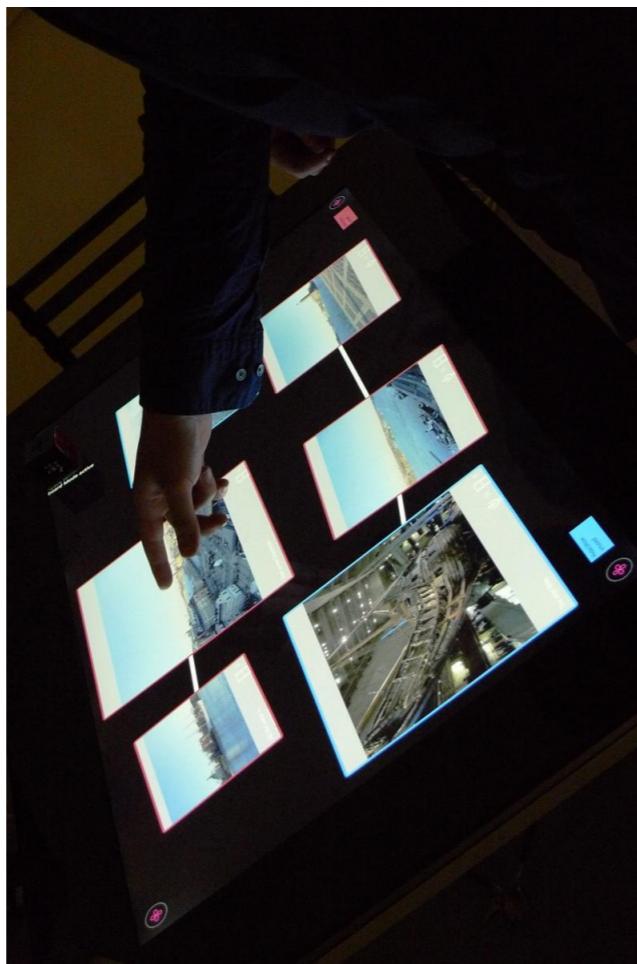
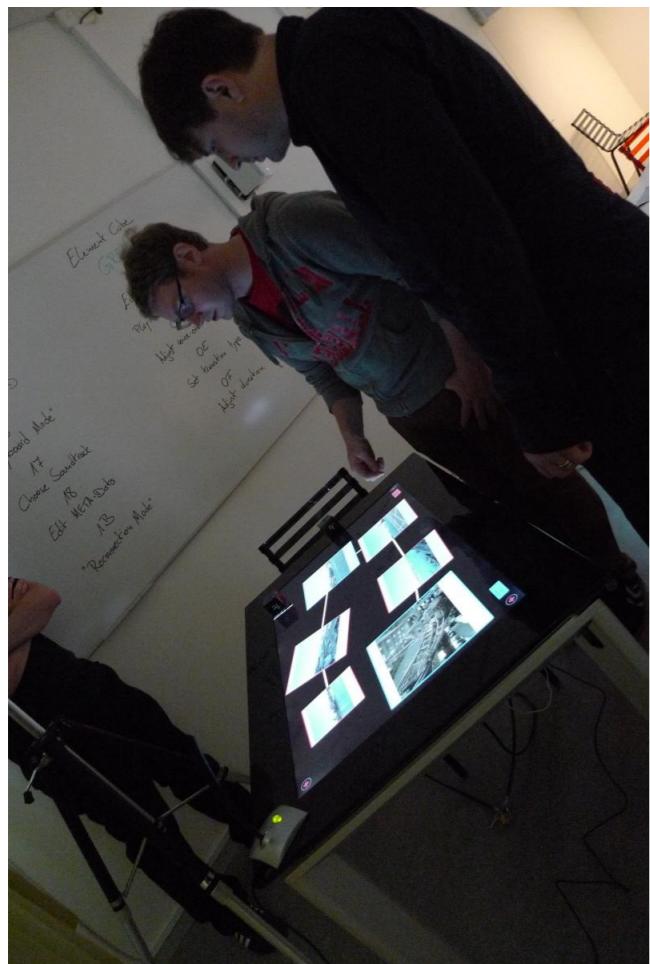
Developed prototype



Study



Study



Study

- two-on-two session
 - 2 researchers: 1 leading the study, 1 observing/notes
 - 2 study participants: collaboration
- participants n = 10
- duration: ~1 hour
- 3 phases
 - pre-session
 - test (participants using the tabletop prototype)
 - set of pre-defined tasks
 - post-session

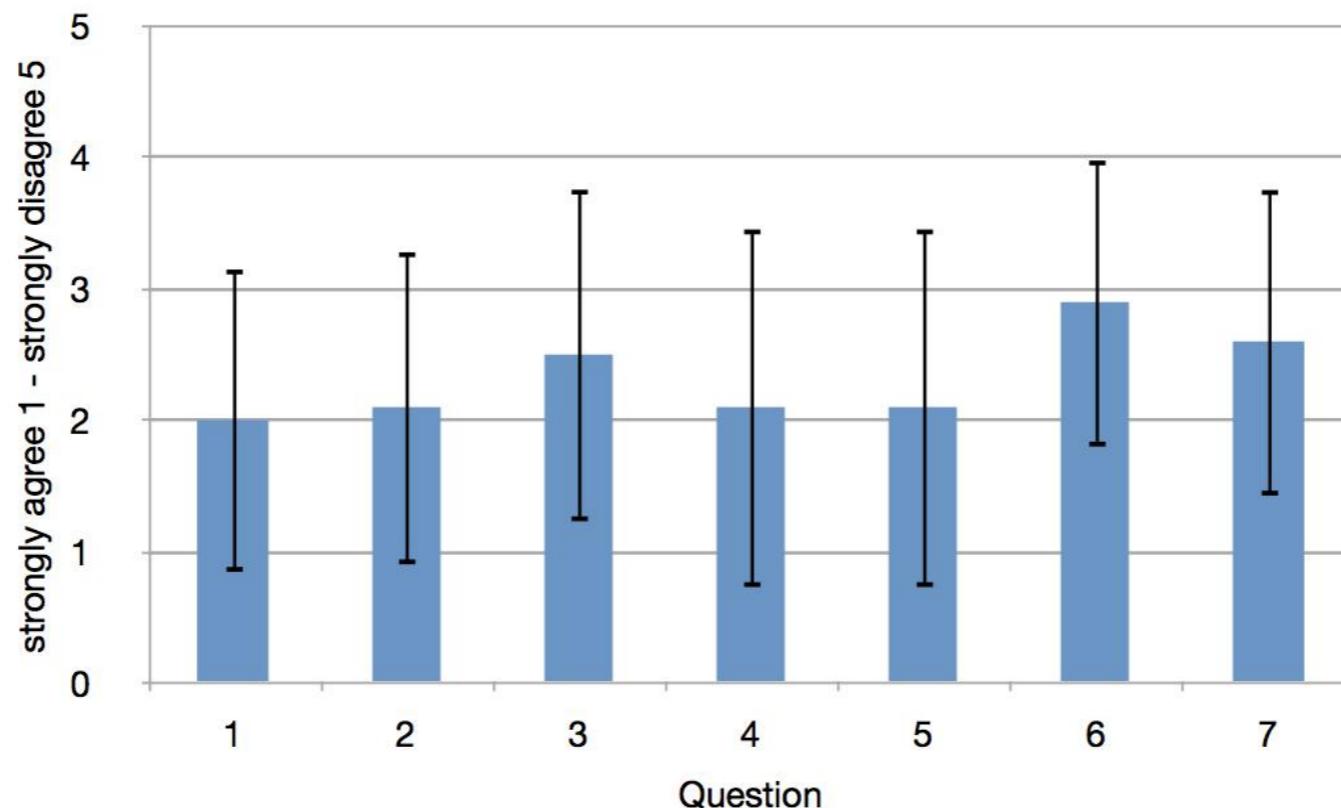
Data collection

- self-constructed questionnaire
 - different investigation “categories”
multi-touch; tangible user interface; collaboration and simultaneous interaction
on-screen; verbal collaboration during using the application; overall
 - 5 point Likert-scale (quantitative data)
 - open questions (qualitative data)
- AttrakDiff questionnaire
 - standardised approach to measure usability and design
of a product
- video recording (as backup)
- think-aloud protocol

Results / Analysis

No.	Statement
1.	It was easy to interact with another person on-screen at the same time.
2.	Simultaneous multi-touch interactions from me and another person were always recognised correctly.
3.	It felt convenient to interact with another person on-screen at the same time.
4.	Sharing objects with another person helped me in my argumentation.
5.	I could always follow what was going on on-screen.
6.	Working on the same objects with another person enhanced my workflow.
7.	Working on the same objects with another person helped focusing on the current task.

Collaboration and simultaneous interaction on-screen: average answers



Results / Analysis



Medium value of the dimensions with
product "Collaborative digital story
telling tool "
confidence rectangle

Master thesis

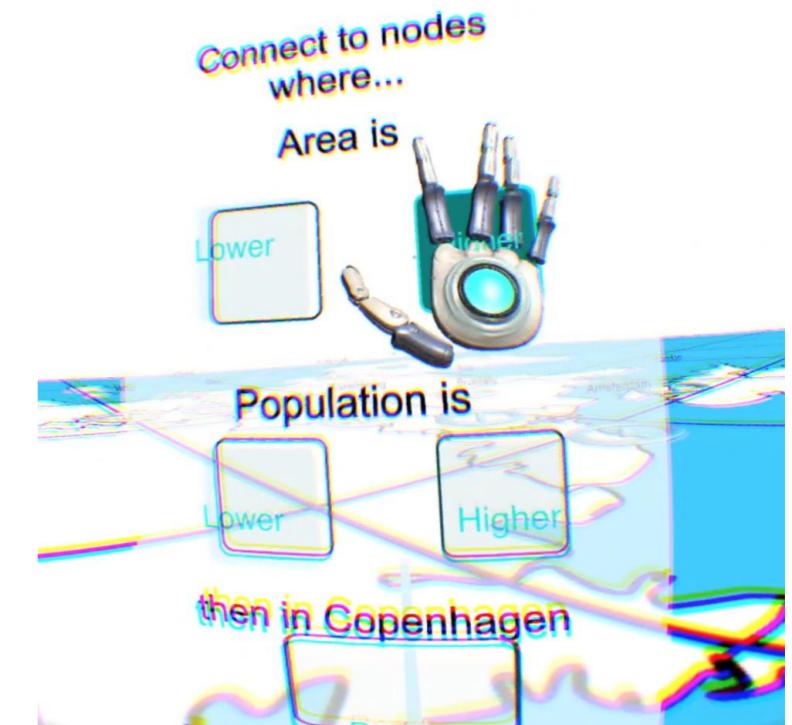
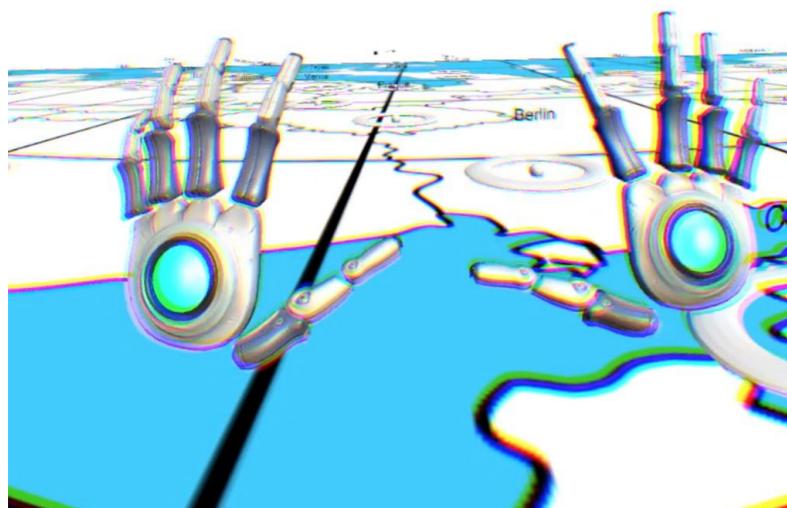
open data exploration; virtual reality;
vision-based motion controls



Scenario

- open data exploration (network-like)
 - data received from various open online sources
 - virtual reality using head-mounted display
 - vision-based motion controls for interaction
- explorative, non-time sensitive setting
- exploration of European capital cities

Developed prototype



Study



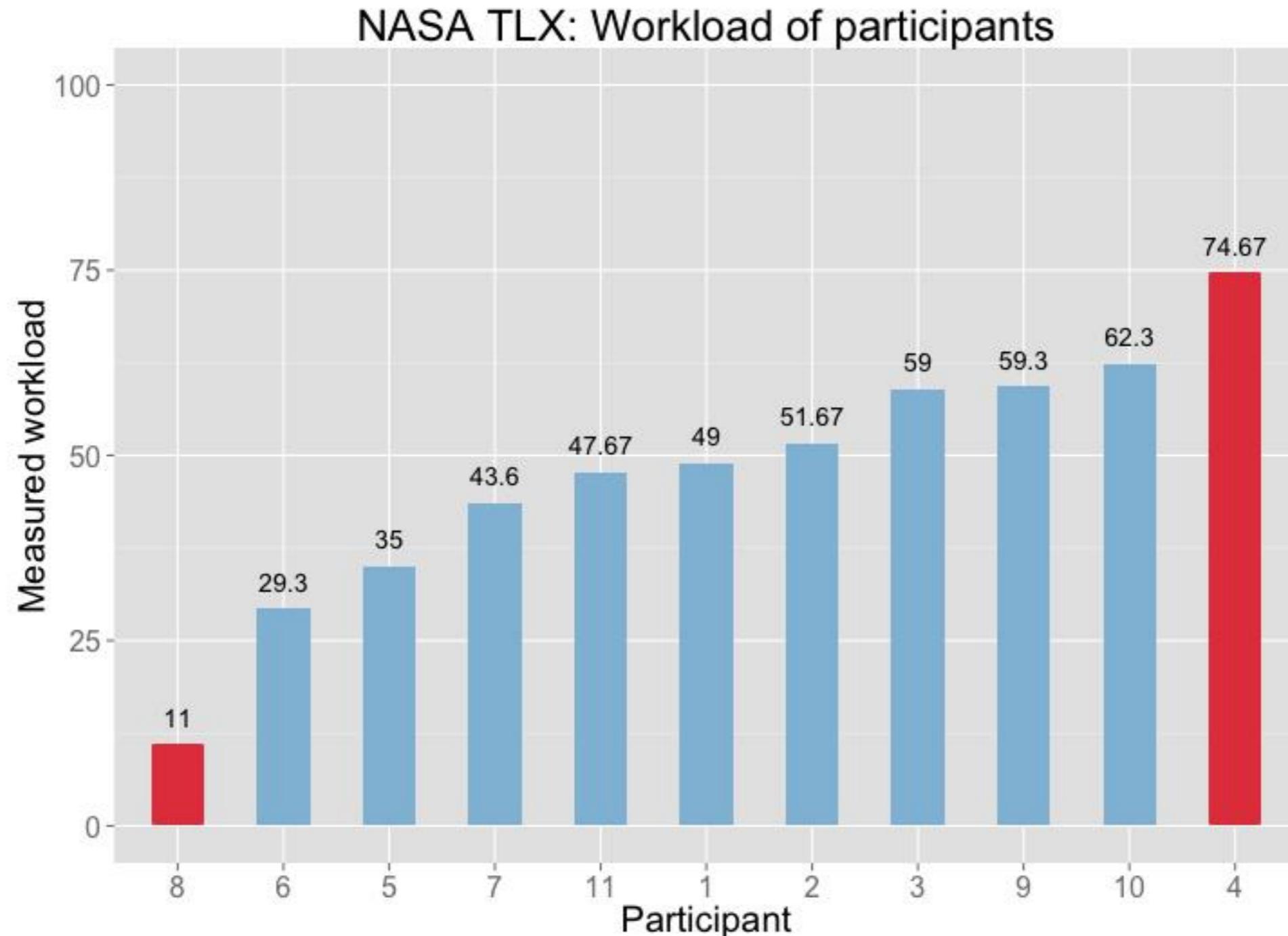
Study

- one-on-one session with 1 participant at a time
- participants n = 11
- duration: ~1 hour 15 minutes
- 3 phases
 - pre-session
 - test (participant using the VR prototype)
 - warm-up, task 1, task 2
 - post-session

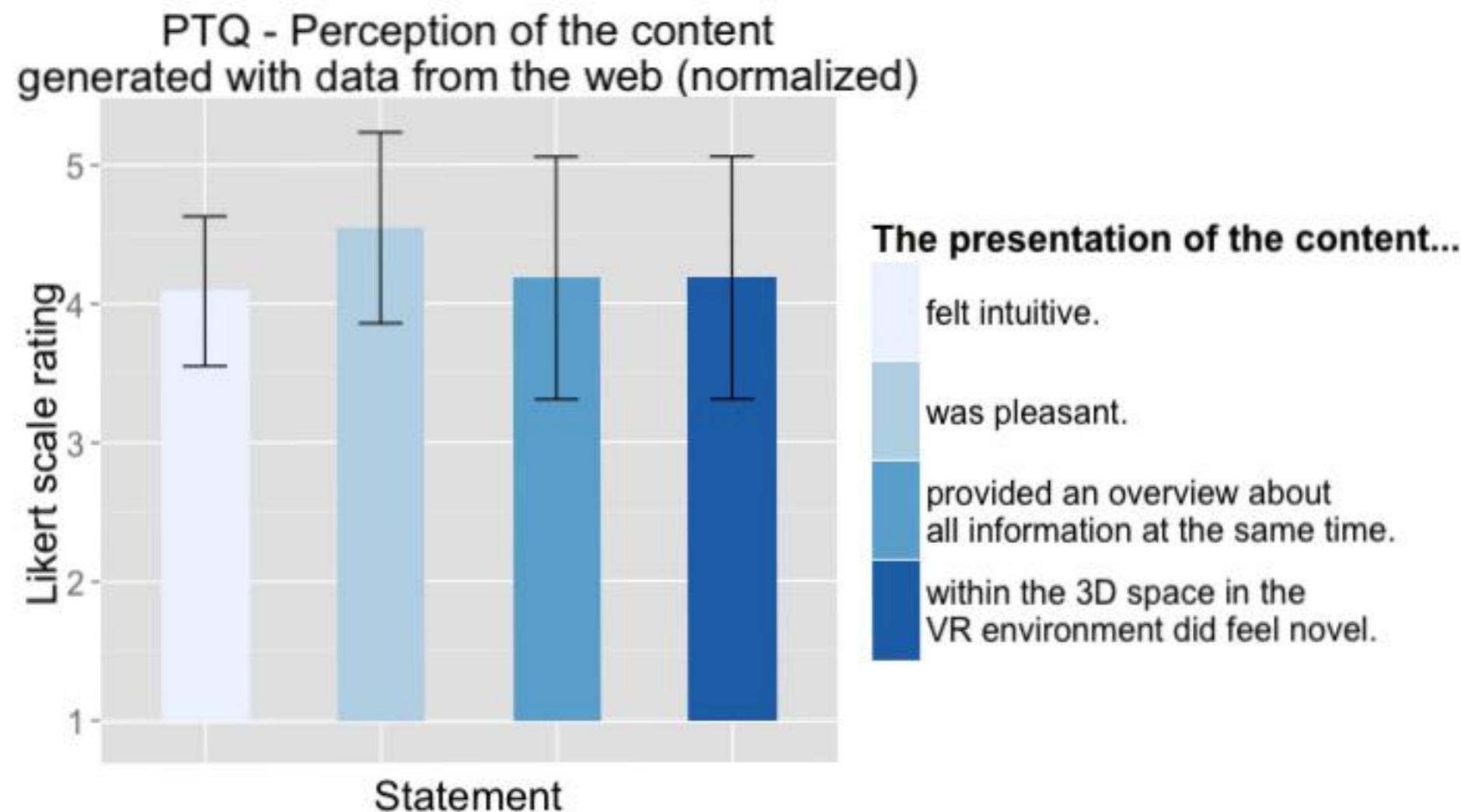
Data collection

- self-constructed questionnaires (pre- and post-session)
 - 5 point Likert-scale (quantitative data)
 - open questions (qualitative data)
- observations
- think-aloud protocol
- NASA Task Load Index (TLX) questionnaire
 - standardized method to report workload in self-assessment
- logging system
 - implemented in the VR application; keeping track of every user interaction

Results / Analysis: Workload (NASA TLX)



Results / Analysis: Likert-scale



Results / Analysis: Logging

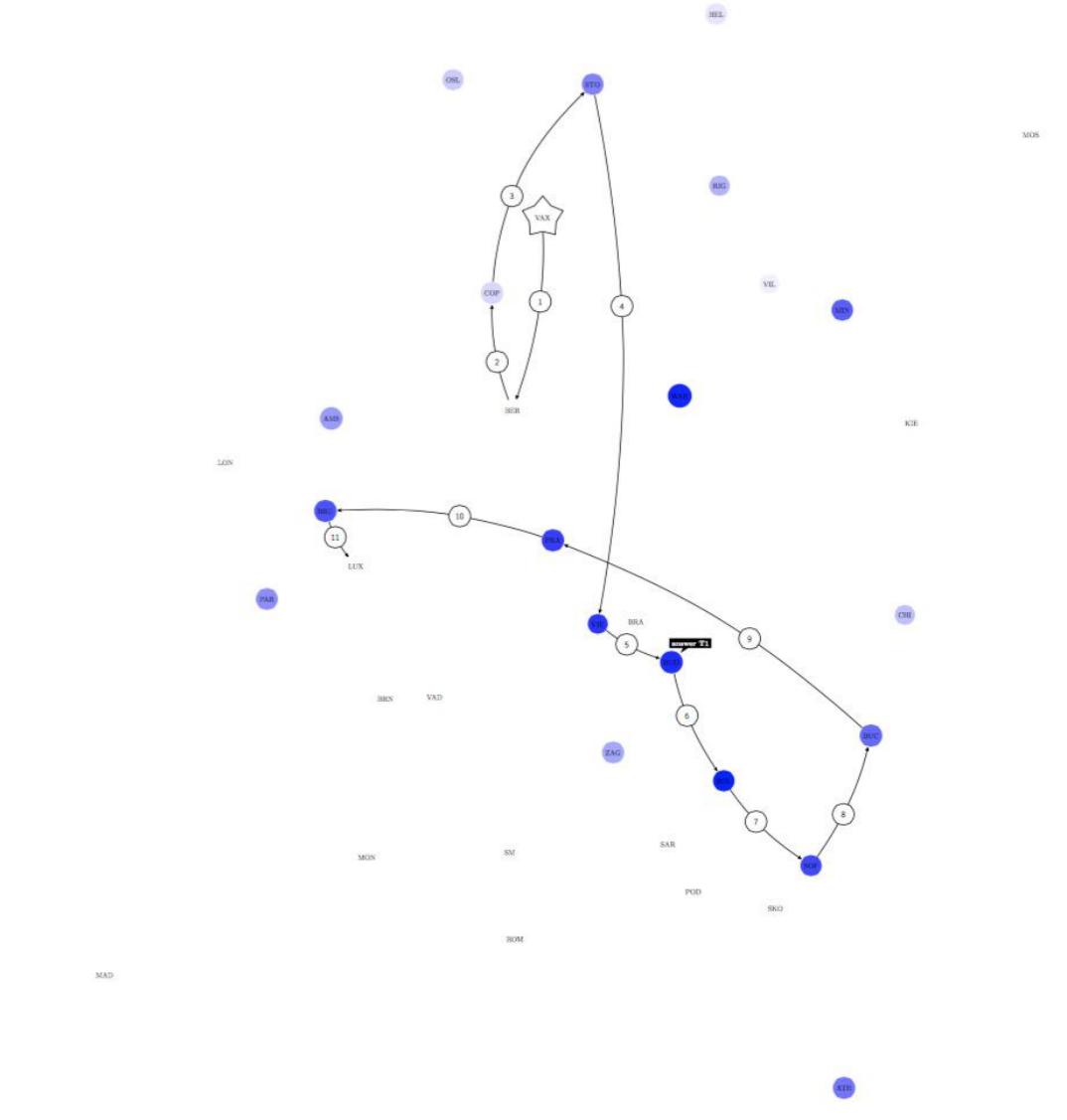
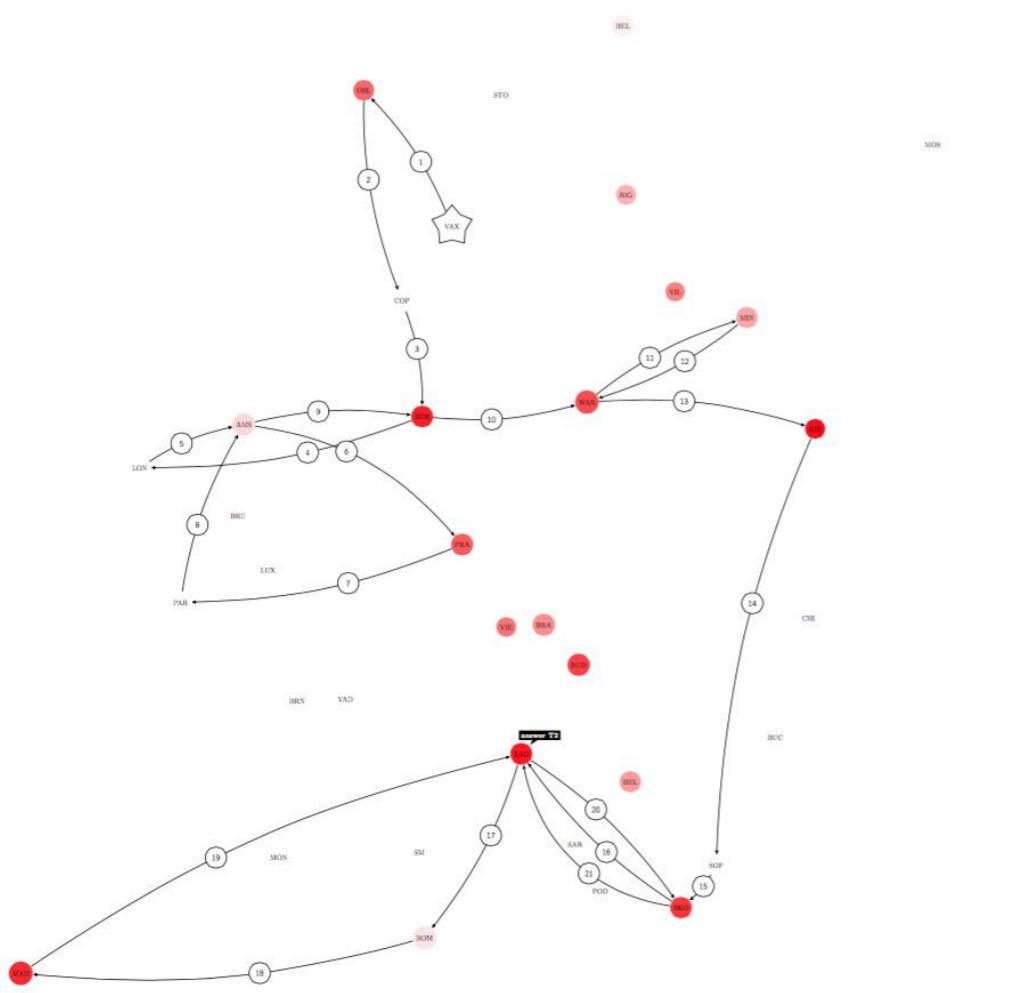
Analysis			Task 1		Task 2		
			AVERAGE	STDEVA	AVERAGE	STDEVA	
Average time spent in traveled City (in sec)			32.94	12.94	31.82	10.93	
Amount of unique visited cities (max. 45)			11	4	11	4	
Amount of visited cities			14	5	13	5	
Amount of interactions			42	15	48	19	
	Movement/Travels	SUM	15	8	15	8	
		Successful	13	5	12	5	
		Unsuccessful	2	3	1	2	
		Forbidden	1	3	2	2	
	Content Exploration	SUM	14	5	13	5	
		Trigger	12	4	12	5	
		Dismiss	11	4	12	5	
		Rotation	2	3	0	1	
	Filter Menu	SUM	13	8	20	11	
		Trigger	4	2	5	2	
		Dismiss	4	2	5	2	
	Connection	SUM	8	6	13	10	
		Area	0	1	8	6	
		Population	6	4	1	2	
		Reset	2	2	4	3	
		SUM	1	0	2	1	
	Size	Area	0	0	1	1	
		Population	1	0	0	0	
		Normal	0	0	1	1	
Amount of time for completion (in sec)			421.84	160.61	391.74	142.33	
in minutes			7.03	2.68	6.53	2.37	

Logging system

- “action-object-target” approach
 - each entry within the log file represents an event within the operation of the VR prototype
 - timestamp when the event occurred
 - the “action”, the “object” performing the action and potentially the “target”, the performed action is applied on

Timestamp	Action	Object	Target
1.000000	MOVE	Player	Stockholm
3.000000	TRIGGER	Filter_Menu	
7.000000	FILTER_APPLY	Connection_Area Higher	Stockholm
11.000000	DISMISS	Filter_Menu	

Results / Analysis: Pathway visualization (logging)



re-visiting

straight

Explorative Expert Discussion

- 2 explorative discussions with experts
 - human-computer interaction (3 experts)
 - information visualization (2 experts)
- presentation of the developed prototype
- semi-structured interview
- gain feedback on the developed VR application from the expert point of view

Early doctoral (PhD) work

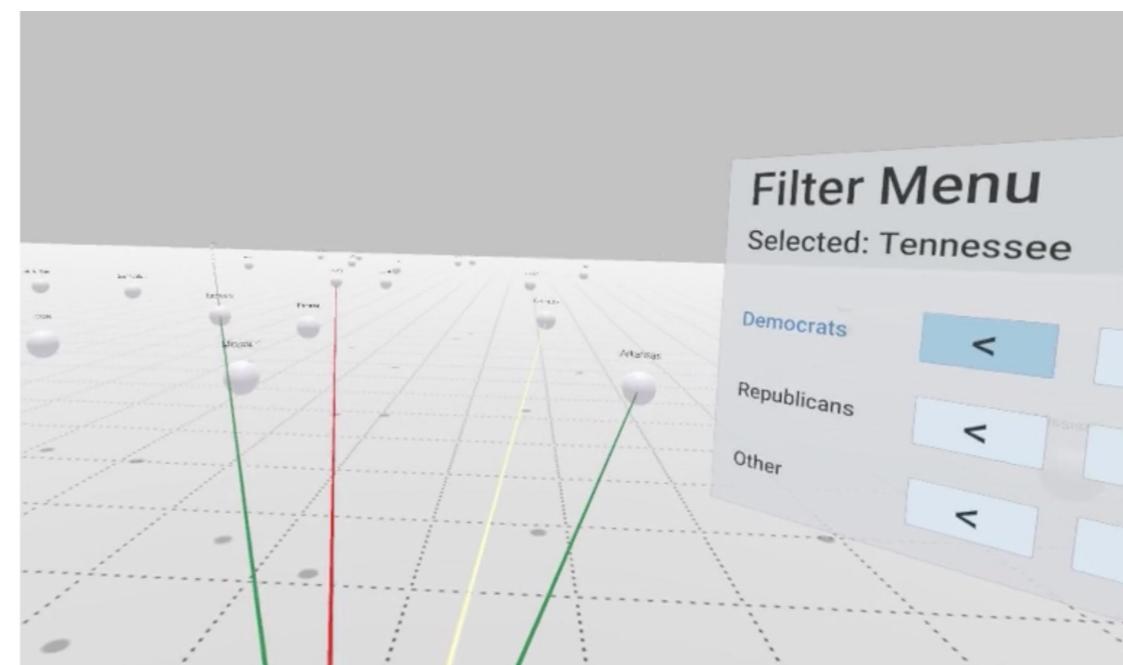
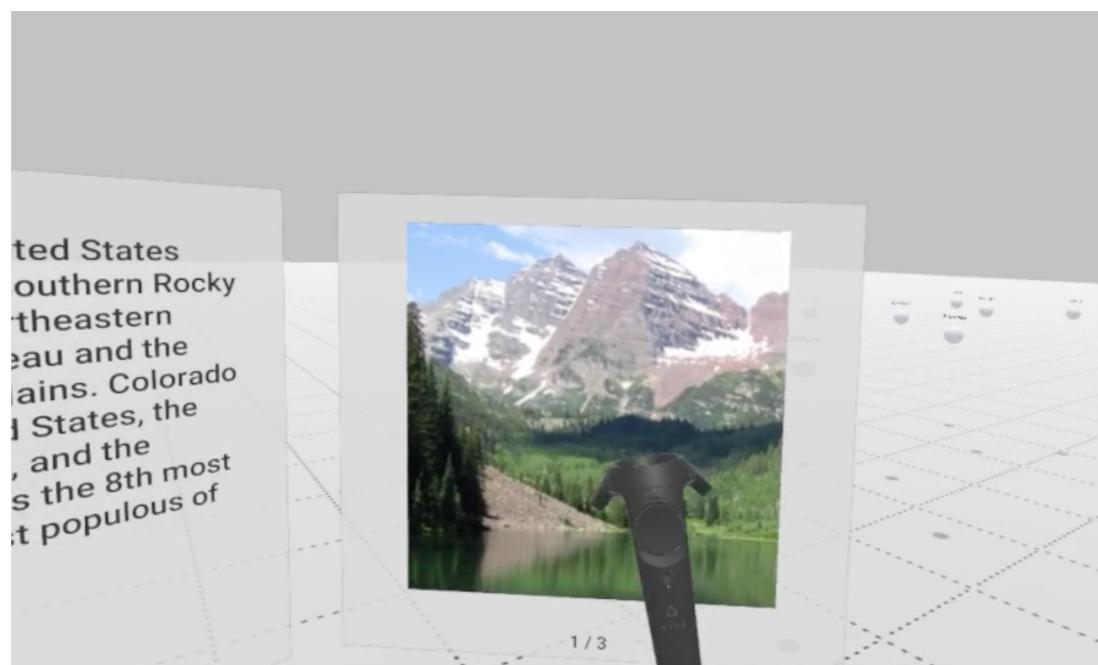
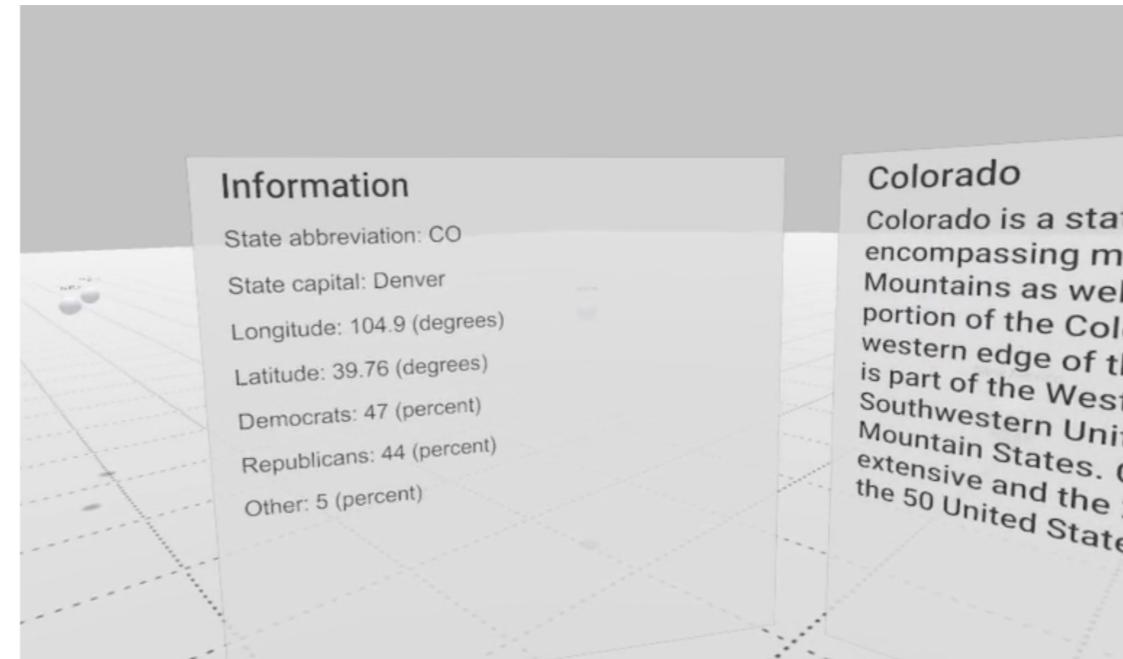
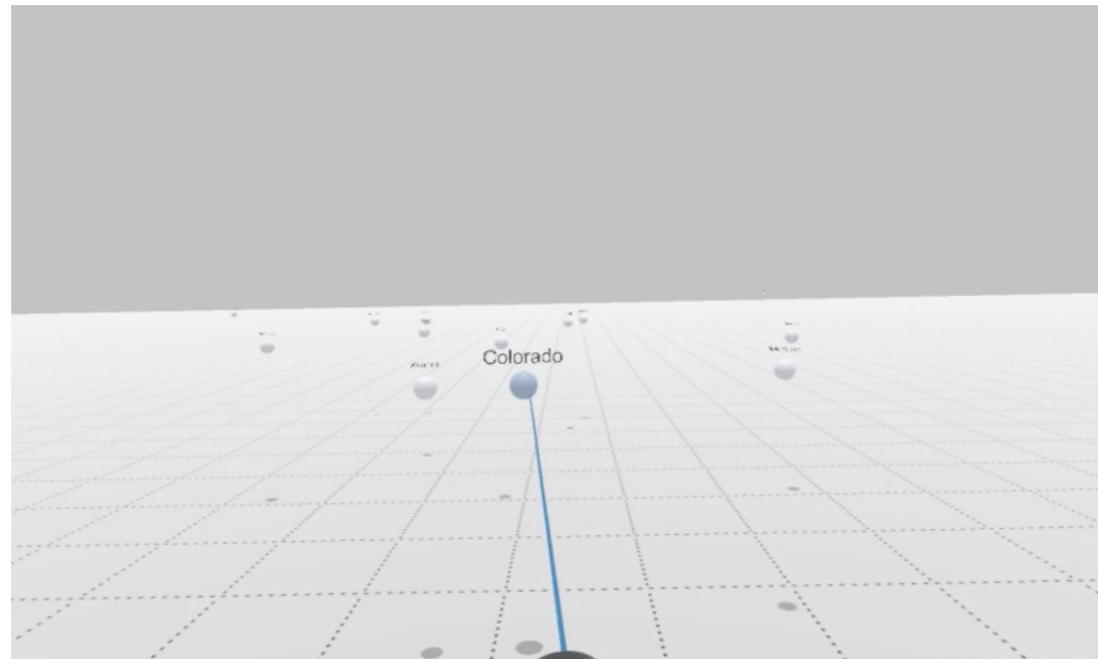
open data exploration; virtual reality; gamepad; vision-based motion controls; room-scale virtual reality



Scenario

- open data exploration (network-like)
 - virtual reality using head-mounted display
- comparative interaction technology study
 - "traditional" gamepad (Xbox One)
 - vision-based motion controls (Leap Motion)
 - room-scale virtual reality (HTC Vive)
- explorative, non-time sensitive setting
- exploration of the results of the 2016 US presidential election

Developed prototype



Video demo: Open Data Exploration in Virtual Reality (ODxVR)

Study



Study

- one-on-one session with 1 participant at a time
- participants n = 24 (8 participants per interaction prototype)
- duration: ~45 min
- 3 phases
 - pre-session
 - test (participant using the VR prototype)
 - warm-up, task
 - post-session

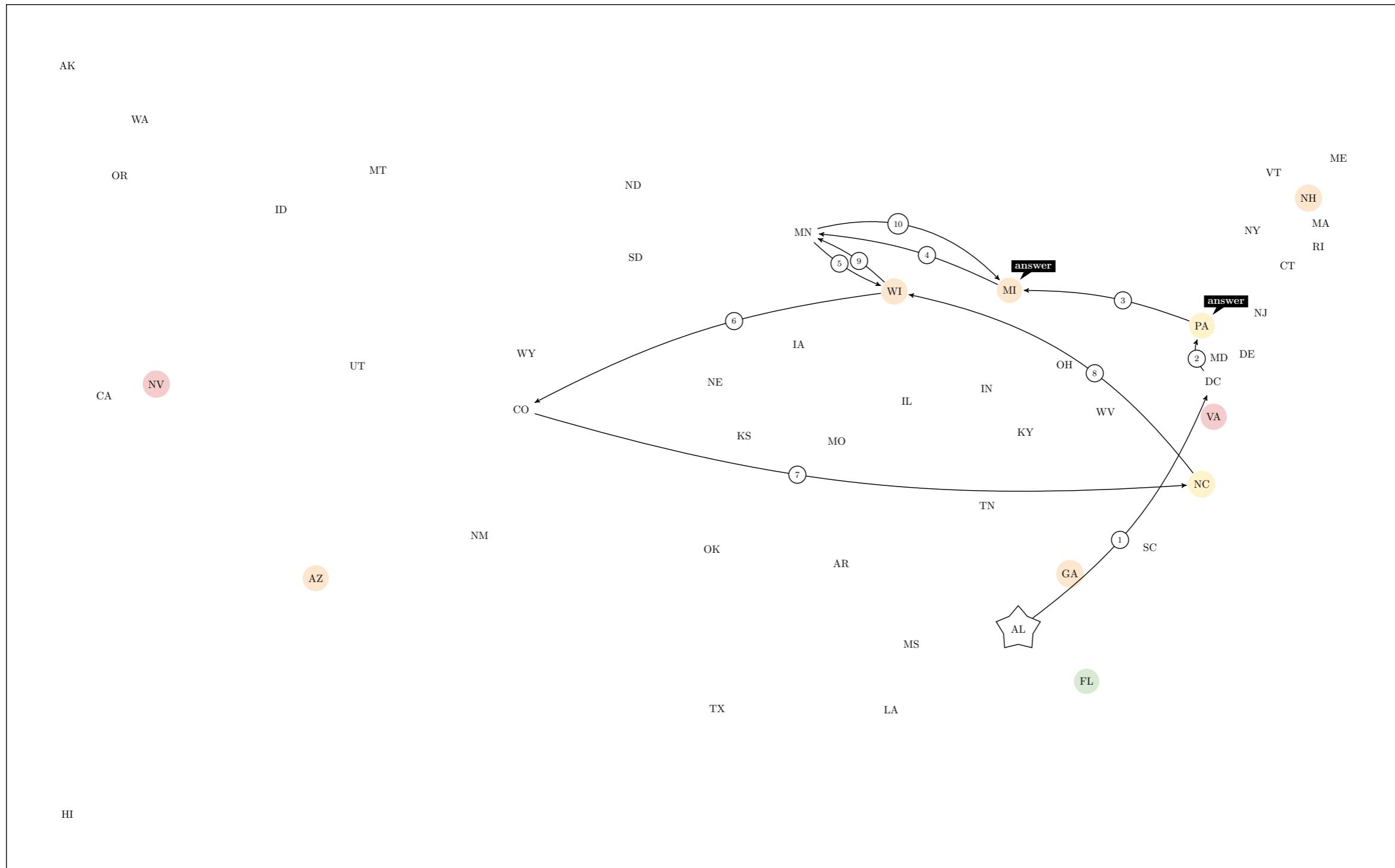
Data collection

- self-constructed questionnaires (pre- and post-session)
 - 5 point Likert-scale (quantitative data)
- observations
- think-aloud protocol
- logging system
 - implemented in the VR application; keeping track of every user interaction
 - “action-object-target-origin-state-mode”

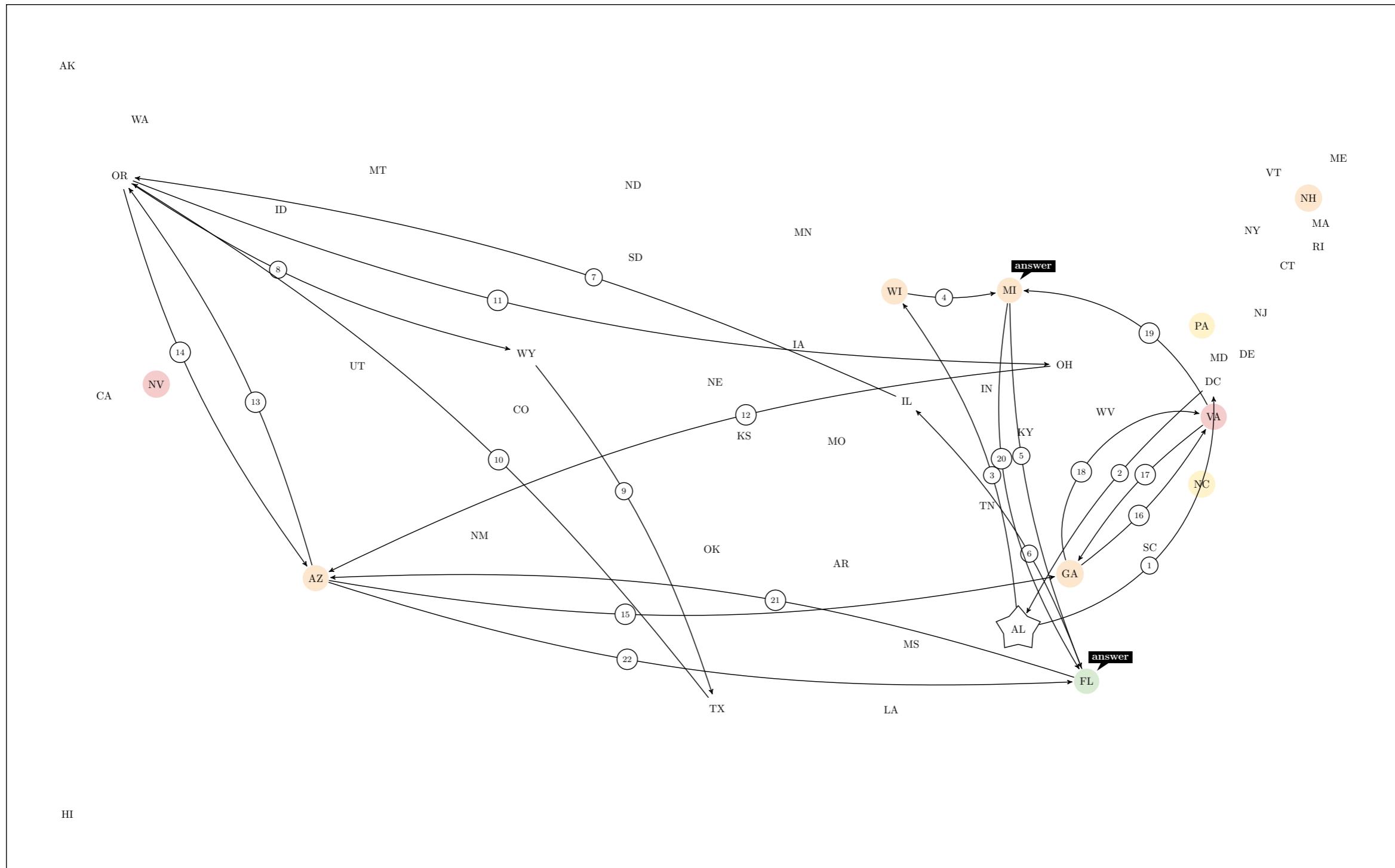
Data collection

- [Simulator Sickness Questionnaire \(SSQ\)](#)
 - standardized method for quantifying simulator sickness
- [NASA Task Load Index \(TLX\)](#) questionnaire
 - standardized method to report workload in self-assessment
- [Flow Short Scale \(FKS\)](#)
 - standardized method to evaluation the interaction “flow” when operating a system or completing a task

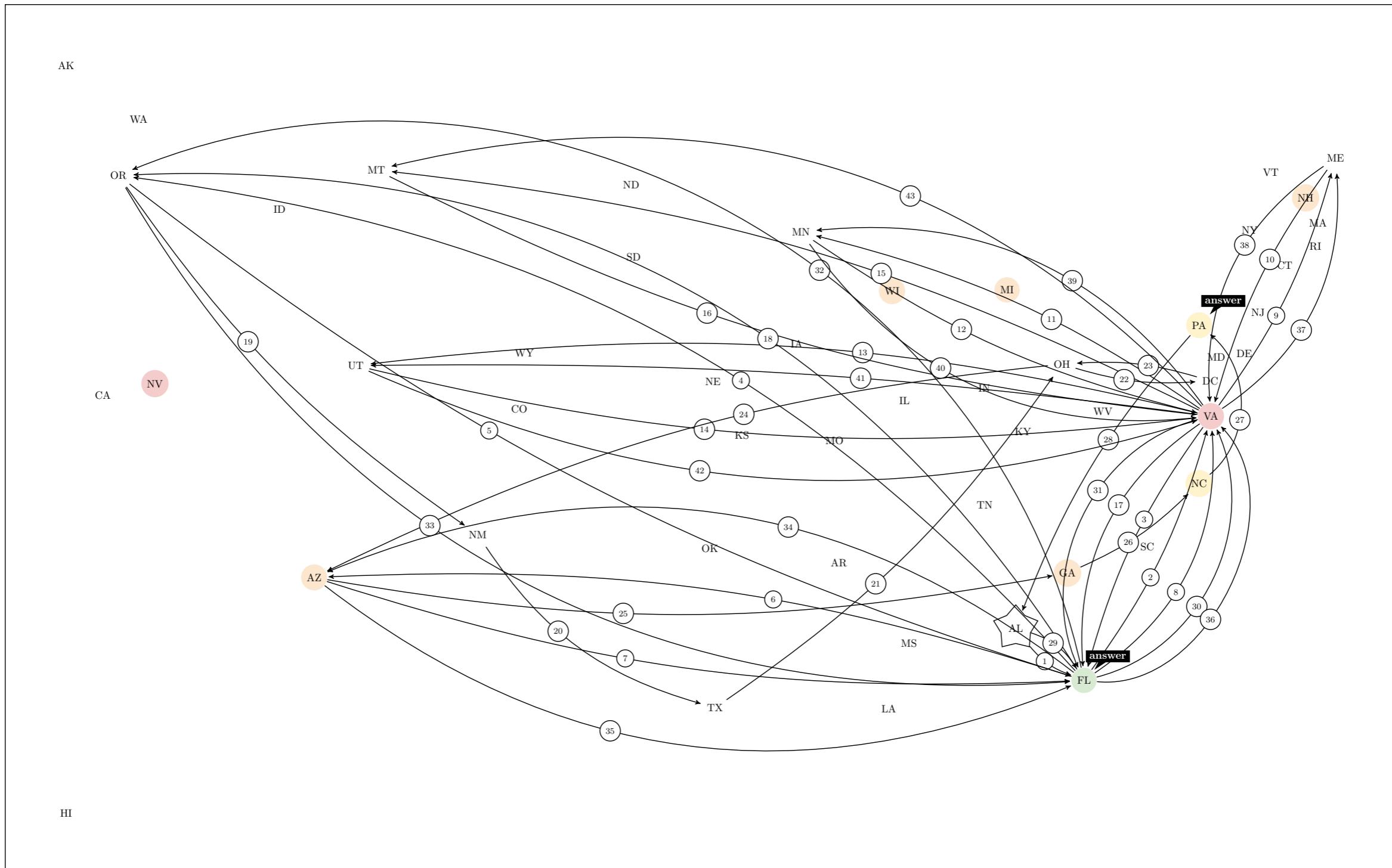
Results / Analysis: Pathway visualization (logging)



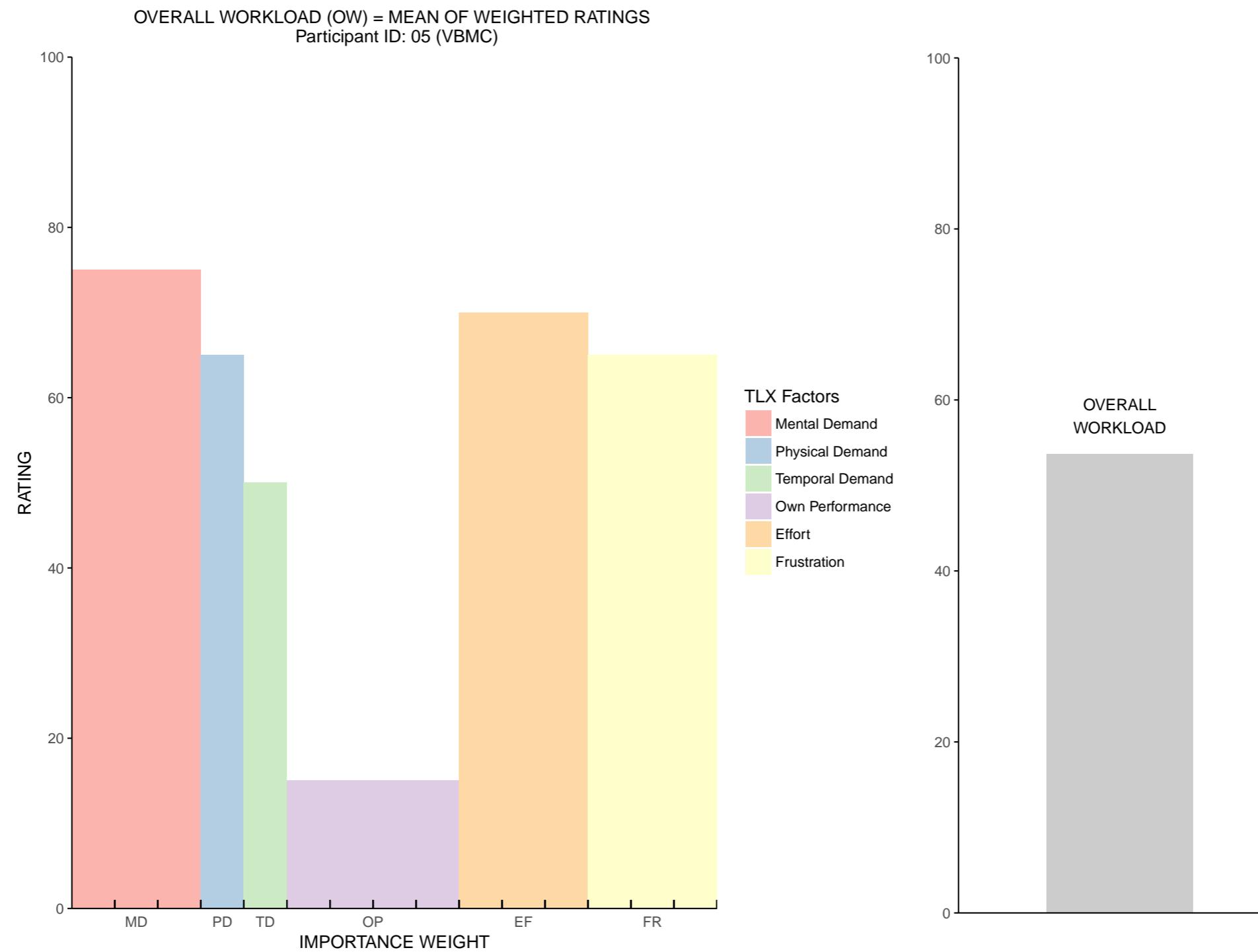
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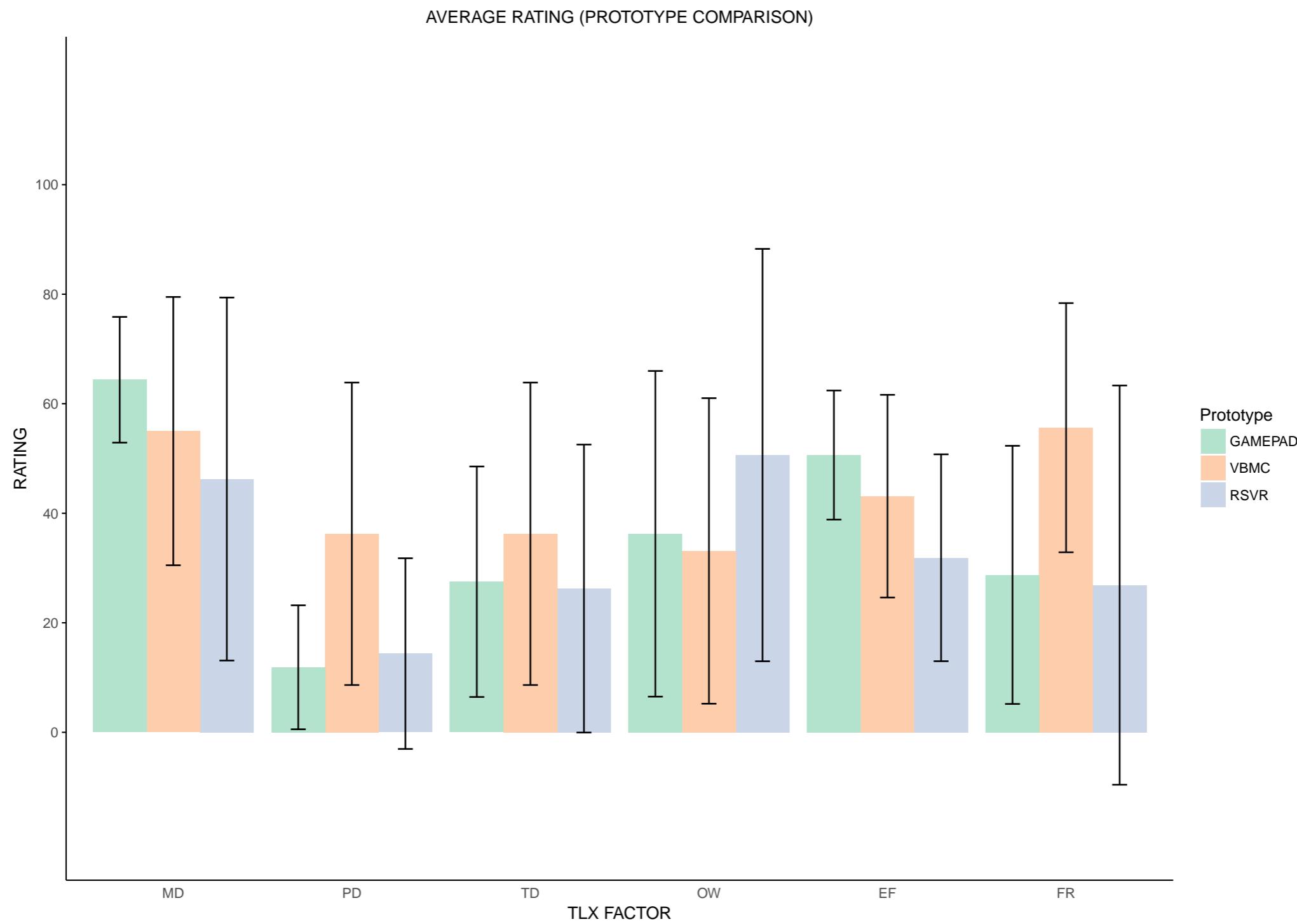
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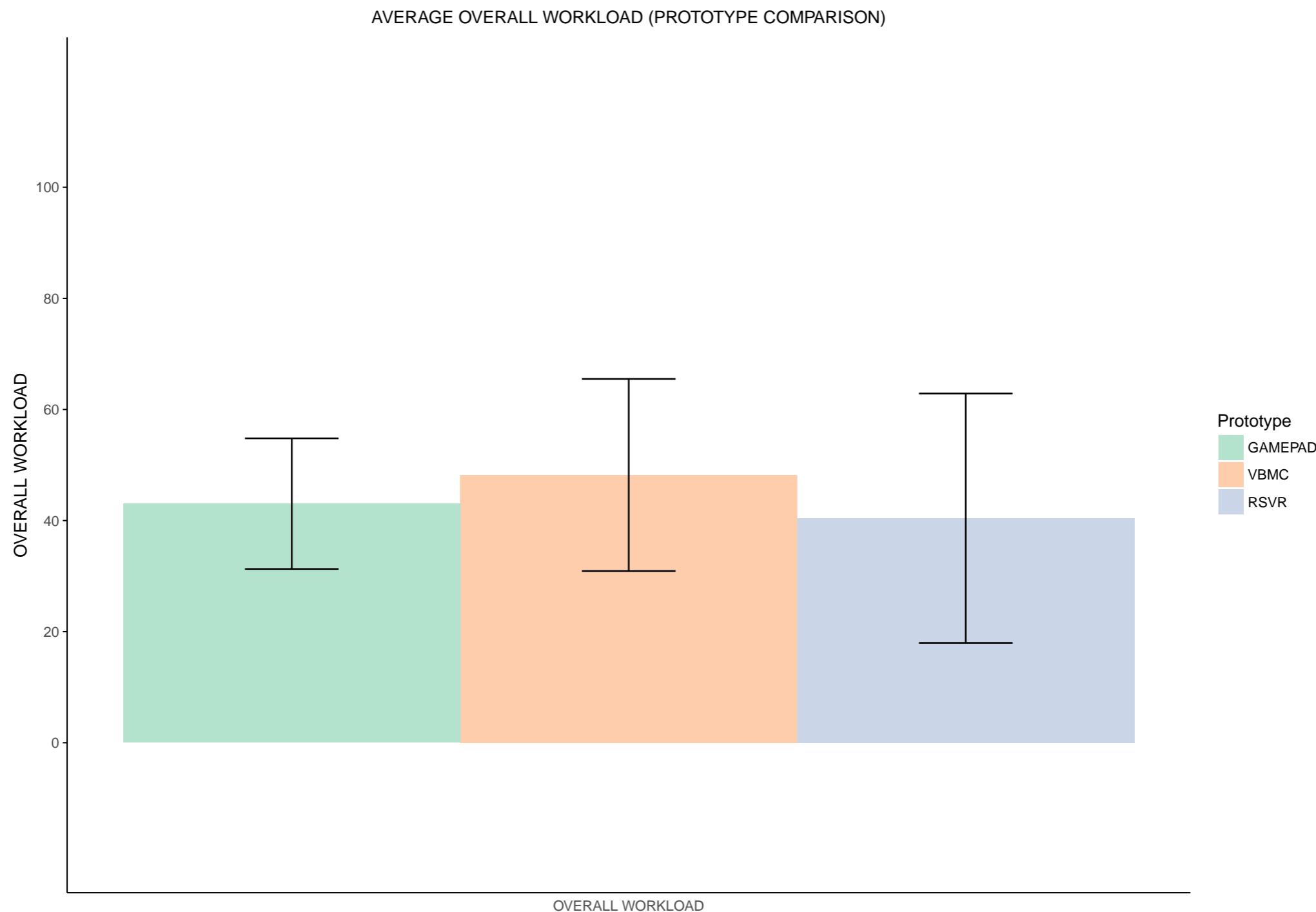
Results / Analysis: NASA TLX



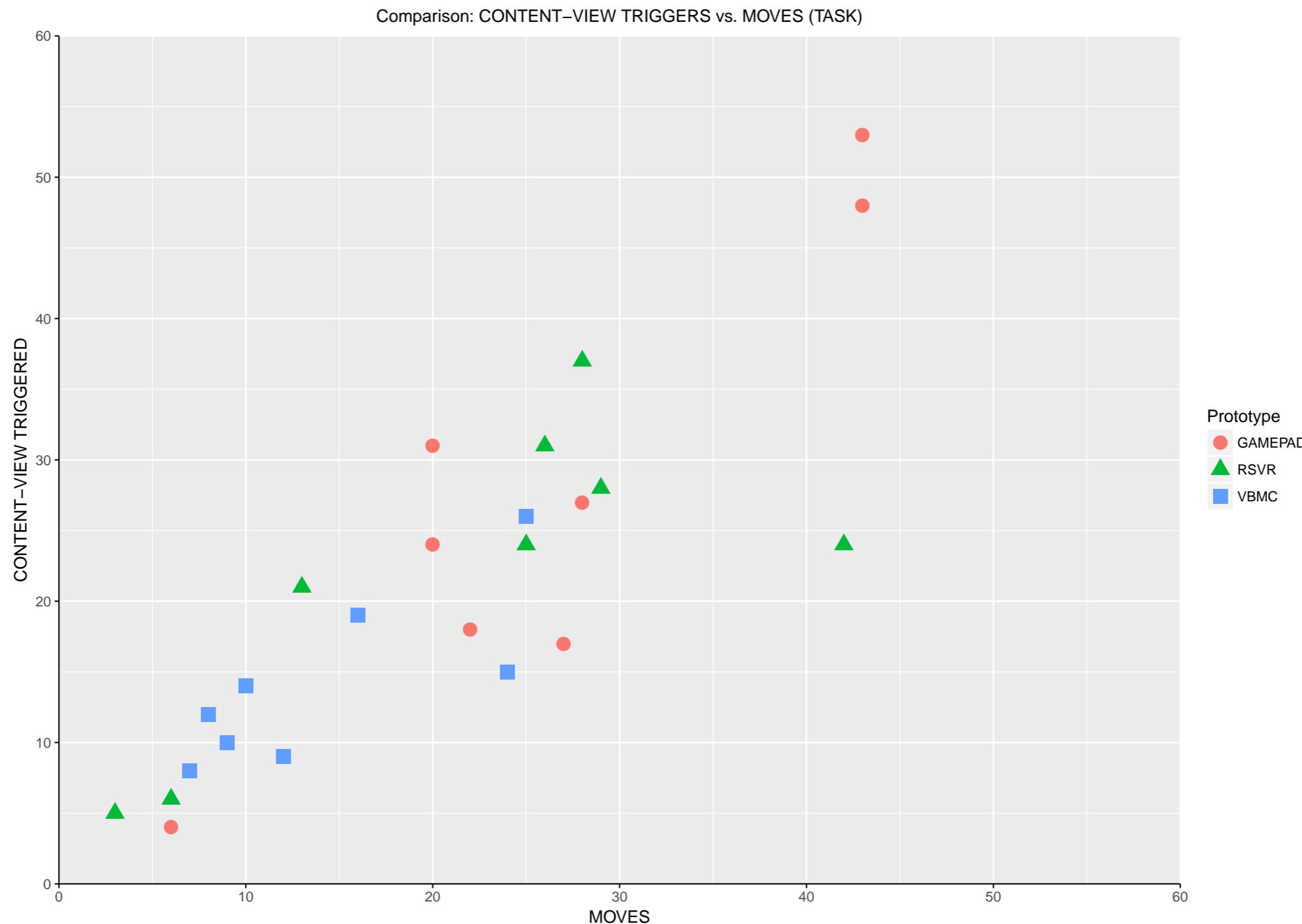
Results / Analysis: NASA TLX



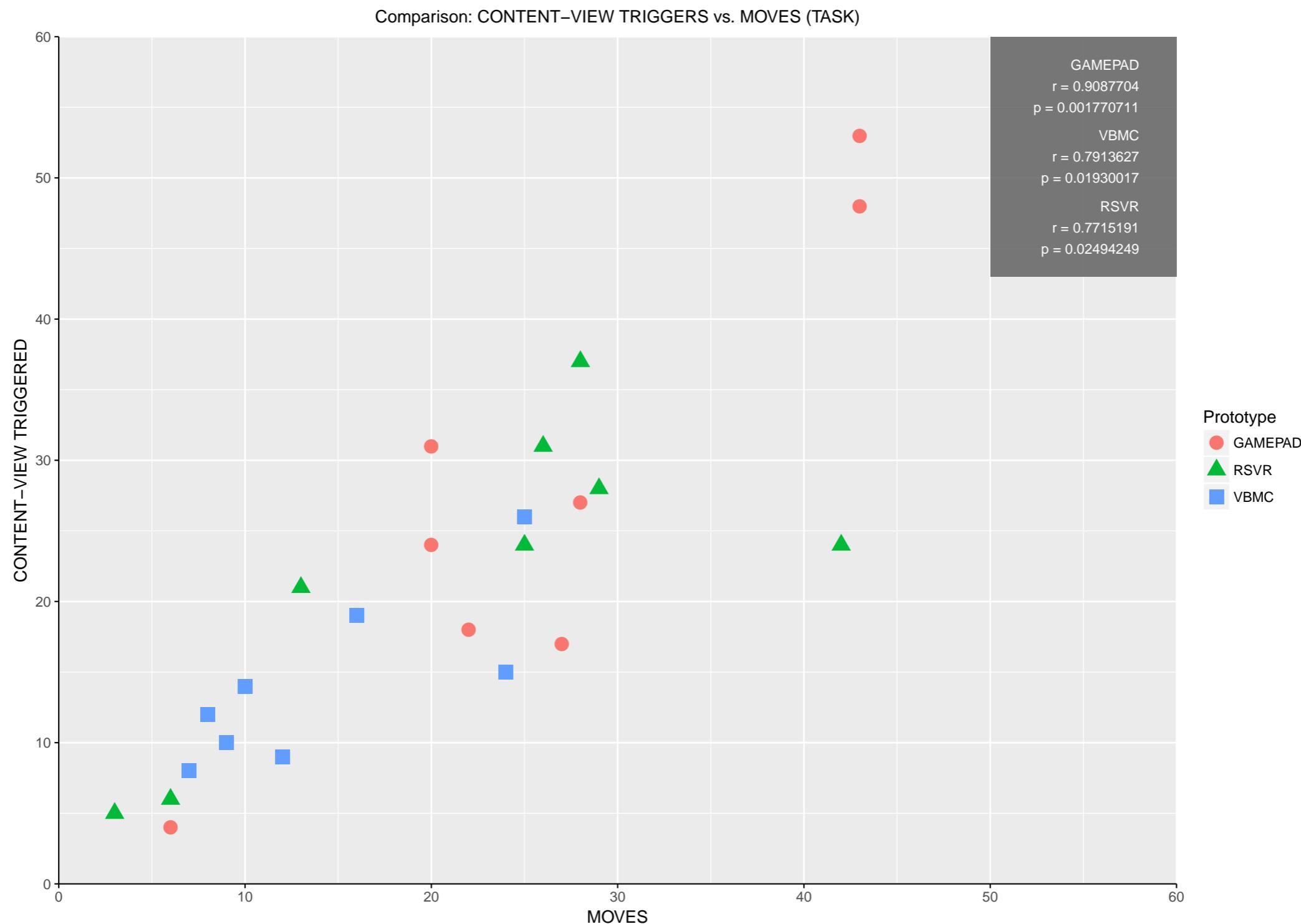
Results / Analysis: NASA TLX



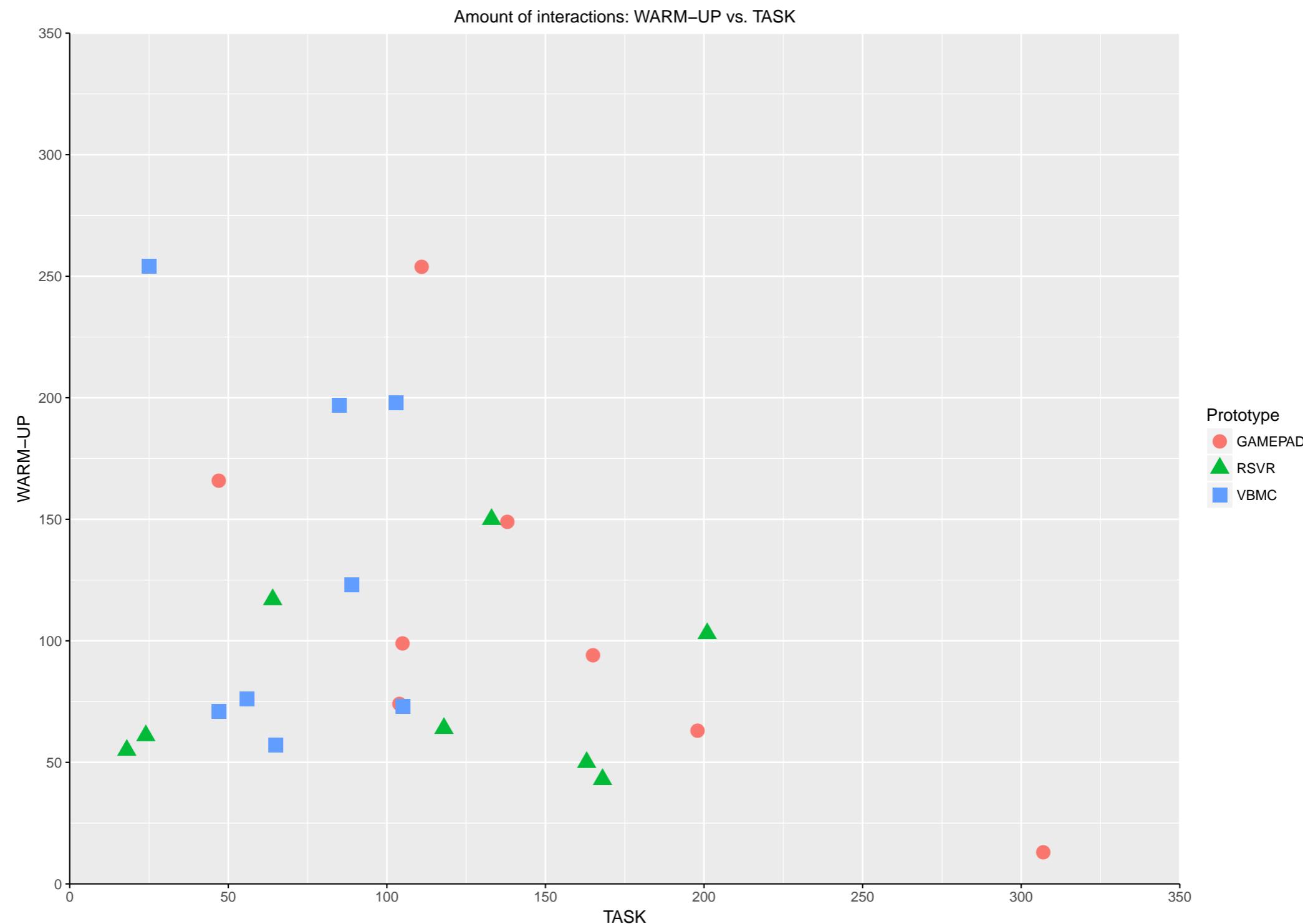
Results / Analysis: Logging



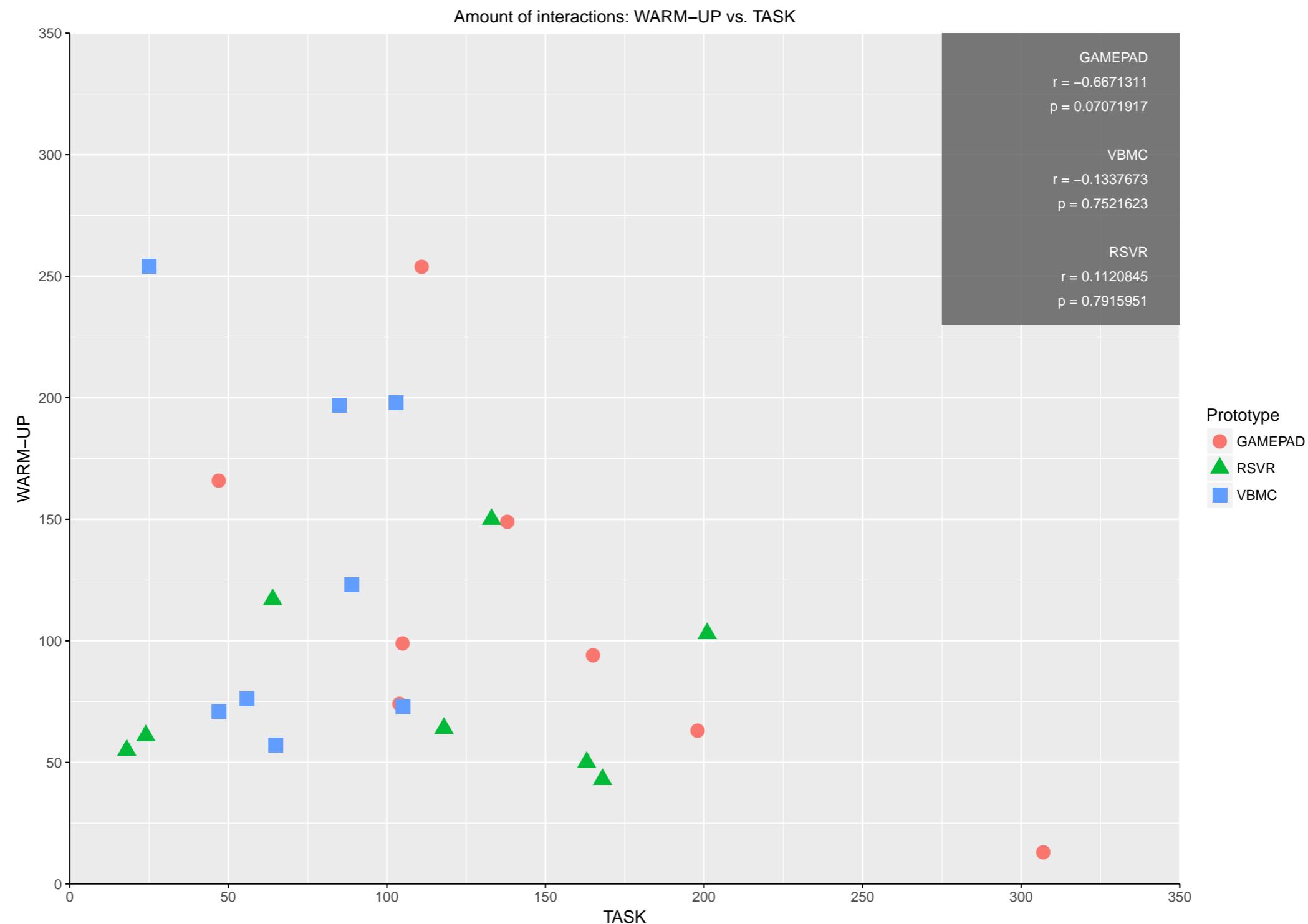
Results / Analysis: Logging



Results / Analysis: Logging



Results / Analysis: Logging



Results / Analysis:

Logging

Analysis		GAMEPAD		VBMC		RSVR	
TASK		AVERAGE	STDEV	AVERAGE	STDEV	AVERAGE	STDEV
Average time spent in traveled node (in sec)		25.35	26.024	24.09	8.882	26.91	8.690
Amount of unique visited nodes (max. 45)		14.00	5.632	9.25	3.059	11.50	5.477
Amount of visited nodes		25.50	10.928	12.88	4.190	20.38	11.759
Amount of interactions		146.88	78.844	71.88	28.402	111.13	68.674
Average amount of interactions per minute		19.57	5.480	14.02	2.421	11.98	4.715
Movement/Travels	Movement/Travels	SUM	26.13	12.369	13.88	7.120	21.50
	Successful	24.50	10.928	11.88	4.190	17.75	10.886
	Forbidden	1.63	1.685	2.00	4.036	2.13	2.800
	(RSVR) No transition	-	-	-	-	1.63	1.061
Content Exploration	Content Exploration	SUM	55.75	32.710	28.38	11.624	43.75
	Trigger	27.75	16.246	14.13	5.987	22.00	11.314
	Dismiss	28.00	16.466	14.25	5.651	21.38	11.135
	Image interaction	0.00	0.000	0.00	0.000	0.38	1.061
	(GAMEPAD) Button A	0.00	0.000	-	-	-	-
	(GAMEPAD) D-pad next	0.00	0.000	-	-	-	-
	(GAMEPAD) D-pad prev	0.00	0.000	-	-	-	-
	(VMBC) next	-	-	0.00	0.000	-	-
	(VMBC) prev	-	-	0.00	0.000	-	-
	(RSVR) touch	-	-	-	-	0.38	1.061
	(RSVR) point	-	-	-	-	0.00	0.000
Filter Menu	Filter Menu	SUM	36.13	25.295	20.38	22.640	29.63
	Trigger	12.13	7.680	5.13	4.190	10.13	9.731
	Dismiss	12.00	7.746	4.75	3.615	10.13	9.731
	Democrats	5.25	5.203	4.88	7.019	5.13	5.055
	less than	1.88	1.642	2.25	3.284	0.25	0.463
	greater than	2.25	1.982	1.38	2.774	3.88	4.643
	off	1.13	2.031	1.25	1.581	1.00	1.069
	Republicans	5.38	5.012	4.50	7.801	4.13	3.758
	less than	2.63	2.264	1.75	3.770	1.25	1.753
	greater than	1.38	1.685	1.50	3.117	2.13	2.475
Bookmark	Other	1.38	1.598	1.25	1.488	0.75	1.165
	less than	0.50	1.069	0.75	1.753	0.00	0.000
	greater than	0.25	0.707	0.00	0.000	0.00	0.000
	off	0.63	1.408	0.38	0.518	0.13	0.354
	Bookmark	SUM	9.25	4.400	1.63	3.159	3.00
	(RSVR) Set	-	-	-	-	1.88	1.885
	(RSVR) Unset	-	-	-	-	0.75	1.035
	(GAMEPAD, VBMC) Set / Unset	7.50	2.928	1.00	1.927	-	-
	Forbidden	1.75	2.712	0.63	1.408	0.38	0.518
	Amount of unique bookmarked nodes	3.38	1.408	0.50	0.926	1.50	1.773
Wrong context	Wrong context	SUM	19.63	17.435	7.63	5.423	13.25
	Exploration	1.63	1.923	6.25	5.036	8.25	8.615
	Content	11.63	14.412	1.00	2.138	0.75	1.035
	Filter	6.38	5.263	0.38	0.518	4.25	4.528
	GAMEPAD	22.63	19.331	-	-	-	-
	Button A	8.75	5.600	-	-	-	-
	Button B	8.88	13.527	-	-	-	-
	Button X	3.00	4.106	-	-	-	-
	Button Y	2.00	1.512	-	-	-	-
	VBMC	-	-	7.63	5.423	-	-
	finger spread	-	-	0.88	0.991	-	-
	thumb up right	-	-	1.00	2.138	-	-
	thumb up left	-	-	0.38	0.518	-	-
	index point forward	-	-	3.38	3.114	-	-
	index point right	-	-	0.63	0.916	-	-
	index point left	-	-	1.38	1.598	-	-
	RSVR	-	-	-	-	18.25	15.229
	App Menu	-	-	-	-	1.25	1.753
	Trigger	-	-	-	-	13.25	11.511
	Grip	-	-	-	-	3.75	4.621
Amount of time for completion (in sec)		459.96	267.405	302.05	97.199	531.41	306.190
in minutes		7.67	4.457	5.03	1.620	8.86	5.103

Results / Analysis:

Observations and think-aloud protocol

Collection of qualitative feedback and observations

# Point of interest	Categorization
Application of filter options systematically for guided exploration in order to identify suitable nodes as task solution.	Interaction
Overall pleasant experience, incl. movement transitions	Experience
Occlusion noted (e.g. due to nodes in more dense areas, or bookmarked node, will occlude content-view)	User Interface
Concept of filter (partially) unclear from instruction video	Application Concept
Minimal (to none) filter options applied during task, following a "trial and error" strategy	Interaction
Request for other view on the nodes (map view, birds-eye view, etc)	User Interface
Button layout on physical controller was not intuitive from the start and needed to be learned (troubles remembering which button does what)	User Interface
Suggestion to attach more/additional information directly to the nodes (preventing to open the content-view e.g. to check on values after specific filter was applied, or e.g. when pointing and highlighting a node)	User Interface
Challenges selecting far away nodes and then triggering movement; Selection through gaze input was physically noticeable	Interaction
Participant did not remember at first that the content-view displays information required to solving the task.	Experience
Selected filter option is not visible in menu after closing and opening filter menu; Applied filter is not displayed when filter menu is closed	User Interface
Overall selection (highlight) + trigger interaction was perceived too much; would have prefered selection + immediate execution	User Interface
Filter menu placement would have been prefered in front instead of slightly to the right	User Interface
Filter concept, incl. colors, were clear for meaning making.	Application Concept

Results / Analysis: Flow Short Scale (FKS)

Flow Short Scale	GAMEPAD AVERAGE	SD	VBMC AVERAGE	SD	RSVR AVERAGE	SD
F I - Smooth automatized process						
8) I knew what I had to do for each step of the way.	4.625	1.767766953	4.875	1.642080562	5.375	1.922609833
7) The right thoughts/movements occur of their own accord.	4.75	1.488047618	4.375	1.922609833	4.375	1.505940617
9) I felt that I had everything under control.	4.875	1.552647509	4.875	0.991031209	5.5	1.927248223
4) I had no difficulty concentrating.	5	1.927248223	4.25	2.49284691	5.875	1.457737974
5) My mind is completely clear.	5.5	1.195228609	4.125	1.726888201	5.625	0.7440238091
2) My thoughts/actions ran fluidly and smoothly.	5.25	1.669045921	4.75	1.488047618	5.5	1.690308509
F II - Ability to absorb						
6) I was totally absorbed in what I was doing.	6.25	0.7071067812	6.125	1.125991626	6.25	1.035098339
1) I felt the right amount of challenge.	4.5	1.195228609	4.75	1.38873015	4.625	1.685018016
10) I was completely lost in thought.	2.5	1.195228609	4	1.603567451	2.75	1.488047618
3) I did not notice time passing.	4.625	1.846811925	4.875	1.125991626	6	1.309307341
F III - Concern						
11) Something important to me was at stake here.	2.375	1.407885953	2.625	2.263846285	2.875	1.807721534
12) I did not make any mistake here.	3.375	1.685018016	2.75	1.982062418	4.25	1.832250763
13) I was worried about failing.	1.875	1.642080562	3.375	2.386719207	2.375	1.922609833
Addtion - Fit of Skill and Requirements						
14) Compared to all other activities which I partake in, this one is ...						
15) I think that my competence in this area is...	5.125	1.726888201	5	2.927700219	6.25	3.875
16) For me personally, the demands were	4.375	0.9161253813	4.75	1.164964745	1.58113883	1.457737974

Prototype	Flow (1-10)	Smooth process (F I)	Absorb (F II)	Concern (F III)
GAMEPAD (N=8)	AVERAGE SD	4.79 0.96	5.00 0.33	4.47 1.54
VBMC (N=8)	AVERAGE SD	4.70 0.60	4.54 0.33	4.94 0.88
RSVR (N=8)	AVERAGE SD	5.19 1.03	5.38 0.52	4.91 1.61

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VRxAR Labs



Department of Media Technology

Faculty of Technology

Linnaeus University, Växjö



Additional references

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