Get Ready for Activity – Ambient Day Scheduling with Dementia

Field test report

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Preface

This document forms part of the Research Project "Get Ready for Activity – Ambient Day Scheduling with Dementia (GREAT)" funded by the AAL 2016 "Living well with dementia" funding program as project number AAL-2016-023. The GREAT project will produce the following Deliverables:

D1.1 Medical, psychological, and technological framework

D2.1 Applicable hardware components

D2.2 Applicable software components

D2.3 Field tested hardware components

D2.4 Field tested software components

D3.1 Implementation report

D3.2 Field test report

D4.1 Communication strategy

D4.2 Stakeholder management report

D5.1 Report on market analysis

D5.2 Dissemination plan

D5.3 Final business plan

The GREAT project and its objectives are documented at the project website http://uct-web.labs.fhv.at. More information on GREAT and its results can also be obtained from the project consortium:

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1. Project background

The project "Get Ready for Activity - Ambient Day Scheduling with Dementia" (GREAT), approved in November 2016 as part of the European AAL programme, aims to develop scalable, flexible and at the same time affordable solutions that improve the quality of life of people with dementia and their families or other carers.

By using controllable lighting systems, the aim is to motivate people with dementia to engage in activities such as eating, sleeping or walking. In addition, light could be combined with odours (aroma application) and sounds (sounds application) to alleviate certain symptoms such as restlessness or mood swings that are common in people with dementia. To assess the effects of the modular systems on people with dementia, they are used in acute inpatient (Austria) as well as in long-term care (Italy and Switzerland). The project will validate the suitability of these module systems for everyday use in the various application scenarios.

Prof. Dr. Guido Kempter from the University of Applied Sciences Vorarlberg is the overall project leader. Besides the University of Applied Sciences Vorarlberg, the project partners are the University of Applied Sciences St.Gallen, CURAVIVA Switzerland, Tirol Kliniken GmbH, Bartenbach GmbH (Austria), Intefox GmbH (Austria), EMT AG (Switzerland) and Apollis OHG (Italy).

2. Objectives of the field test report

The objective of this report is to highlight the effects of the Great system's impact on demented people who have tested it and to highlight any effects of using the system on caregivers' work. The empirical results that will be reported emerge from the evaluations of the participants in the field trials carried out in the three reference countries: Austria, Italy and Switzerland.

Great modules were also tested in a closed booth developed by FHV, the first part of this report is dedicated to the results of the tests carried out in this booth.

3. Results of the closed booth

Our project is partially based on the idea that a combination of light, scent and sound is more effective in relaxing or activating people with dementia than biodynamic lighting alone. To validate this, we presented our system in a closed booth during two events in 2018 and let visitors' rate how they perceived the atmosphere created by the modules. The tests were completely anonymous; therefore, no sociodemographic data was recorded. The setup of these tests can be seen in the picture below: the lamp is highlighted in blue, the scent module in red and the tablet used for rating the combination in green. The sound module was hidden above the top panel highlighted in yellow (gaps on the side allowed the sound to enter the room uninterfered).

Figure 1: Test setting during events uDay XVI & "Lange Nacht der Forschung"

3.1 Description of the dataset

This way we gathered 1680 ratings on a scale with 9 steps between "relaxing" and "activating". After each rating a new combination was presented and the person could rate again or leave the booth and the next visitor would take a seat. The built-in ventilation led to a rapid decrease of the scent inside. We therefore decided to discard 91 ratings as the atmosphere was present for longer than a minute and we could not guarantee the scent still being present at the time of rating. The chronological order and histogram of all the ratings can be seen below.

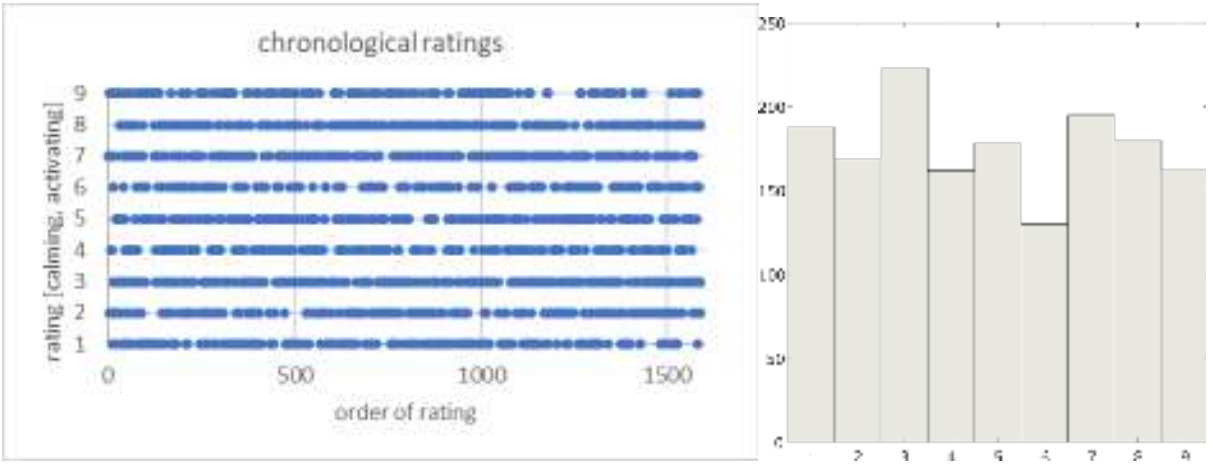

Figure 2: Chronological order of ratings (left) and histogram of the population (right)

These figures show an even distribution, which means that we chose a balanced set of combinations, ranging from very relaxing to very activating or somewhere in between.

The following table is used to describe the groups in the figures following later on in this report. Each group is labelled with three indices, the first one represents light, the second one scent and the third one sound.

Index 1 – light	Index 2 – scent	Index 3 – sound at low volume	Index 3 – sound at high volume
1: cold-white	1: „good mood“	1: birdsong 40kHz	7: birdsong 40kHz
2: warm-white	2: „harmony“	2: birdsong 80kHz	8: birdsong solo
		3: watersplash 40kHz	9: insects & frogs 40kHz
		4: watersplash 80kHz	10: seawaves solo
		5: birdsong solo	11: seawaves 40kHz
		6: watersplash solo	12: insects & frogs solo

Table 1: Indexes of group names

As the goal of this project was to influence people to feel more activated or relaxed by using light, scent and sound, we presented only combinations of all three sensory channels to the visitors. Nevertheless, we want to find out, whether our modules can create atmospheres, more relaxing or activating than lighting alone, as literature shows that it alone is already a very potent stimulus. To find proper control groups we therefore split the dataset by type of light (cold and warm). The respective histograms are presented below.

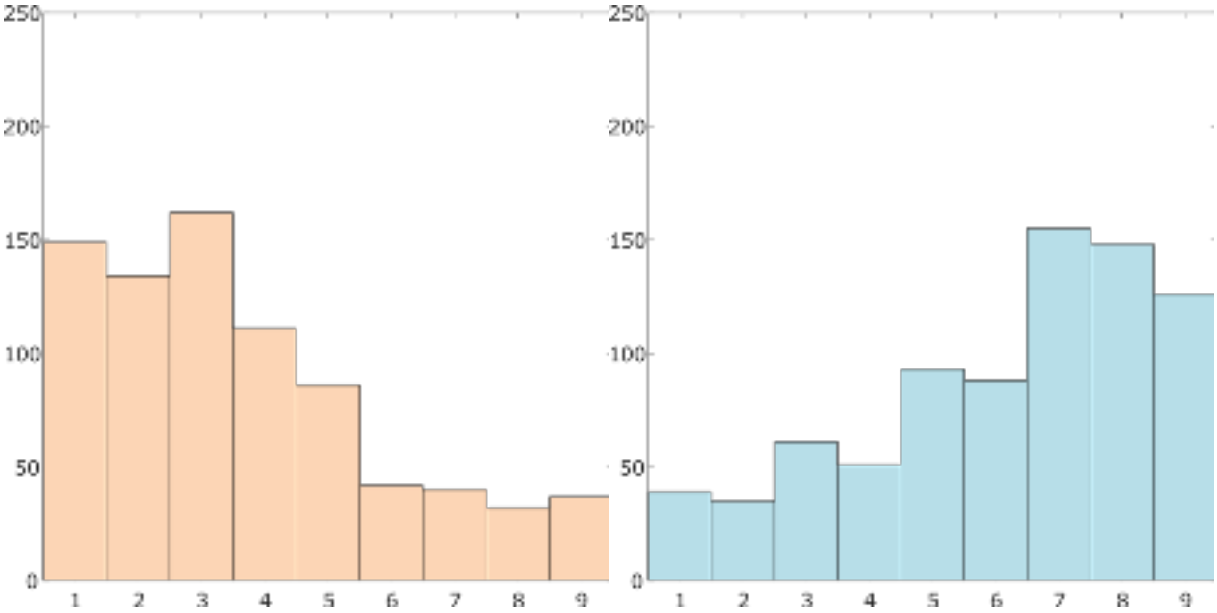

Figure 3: Distribution of control groups: warm-white (left) and cold-white (right)

The distributions align very well with aforementioned current literature: warm-white lighting is perceived as relaxing, cold-white lighting is perceived as activating.

The arithmetic means and standard deviation of the 48 test groups can be seen in the figure below.

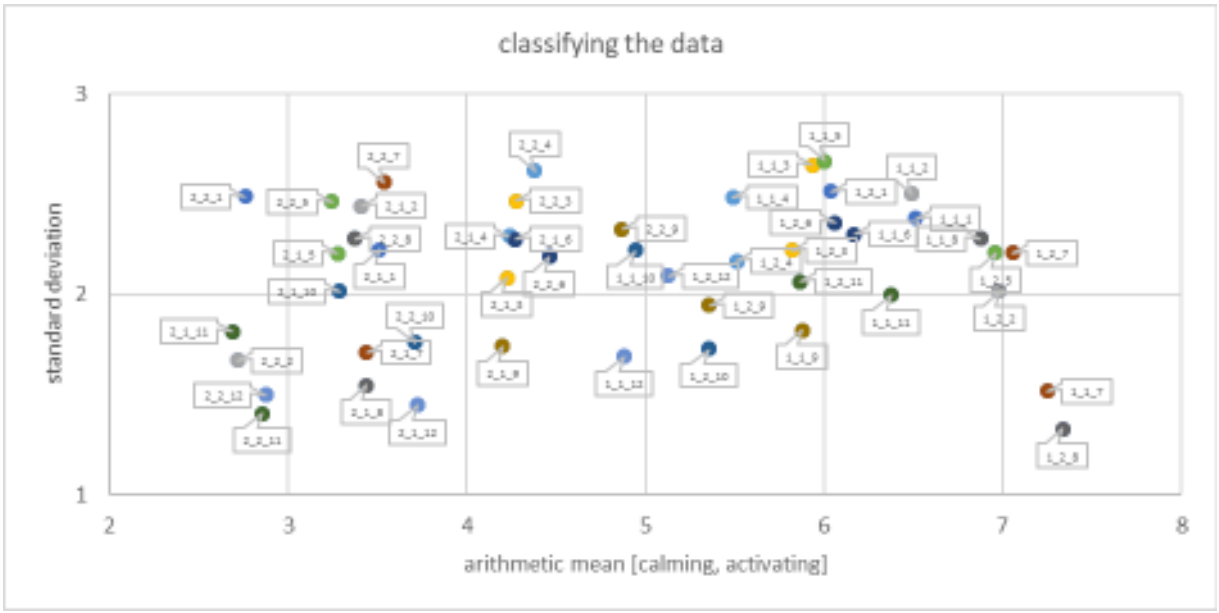

Figure 4: Test groups arithmetic means and standard deviations

There are no groups with an arithmetic mean below 2.5 or above 7.5. Standard deviations vary between 1 and 3. For further comparison we calculated the confidence interval at 95% of each of the 48 test groups and the two control groups and created the following figure.

3.2 Finding significantly calming or activating combinations

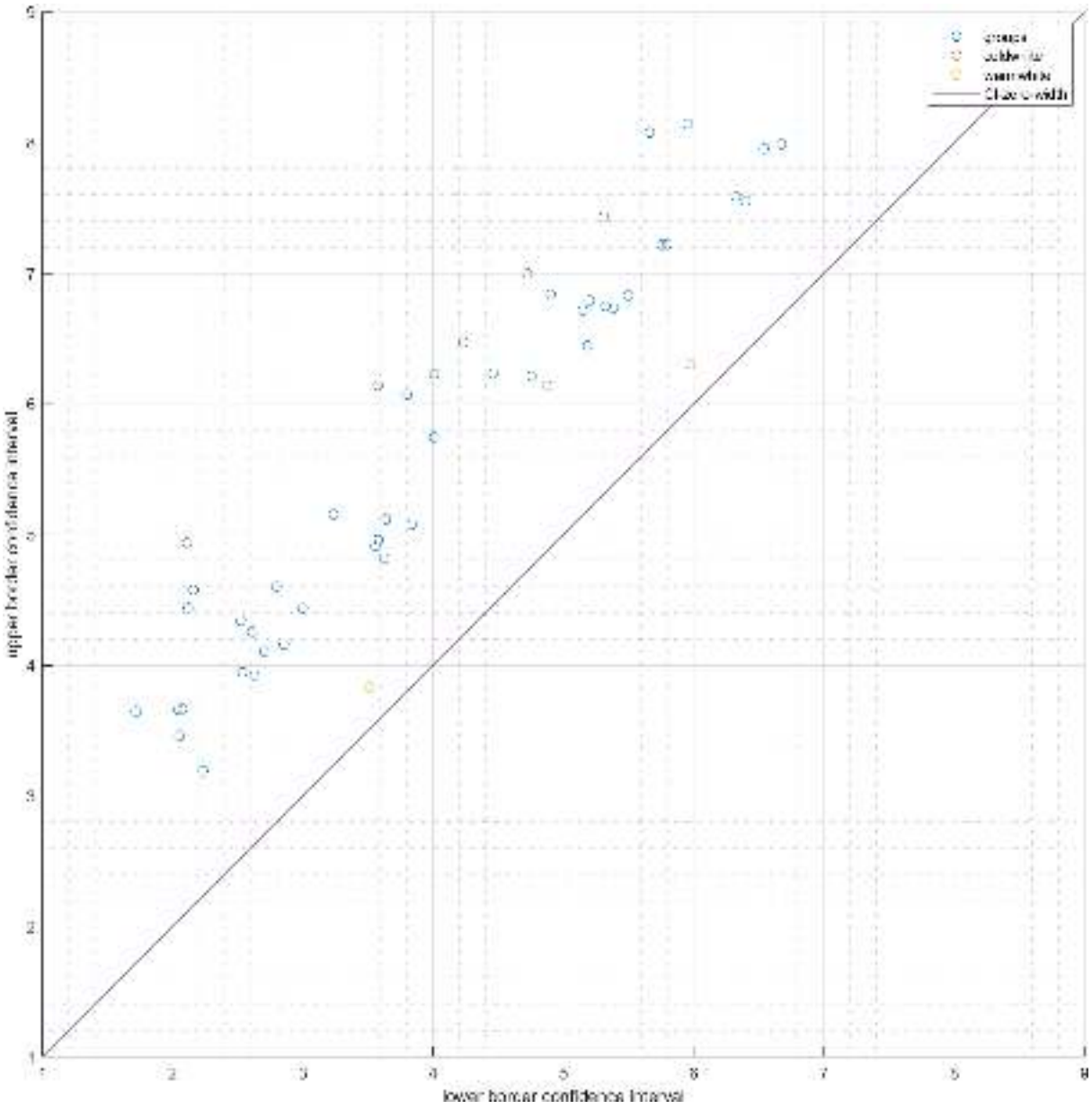

Figure 5: General confidence interval plot

The x-axis shows the lower border of the confidence interval, the y-axis shows the upper border of the confidence interval. The diagonal at an angle of 45° depicts all fictive confidence intervals with a width of zero.

For the first analysis, the figure is split in four parts:

1. below the CI-zero-width line: this is an unfeasible area, as the upper border always has a higher value than the lower border
2. Above the CI-zero width line:
    a. Lower border < 5: the combinations of these groups are significantly calming

b. Lower border < 5 & upper border > 5: the combinations of these groups are neither significantly calming nor significantly relaxing

c. Upper border > 5: the combinations of these groups are significantly activating

Criteria 2a fits to 19 test groups and the control group warm-white (according to our index-labelling "2_X_X"), criteria 2c fits to 15 groups and the control group cold-white (according to our index-labelling "1_X_X"). This shows that it is possible to create activating and relaxing combinations using scent, sound and light.

3.3 Finding combinations more effective than light alone

For the analysis in the following picture we use the same base data but split the plotted area differently and also display the values for control and significant groups. The table below shows the group name for each x-value:

Group name	Light	Scent	Sound	X Value	Y Value
2_X_X	Warm white	All	All	3,5125	3,8321
2_2_1	Warm white	Rose	Birdsong quiet 40 kHz	2,0531	3,4605
2_2_2	Warm white	Rose	Birdsong quiet 80 kHz	2,2344	3,1899
1_X_X	Cold White	All	All	5,9762	6,3036
1_1_7	Cold white	Citrus	Birdsong loud 40 kHz	6,5398	7,9534
1_2_2	Cold white	Rose	Birdsong quiet 80 kHz	6,4007	7,5533
1_2_5	Cold white	Rose	Birdsong quiet solo	6,3251	7,5876
1_2_8	Cold white	Rose	Birdsong loud solo	6,6727	7,9876

Table 2: Significant groups

To find groups which are more extreme than our control groups, we plotted the green and purple line. The green line is plotted horizontally on the y-axis. It's placed at the value of the lower border of the confidence interval of the control group 2_X_X (3,5125). Any confidence which has an upper border of the confidence interval below that line is significantly more calming than the control group. The purple line is plotted vertically on the x-axis. It's placed at the value of the upper border of the confidence interval of the control group 1_X_X (6,3036). Any confidence which has a lower border of the confidence interval to the right of that line is significantly more activating than the control group.

The upper border of the confidence interval of the groups 2_2_1 (3,4605) and 2_2_2 (3,1899) both lie below the critical value of 3,5125. The lower border of the confidence interval of the groups 1_1_7 (6,5398), 1_2_2 (6,4007), 1_2_5 (6,3251) and 1_2_8 (6,6727) all lie above the critical value of 6,3036.

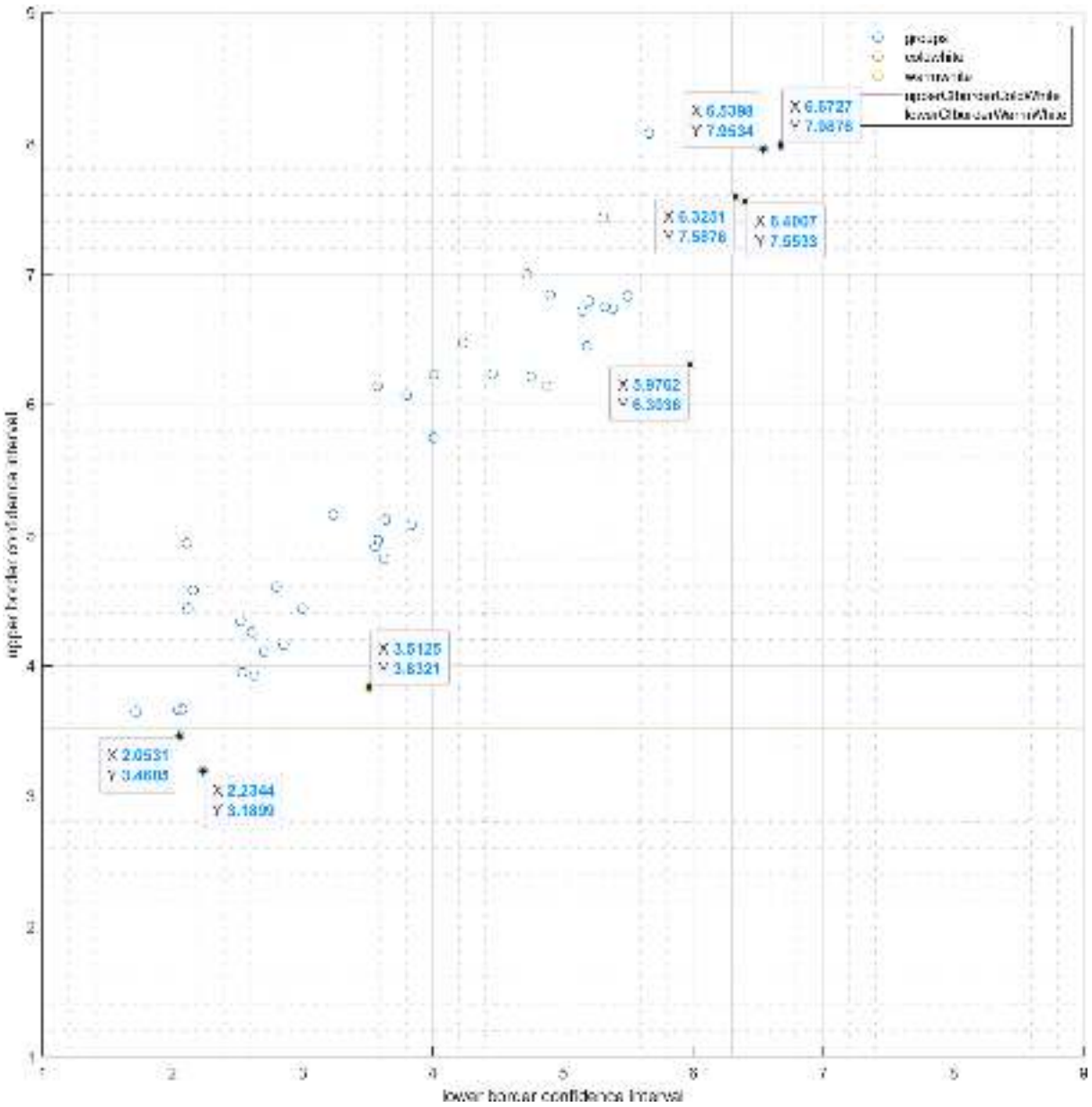

Figure 6: Confidence interval plot with significant groups

We also used ttest2-methods provided by MATLAB to ensure this:

- 2_X_X to 2_2_1: t(817) = 2,7509; p = 0,0061
- 2_X_X to 2_2_2: t(841) = 2,9540; p = 0,0032
- 1_X_X to 1_1_7: t(815) = 2,3409; p = 0,0195
- 1_X_X to 1_2_2: t(819) = 2,4772; p = 0,0134
- 1_X_X to 1_2_5: t(819) = 2,4062; p = 0,0163
- 1_X_X to 1_2_8: t(813) = 2,3950; p = 0,0168

3.4 Confirming Birdsong as the most effective of the tested sounds

As all of the groups showing significantly better results than the control groups in the previous chapter play the birdsong sound, we looked at the data only separated by sound. The following figure was created.

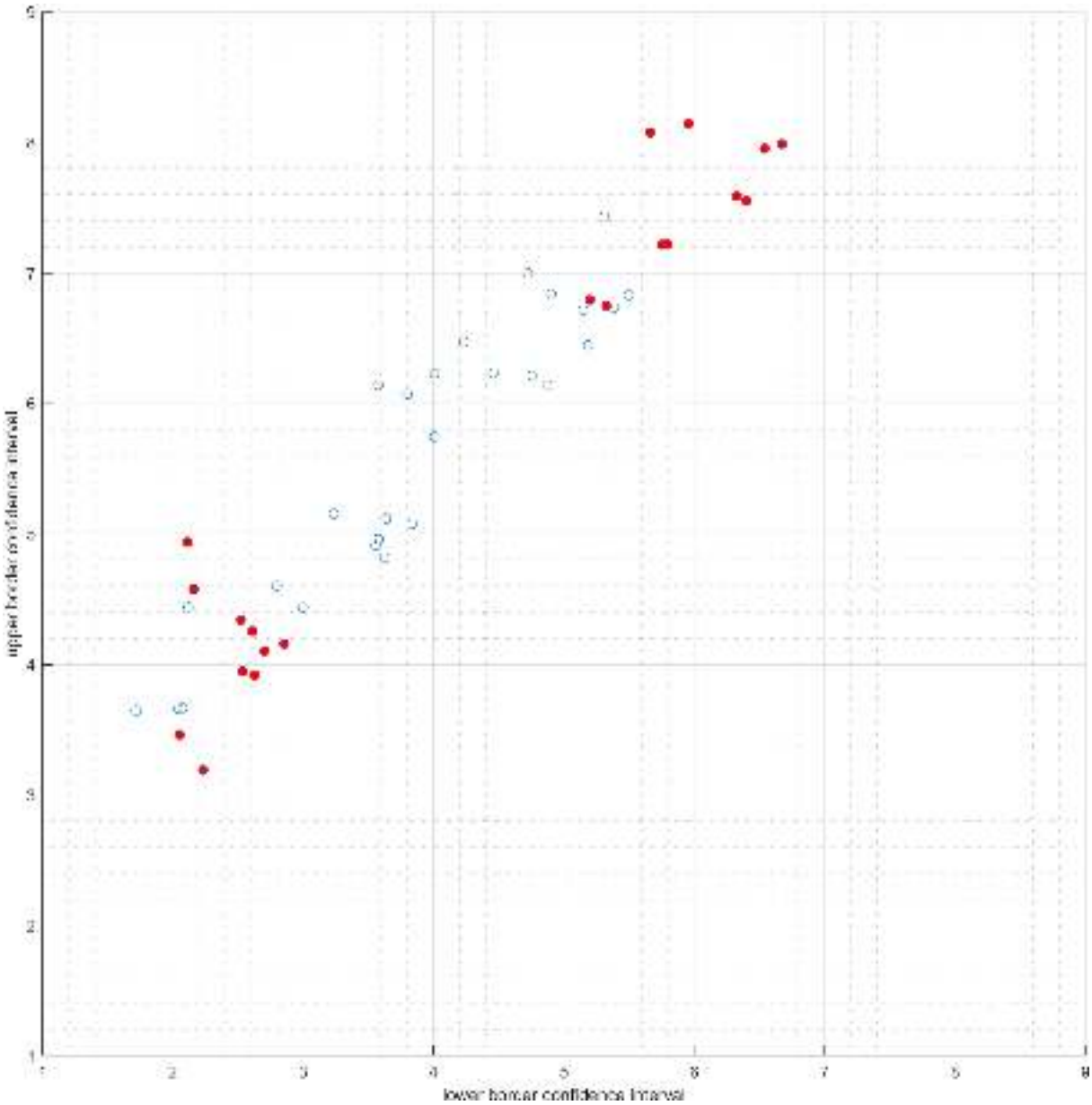

Figure 7: Bridsong groups

All 12 groups which contain birdsong are marked red. For all groups, where cold white light was used, the lower and upper borders of the confidence interval are greater than 5. For all groups, where warm white light was used, the lower and upper borders of the confidence interval are smaller than 5. This means that whenever a birdsong sound was played, the setting was perceived significantly activating or calming. Of the four sounds used, this is a unique feature and the second strongest influence overall after color-temperature. This means that the birdsong can't be

categorized as activating or relaxing. It rather seems that it increases the effect of the emitted light.

3.5 Physiological impact of the GREAT system in a cabin setting

For the next three public events we visited (AAL Forum Bilbao 2018, AAL Kongress Karlsruhe 2018 and uDay meets SMARTERLIVES 2019) we again brought the cabin with us. This time, however, we did not ask the visitors to rate, how they perceived the atmosphere in the cabin but let their physiology do the work. Again, they were presented with a combination of light, scent, sound and additionally the task to either relax or agitate themselves. Each visitor was tested for three segments, each lasting 30 seconds. During the first and third segment, the modules were actively enhancing the cabin, during the second the modules were switched off. We measured their skin conductance with a glove, as seen in Figure 8. Generally speaking, high levels skin conductance mean activation, lower levels occur when feeling relaxed.

Figure 8: Skin conductance measurement tool: (left) how to wear it (right) it measures the skin conductance between index finger and thumb

The raw measurement of the glove is plotted over time and can be used to derive three analysable parameters. The first one, named "avg", is the baseline against which the latter two will be measured. It is the average of all measurement values collected between seconds 5 and 10 of each segment. A graphical interpretation can be seen in Figure 9 on the left side. The second parameter is called "relaxArea" and it is calculated by integrating the area between "avg" and the measurements between seconds 10 and 30. Again, a graphical explanation of the value can be seen in Figure 9, this time in the middle. The last parameter is called "relaxCount". For each step of the measurement (equalling 20 ms) during seconds 10 to 30 a counter is either decreased if the current value lies above the "avg" or increased if it's lower. This reduces the effect of personal differences – some people's skin conductance changes greater than others. It's depicted in Figure 9 on the right side. The axis of the two latter groups "relaxArea" and "relaxCount" are reversed as they are subtracted

from the "avg" value. This means that positive values are signs of relaxation and negative values are signs of activation.

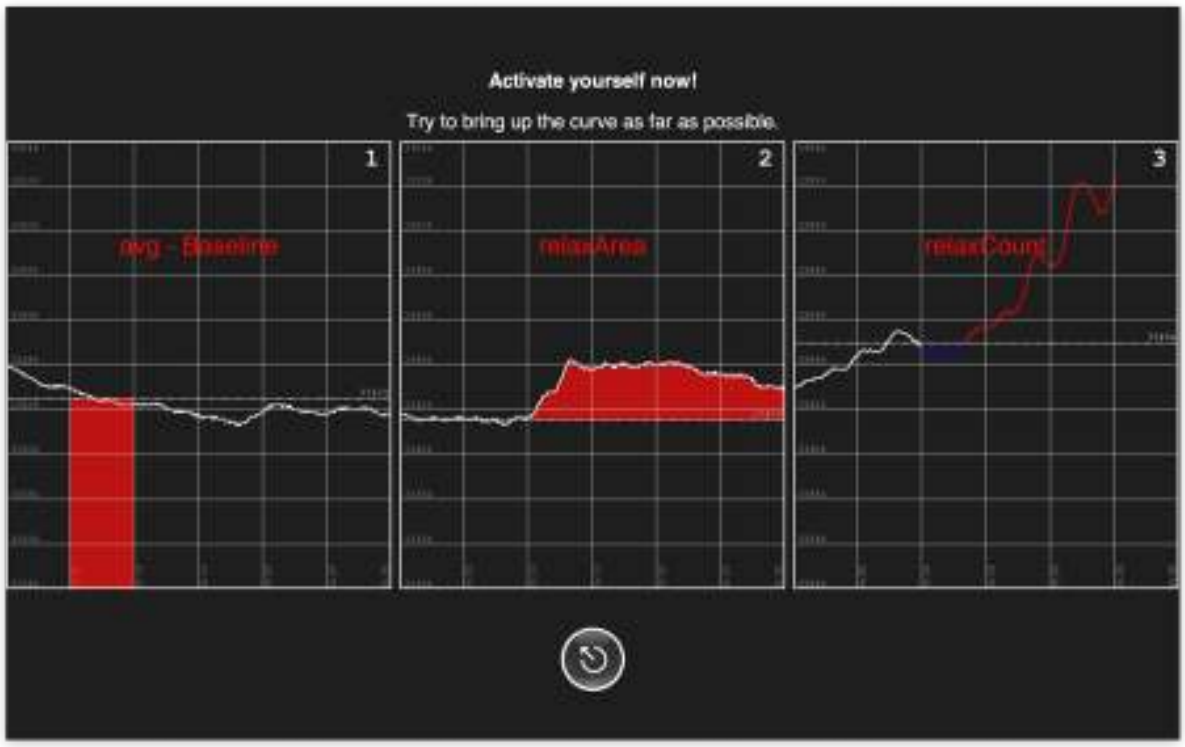

Figure 9: Skin conductance measurement info screen

This way we tested 156 people, resulting in 468 segments. Again, due to reasons of data protection, no sociodemographic data were recorded.

3.6 Analyzing the first impact of interventions generated by the GREAT system

Several interesting features appear in Figure 10: the values of aScent (*) and rScent (*) – which are combinations of all settings where activating and relaxing scent was dispersed respectively, differ more than any other comparable group (aLight vs. xLight, aTarget vs. rTarget, aSound vs. rSound). Running a ttest2 ($t(310) = 3.599$, $p < 0.001$)) shows a highly significant difference between the physiological reaction on citrus- and rose-based scent during early periods (between seconds 5 and 10 of the measurement).

If we take a closer look at the "calming"-line, depicted as red dash-dots with black stars at the end we see that the aforementioned group "aScent" and 5 specific combinations (labelled with their respective n and the task – whether the tested people should feel relaxed "-" or activated "+" by the setting: 2+, 7+, 11+, 15- and 15-) lie below it. That means that the confidence intervals of the complete dataset and them don't overlap which gives reason to look at the ttests:

Comparing the complete dataset against the aScent group gives $t(602) = 2.578$, $p = 0.005$, which is a significant difference. The comparison of the five specific groups

against the complete dataset unfortunately don't show significant results, although the last two get very close:

„2+" $t(468) = 0.525$, $p = 0.300$
„7+" $t(473) = 0.952$, $p = 0.171$
„11+" $t(477) = 1.136$, $p = 0.128$
„15-" $t(481) = 1.425$, $p = 0.077$
„15-" $t(481) = 1.484$, $p = 0.069$

The interventions of two groups „15-" are both warmwhite light and citrus-based scent. The circle has calming sounds, the diamond has activating sounds. During both, participants were told to activate themselves.

No activating effects were found while analyzing the data. A possible explanation is that after the first 5 seconds, some combinations lead to a quicker relaxation after the first exciting impression of entering the cabin and wearing the data glove.

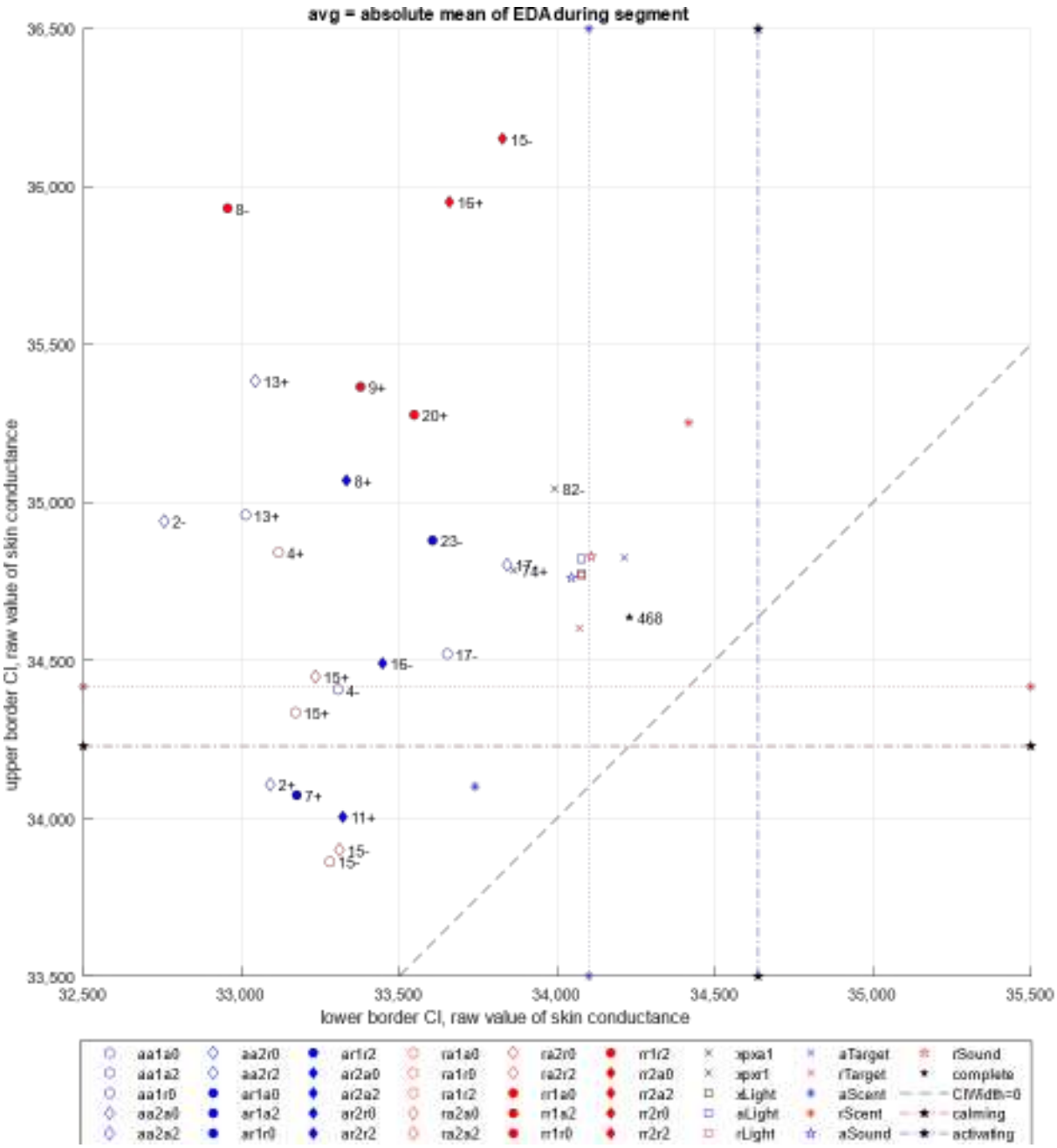

Figure 10: avg measurement confidence intervals

3.7 Regarding effects on participants physiology after the first impact

Figure 11 is constructed similarly to Figure 10 but shows the sum of the areas below and above the baseline measurement. If any confidence intervals were above or below zero it would be a strong indicator for relaxing (values greater than zero) or activating (values smaller than zero) effects. There are 5 markers plotted below the blue "activating"-line.