Report

No effect of mobile phone exposure on average erythrocyte aggregation as viewed in dark-field microscopy, with or without a "mobileFloww" device. A double-blind pilot study

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Abstract

The aim of this study was to examine whether a mobile phone has any measurable effects on the average erythrocyte aggregation (AEA) in whole undried peripheral blood, and whether a mobileFloww device has any measurable effects on the AEA size in such whole undried peripheral blood. The study was a placebo-controlled double-blind randomised one. The images made with the dark-field microscope were counted in channels. Aggregation was defined by red blood cells that overlapped. Each aggregation was accounted for separately within each image. Cell deformation was defined as cells having a non-round shape that was visually distinctly different from a round shape. The result showed that the mean AEA of the three groups “mobile”, “placebo” and “floww” was 51.7, 18.5 and 27.8 respectively. The median AEA for these three groups was 53.2, 14.0 and 4.1, respectively. No statistically significant differences were established meaning that we could not demonstrate any effect of mobile phone radiation on the AEA of peripheral blood, and, thus, as a consequence we could not establish any possible effect of the “mobileFloww” device.

Introduction

An increasing number of people, governments and institutions, including the World Health Organization and the Council of Europe, show concern about the health effects of electromagnetic radiation. Scientific studies show a connection between artificial electromagnetic fields and stress and fatigue. Yet wireless communication has become indispensable. More and more electronic wireless communication devices are in use throughout the world, with more breadth of usage across locations and ages with new networks, and the ability to be online anywhere and at any time. The adoption and use growth percentage of wireless networks of several types have increased significantly in the last 10 years. All these wireless networks generate different forms of non-ionising, electromagnetic radiation of various frequencies, modulations, pulsations and strengths. The age of the users has spread to the youngest and oldest in the last years. Therefore it becomes more and more important to find ways to utilize these forms of radiation in a responsible way, thus trying to protect the users. This is the aim of Floww Health Technology.

What is known

The earliest research regarding these electromagnetic fields and their potential effects dates back to 1970 and before, with a definite increase in the volume of studies in this field in the last years. The investigation methods and results are diverse. This is understandable because there is no single unequivocally proven mechanism yet for how the radiation from these networks could influence a human being, animals, plants or bacteria. This is highlighted further by the absence of replications of studies completed before.

The results of the known studies so far are diverse. Most studies focus on the short-term effect. Recently, a theory has been proposed about polarisation of molecules that aims to explain some of the chemical chain events in human beings occurring as a result of such artificial electromagnetic radiation, bringing an explanation of a potential mechanism closer.

Area where information is missing

Studies mainly focus on the effects of this electromagnetic radiation, or absence of effects, to determine whether there is a potential danger for human beings. That there are potential negative effects is clear, but studies that focus on potential solutions other than shielding are few and far between. Studies into potential solutions other than shielding for people who experience effects, with thorough methodology, blinding and randomisation are even more scarce.

Aims of this study

The aim of this study was to examine whether a mobile phone has any measurable effects on the average erythrocyte aggregation (AEA) in whole undried peripheral blood, and whether a mobileFloww device has any measurable effects on the AEA size in such whole undried peripheral blood. Since the effects of wireless electromagnetic radiation can potentially be subtle and/or individually unpredictable, an influence of the psychological state of a participant cannot be excluded upfront. Hence another aim of this study is to determine the general ‘psychological state’ of the participants with questionnaires before and after interventions.

Hypotheses

The first hypothesis was: An active mobile phone with a “placebo mobileFloww” device will lead to a significant increase of AEA in undried blood.

The second hypothesis was: An active mobile phone with an “active mobileFloww” device will restore the AEA in undried blood back to normal levels.

The third hypothesis was: The psychological state of a participant can alter their AEA in undried peripheral blood.

Design

Study description

The study was a placebo-controlled double-blind randomised one. In view of the actual circumstances with participants, investigators, observers and device preparation blinded, it was a triple-blinded study. It was carried out at the offices of Floww International in Nuland, The Netherlands, in a wing of the building that was closed to others during the study. The study was performed with 18 healthy participants each receiving two interventions, with the aim of providing a reasonable pilot sample size based on the outcome of earlier experiments. A short questionnaire was used before and after interventions to sample the general ‘psychological state’ of the participants and to provide a way to assess the level of bias their psychological state may have contributed to the outcome of the study.

Interventions

The interventions that were compared are:

1. a mobile phone that was turned completely off with a dummy mobileFloww device attached to the phone (‘placebo’);
2. a mobile phone with active phone call but without active user actions with a dummy mobileFloww device attached to the phone (‘mobile’);
3. a mobile phone with active phone call but without active user actions with a working mobileFloww device attached to the phone (‘floww’).

Study population

To avoid bias in selection, recruitment has taken place through 3 adverts in two regional newspapers that were distributed door-to-door in the area of Hertogenbosch, close to the Floww company premises. Twenty participants were entered that met the inclusion/exclusion criteria on a first-come first-serve basis. Ten reserve participants that met the inclusion/exclusion criteria were entered on a first-come first-serve basis to fill in in case a participant was unexpectedly not present.

Methods and Materials

Delivery of interventions

The interventions were delivered to the participant in a black cotton glove with elastic band on the inside to hold the mobile phone in place. The interventions were prepared by a separate independent blinded person who had no contact with the investigators during the study. After preparation, the glove was carried to the research room and left outside the door. The investigators picked up the glove from outside the door for use by a participant. The participant put his/her hand in the glove on top of the test object. After 15 minutes, the participant was informed that they could withdraw their hand from the glove. The glove with the intervention device was then taken away from the participant and placed outside the study room door without opening the glove.

Only strict necessary communication was allowed between the participant and the investigators/observers. No subject of any kind was discussed during the study other than procedural questions and/or directions that were needed during the tests.

Blinding/randomisation

The participants were given a number after they had signed and sent their consent forms. The notary assigned the participant's number to the interventions randomly with a 1:2 ratio between the placebo and the other intervention groups. The participant numbers were written on envelopes, with the interventions a participant was to receive written on a piece of paper and inserted into the envelope with that participant's number. The envelope was then sealed. All envelopes were sealed in a larger envelope by the notary. The envelope for any particular participant was only opened just before the start of that participant's test by the person preparing the interventions, thus ensuring that every step remained completely blinded. The intervention devices were stored after each test day with the independent person that prepared the interventions to keep the blinding intact.

Only the notary had the key to the blind code, all others were blinded to which intervention code was which. Furthermore, only the person preparing the interventions knew which participant numbers received which intervention within approximately ten minutes before the start of each participant's testing. The investigators, the support staff and the observers were blinded as to what interventions which participant received. The personal details of the participants were kept in a secure position during the study. The investigators, the observers and the intervention preparation person had no part in the selection process and were blinded to the identity of the participants during the study.

Randomisation of images was done by using the center of a blood drop as reference from which to generate four randomised locations for the subsample acquisition.

Image analysis and counting of red blood cells (RBCs)

The images made with the dark-field microscope (DFM) were counted in channels. Aggregation was defined by red blood cells that overlapped. Each aggregation was accounted for separately within each image. Cell deformation was defined as cells having a non-round shape that was visually distinctly different from a round shape. A visual analogue scale (VAS) was done by grouping the images into categories and translating these categories into a scale from 0 to 100. Cell form deformations were counted. All analysis, counting and scoring was done by the two investigators separately and before any blinding was broken.

Dark Field Microscope (DFM)

The DFM used was a Hund-Wetzlar H 600 LL HP/NP 50/100, with 100x oil-immersed objective.

Research location

The location used was a wing of the Floww company building that was closed to other people during the study, with a separate side door being used for the study participants and the main entrance being locked. The setup was such that every participant was stationed in a separate room, and that they were guided through the hallway by research staff to ensure that there was no interaction between participants before or after testing. The intervention devices were prepared in a separate room as well, and were carried to and from the research room separately by the same person that guided the participants.

During the investigations, the investigators were not allowed to leave the study location. The observers were free to walk between rooms and assess that no interaction took place outside of the prescribed procedures for the study.

Protocol breach

On the evening before the start of the study, the primary investigator learned that 4 participants with indirect ties to company personnel had been entered into the study inadvertently. The participants involved were taken off the list, and both independent observers were informed of the breach of protocol and the rectification measures taken. Due to the exclusion, reserve participants were used to fill 2 participant slots. The other slots could not be filled by reserve participants, which lowered the number of participants from 20 to 18.

Results

The results below are given for the entire groups 'mobile', 'placebo' and 'floww' across intervention moments, and are given as means and medians with a confidence interval (CI) of 95% as error bars.

Three types of results are reported below: the mean and median Average Erythrocyte Aggregation (AEA), the mean and median Visual Analogue Scale (VAS), and the mean and median number of cell deformations.

Mean and median

To exclude any individual influences, the results were averaged over participants for each investigator performing the analysis. These final averages for each observer were then averaged as well to obtain the mean values.

Besides the mean, the median was also chosen as a value to report on. The median (the middle value of all mean values) is of interest because it shows whether or not the collection of mean values are normally distributed or not. When the median deviates a lot from the mean, it means that the collection of values are not normally distributed but that the population is skewed to one side. When the median is lower than the mean, this means that values below the mean are present more often than the values that are higher than the mean.

Average Erythrocyte Aggregation (AEA)

The mean and median Average Erythrocyte Aggregation (AEA) for the groups were:

	Mean	Median
mobile	51.7	53.2
placebo	18.5	14.0
floww	27.8	4.1

The results for the mean and median Average Erythrocyte Aggregation (AEA) are detailed below in graphical form in Figure 1 and 2.

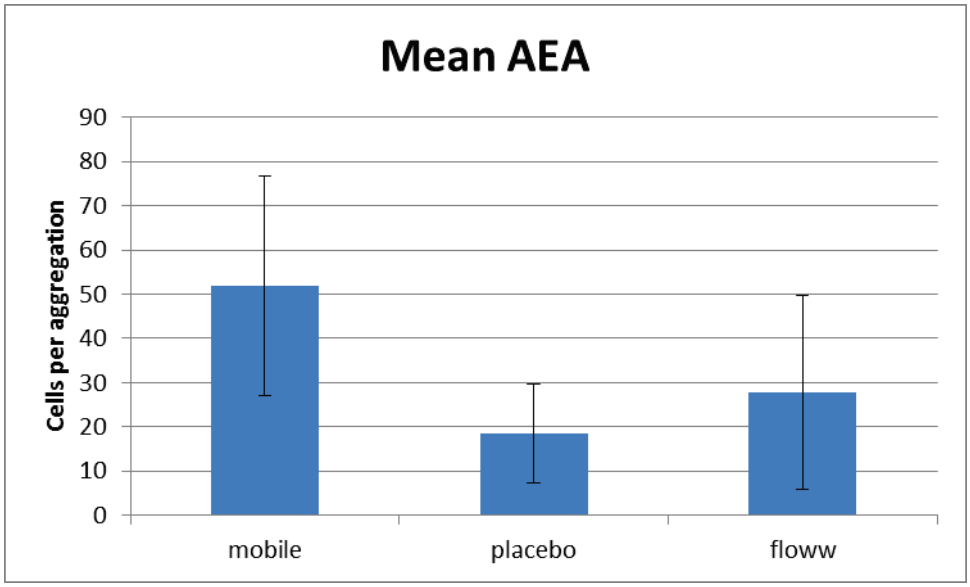


Figure 1: Mean average erythrocyte aggregation for all three intervention groups

Figure 2 indicates that the mean aggregation size in the 'mobile' group was larger than in the other groups, that the mean aggregation size in the 'placebo' group was lowest, and that the mean aggregation size in the 'floww' group was in between the other two groups, being approximately 50% lower than the 'mobile' group and 35% higher than the 'placebo' group.

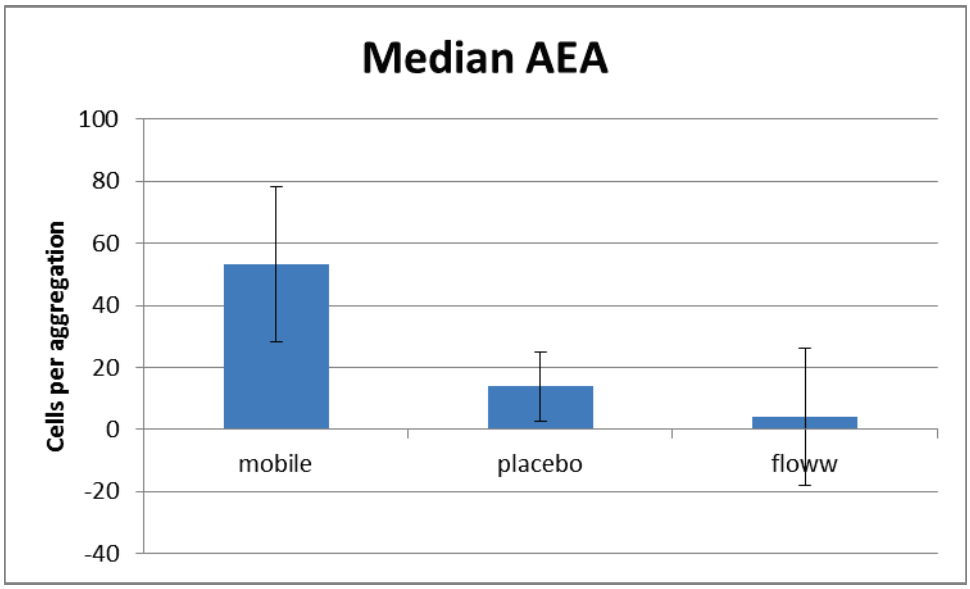


Figure 2: Median average erythrocyte aggregation for all three intervention groups

Figure 2 indicates that the median aggregation size in the 'mobile' group was highest, that the median aggregation size in the 'placebo' group was in between the other two groups and that the 'floww' group median aggregation was lowest. The values for the 'placebo' and 'floww' groups were approximately 75% and 90% lower than the median value for the 'mobile' group, respectively.

Visual Analogue Scale

A Visual Analogue Scale (VAS) was given to each image processed as an alternative way to score the results. The VAS was averaged out for each test and for each investigator performing the analysis. To obtain a VAS, each image was given a score between 0 and 100, where 0 means a completely unaggregated image and 100 means a completely aggregated image.

	Mean	Median
mobile	39.2	43.1
placebo	33.9	37.2
floww	36.9	28.9

The results for the mean and median VAS are detailed below.

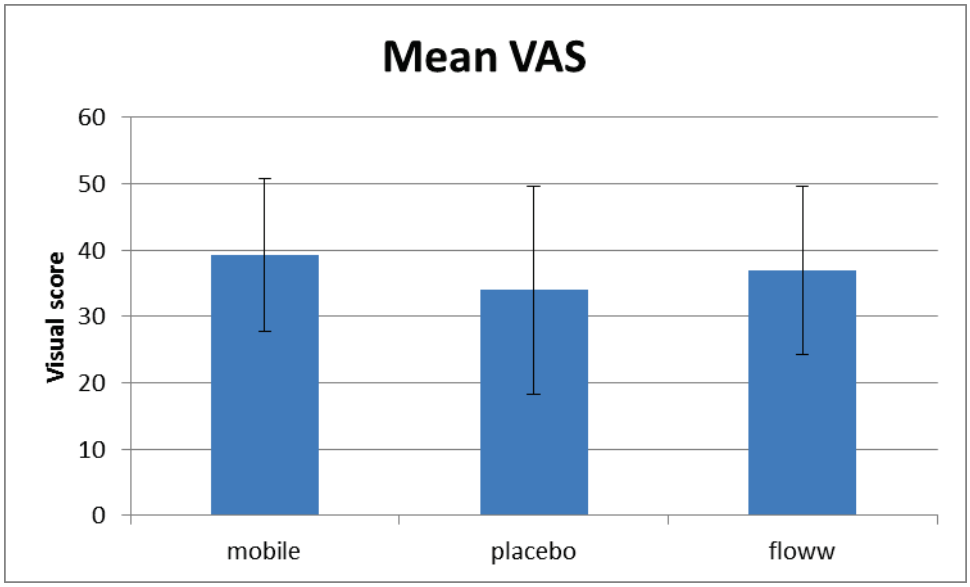


Figure 3: Mean visual analogue scale for all three intervention groups

Figure 3 shows that the mean VAS for all groups did not differ from each other, with all groups being within a bandwidth of approximately 3 points or 15% of each other.

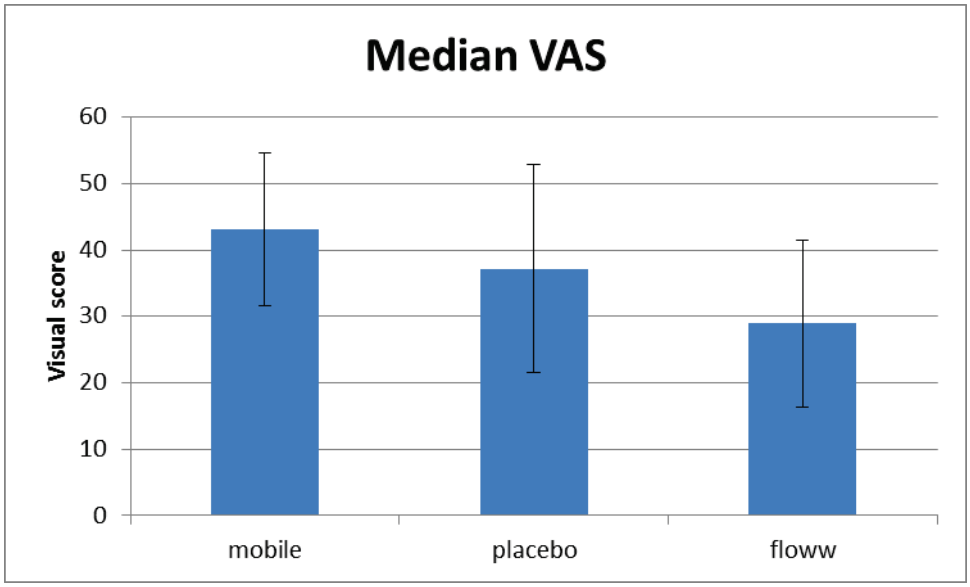


Figure 4: Median visual analogue scale for all three intervention groups

Figure 4 shows that the median value for the three groups indicates a somewhat bigger difference than the mean value. The median for the 'mobile' group was highest, followed by the 'placebo' group with the 'floww' group median value being the lowest. The 'placebo' and 'floww' median was approximately 15% and 35% lower than the 'mobile' group median value respectively.

Cell deformations

The number of cell deformations for each image were processed as an alternative way to score the results. A deformation was defined as a deviation from the normal round shape of an erythrocyte. Deviations like dents were counted and averaged out to obtain the values presented below.

	Mean	Median
mobile	12.7	9.5
placebo	28.8	34.5
floww	13.4	14.5

The results for the mean and median cell deformations are detailed below.

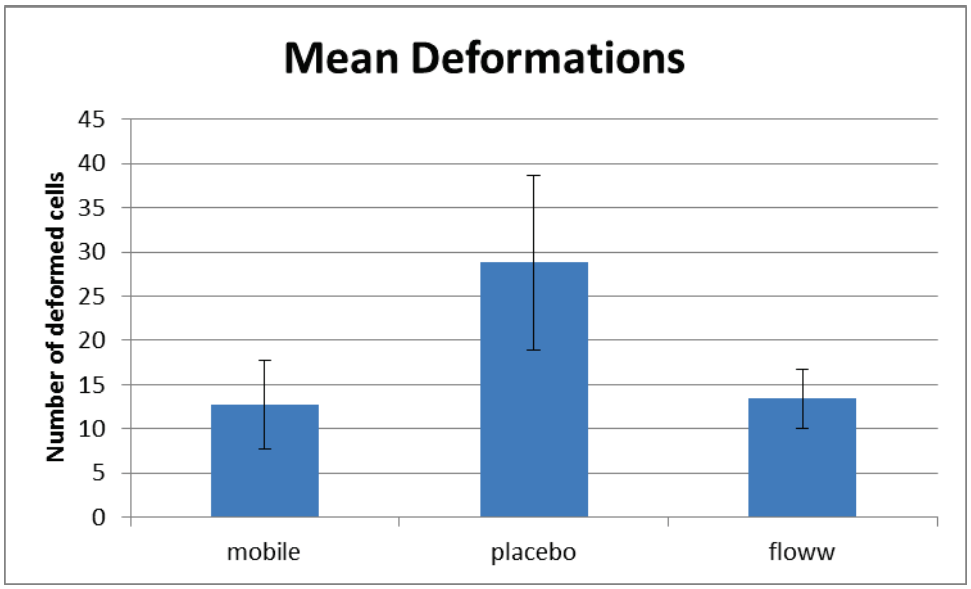


Figure 5: Mean number of deformed cells for all three intervention groups

Figure 5 shows that the average number of cell deformations were largest in the 'placebo' group, followed by almost identical values for the groups 'mobile' and 'floww'. The values for the 'mobile' and the 'floww' groups were approximately 55% lower than for the 'placebo' group.

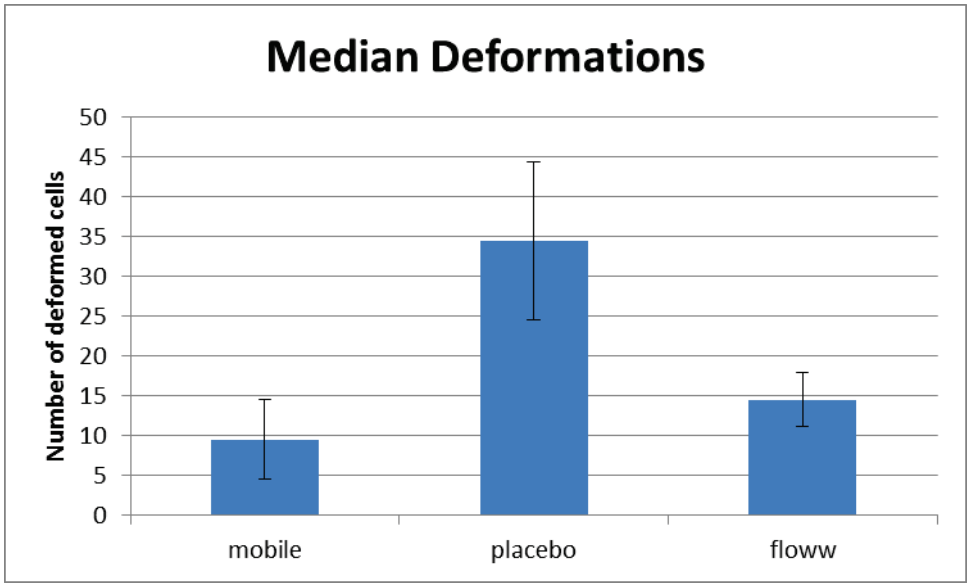


Figure 6: Median number of deformed cells for all three intervention groups

Figure 6 shows that the median deformation was highest for the 'placebo' group, followed by the 'floww' group with the 'mobile' group showing the lowest value. The values for the 'mobile' and 'floww' groups were approximately 75% and 60% lower than the value from the 'placebo' group respectively.

Statistical Analysis

The result show that the mean AEA of the three groups “mobile”, “placebo” and “floww” was 51.7, 18.5 and 27.8 respectively. The median AEA for these three groups was 53.2, 14.0 and 4.1, respectively. The data was analysed by Elisabeth Berg at the LIME/MedStat unit of the Karolinska Institute using a Statistical Analysis System (SAS) software package employing a mixed procedure for statistical differences between the intervention moments and for the differences between the interventions ‘mobile’, ‘placebo’, and ‘floww’. Differences in mean and median values were observed for two of the three scoring systems, but none were statistically significant, meaning that we could not demonstrate any effect of mobile phone radiation on the AEA of peripheral blood, and, thus, as a consequence we could not establish any possible effect of the “mobileFloww” device.

The results from the psychological questionnaires were not statistically analysed, since no significant results from the other data meant that no conclusions about the psychological state were possible.

Discussion

This study set out to investigate the effects of a mobile phone with and without a “mobileFloww” device on the average erythrocyte aggregation (AEA) in whole undried peripheral blood. The results show that difference trends in means and medians were present, but they were not statistically significant.

There are several possible reasons why the results in this study are not statistically significant, while the uncontrolled experiments beforehand did show differences. At this point, these reasons are purely speculative, since a full analysis and re-testing of i.a. the measurement instrument/method remains to be done. A non-exhaustive list of possible reasons is given below:

- the number of participants in this pilot is low;
- due to the setup, the statistical power was low, where a cross-over design would have been more favourable;
- there may have been variables present that are unknown at this time;
- there are studies that denote physical differences between people suffering from electrohypersensitivity (EHS) and people not suffering from EHS, while the participant group chosen in this study due to the selection criteria may have responded differently from people suffering from EHS;
- the measuring method may not have been sensitive enough;
- the outcome may also be correct, thus demonstrating that mobile phone radiation does not increase the AEA of peripheral blood in the current setup, potentially leaving us with an impossible task to prove any effect of the “mobileFloww” device through this measurement method.

This study is just one of the steps of investigation into the Floww devices. Since the study does not show significant differences, all potential next steps need to be assessed before a follow-up study is done, including a re-assessment of the measurement method.

Invitation

At this point, we would like to acknowledge the outstanding contributions of everyone involved so far, and extend a heartfelt invitation to all scientists who feel they have something to contribute to provide Floww with feedback, comments and possible avenues of investigation. We are on a mission to further the use of weak electromagnetic radiation for the absolute well-being of people, while still retaining and combining an open mind with rigorous research methodology. For these reasons, we are more than happy to share our raw data with any serious, yet critical scientist, for together we know more than apart. You can contact us at paul.mak@floww.com for any inquiries.

Acknowledgements

We would like to thank the statistician, Elisabeth Berg of the Karolinska Institute for her dedication and explanations. Also, we would like to thank Barry Martijn of Kragd Notaries for his advice and impeccable randomisation. Without these good people, this report would not have been possible.

Appendix

Intervention delivery and devices



Figure 7, 8, 9: Glove used for intervention (100% cotton, zipper and elastic band are adjustments for the study)

Figure 10: Intervention devices wrapped in paper to ensure identical touch sensation

Research location

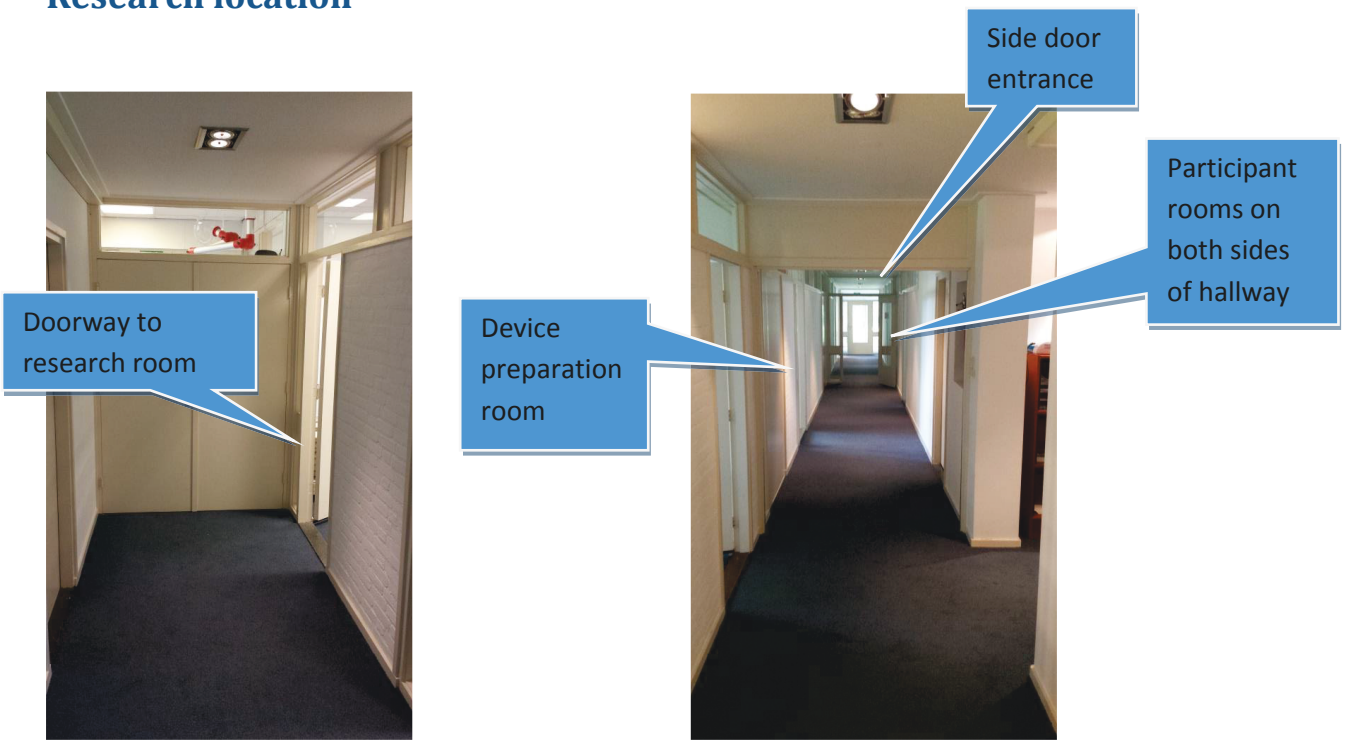


Figure 11, 12: Hallway in two parts: with research room door (left picture, right door), and hallway from research room to the other rooms ending with the side door used for entry.

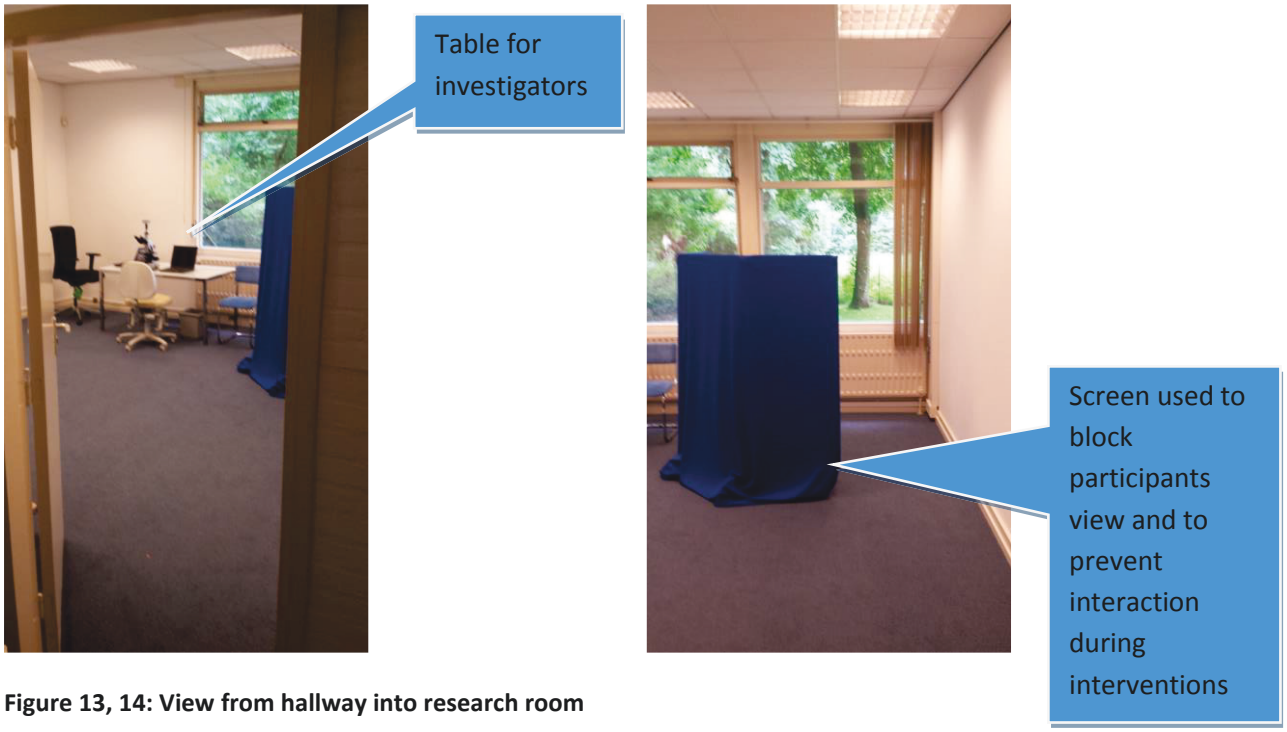
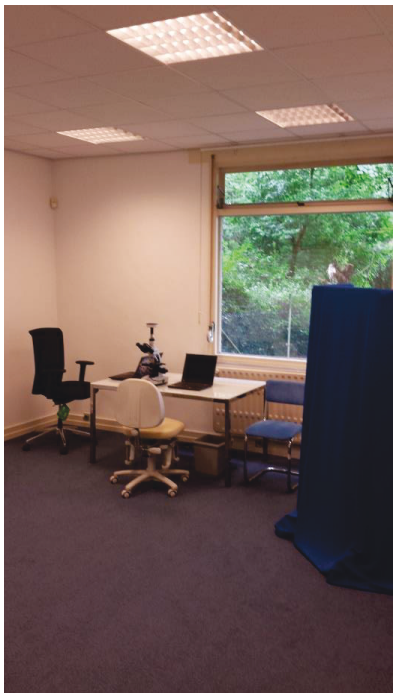
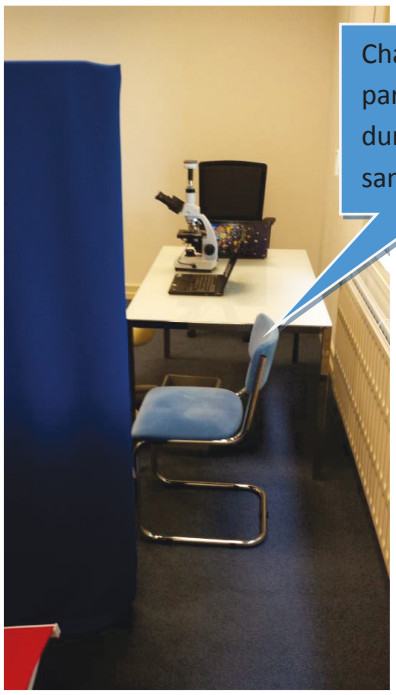


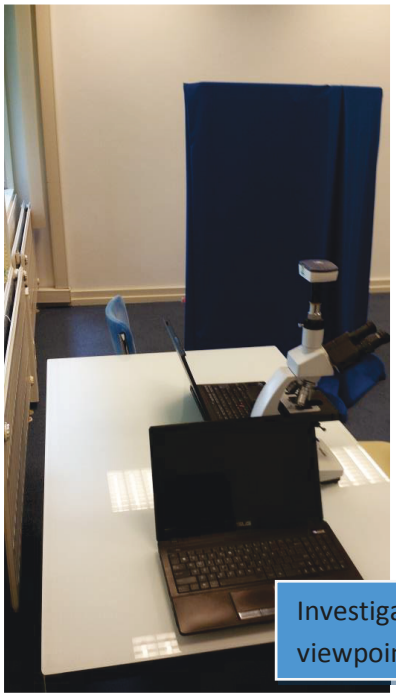
Figure 13, 14: View from hallway into research room

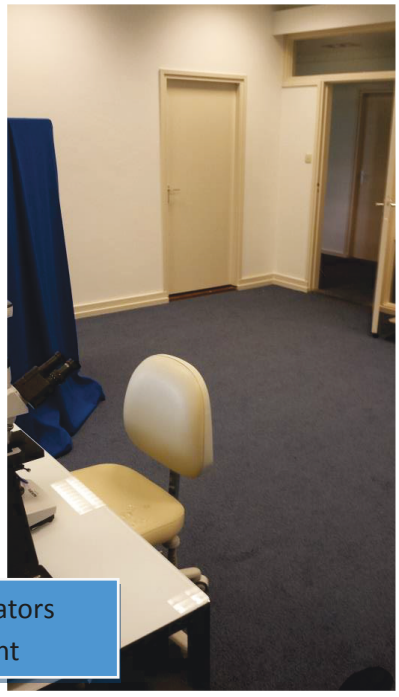
NB The pictures here are meant to show the setup during the study. The DFM, computers and observer chairs in the study were different from the ones depicted here. Their location, however, is correct.

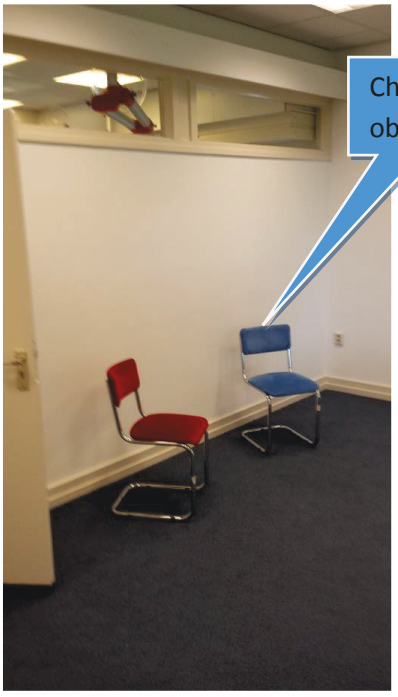




Figures 15, 16, 17: Research room setup







Figures 18, 19, 20: Research room setup (cont.)

Path to side door

Figure 21: Entry onto the company grounds

Figure 22: Next to tree

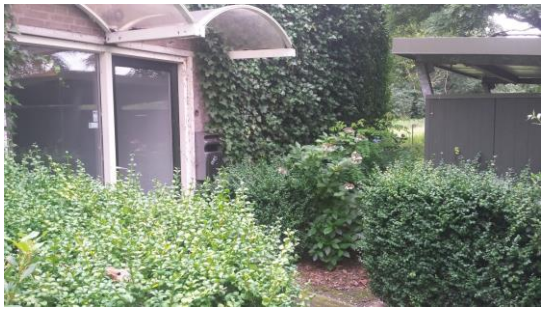
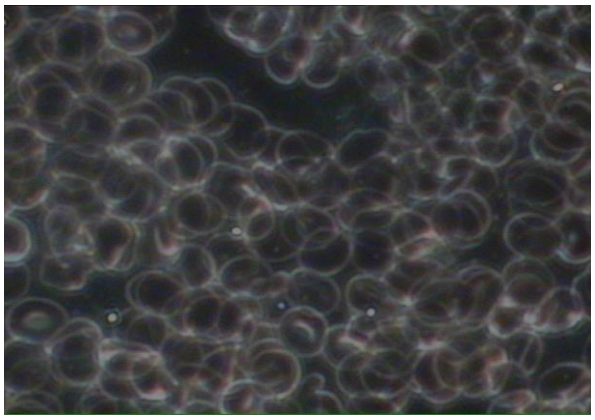


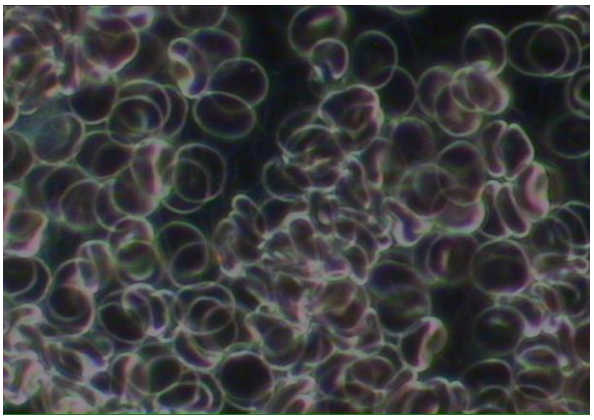
Figure 23: Beside building

Figure 24: Side door

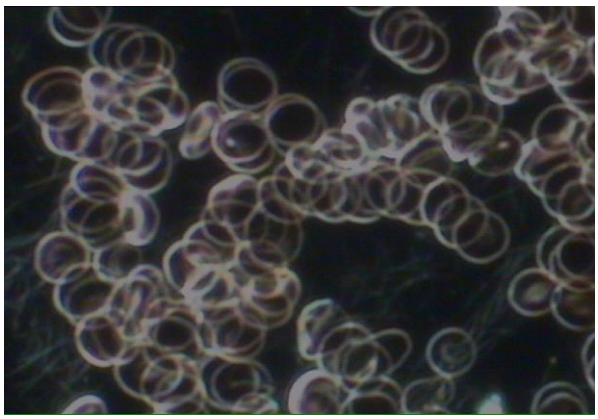
Example images for different levels of aggregation



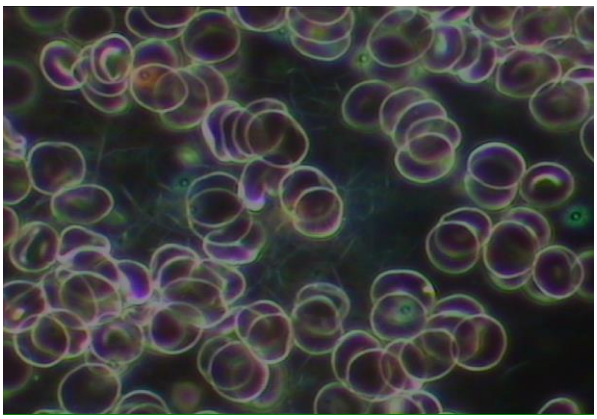
Average aggregation level: 52



Average aggregation level: 27



Average aggregation level: 18



Average aggregation level: 4