B B C R&D

R&D White Paper

WHP 287

January 2015

A Survey of UK Television Viewing Conditions

Katy C. Noland and Louise H. Truong

Future Media
BRITISH BROADCASTING CORPORATION

A Survey of UK Television Viewing Conditions

Katy C. Noland and Louise H. Truong

Abstract

We have conducted a survey of UK television viewing conditions. Information about television screen sizes and viewing distances was collected, as well as the sizes of the screens people would ideally like to have in their homes. Our key results are a median absolute viewing distance of 2.63 m, and a median relative viewing distance of 5.5 times the screen height (5.5 H). Demographic biases lead us to expect the true median relative viewing distance to be slightly larger, but not more than 5.8 H. Comparison with an earlier study indicates that screen sizes have increased since 2004, but viewing distances have remained approximately the same. There was little correlation between the screen size and absolute viewing distance, the viewing distance limit is most likely to be determined by the size of the room. The proportion of people currently watching from 3 H or closer, who could potentially benefit from resolution beyond that of high definition, is 10.2 %. If respondents were to upgrade to their estimated ideal television size but remain at the same absolute viewing distance, that increases to 22.9 % of respondents who would watch from 3 H or closer. We also found that 17.9 % of respondents have a surround sound system, 39.8 % of respondents prefer to watch television in a room that is either dimly lit or completely dark, and 59 % prefer medium or bright room lighting. We additionally collected details of respondents' viewing habits, including preferred genres and time spent watching television per day. The results of the survey are of particular interest for determining the technical parameters of future television services.

Additional key words: consumer, home, screen size, survey, television, viewing conditions, viewing distance, viewing habits

A Survey of UK Television Viewing Conditions

Katy C. Noland and Louise H. Truong

Contents

BBC Research & Development
White Paper WHP 287

A Survey of UK Television Viewing Conditions

Katy C. Noland and Louise H. Truong

1   Introduction

The viewing environment can make a significant difference to the perceived quality of a television system, so it is important to understand home viewing conditions in order to optimise the technical parameters of a television service. For example, the screen size and viewing distance determines how much detail can be seen, and hence how much detail is needed. In 2004, Tanton carried out a survey of 102 people, which primarily collected information about screen sizes and viewing distances [1]. A related study in 1989 investigated preferred screen sizes and viewing distances for high definition (HD) services [2], with responses from 33 people.

Tanton's 2004 data has been used extensively in discussions regarding appropriate technical parameters for television, but it is acknowledged that it was collected from a relatively small sample of people, most of whom had a strong technical background, so it may not necessarily be representative of the general population. Furthermore, since 2004 flat screen televisions have become the norm, screens available for purchase have increased in size, and the switch to digital broadcasting in the UK will have acted as a prompt for many people to replace their televisions, so the results are out of date.

We have therefore conducted a new survey, from which we aimed to collect a much larger number of responses than previous surveys, that are more representative of the general population. In order to achieve this, the survey took the form of an online questionnaire, which was publicised on the BBC website and through social media (see section 3).

2   The Survey

This survey differs from previous surveys in that it was targeted at a general audience, rather than those with a technical background. This meant we could collect data from a wider and more representative sample of the population, but also limited the amount of technical detail we could ask for. It was essential for the questions to be both easy to understand and quick to answer.

The information of most interest is the size of people's screens, and the distance from the screen at which they typically watch. From this data, it is possible to draw conclusions about how many people are able to experience the full benefit of HD pictures, and how many might benefit from a higher spatial resolution such as that offered by Ultra-High Definition (UHD).

Since these results will be used to help plan future services, it is also of interest to understand how screen sizes might change in the future. Hence, we asked respondents to estimate the size of the ideal television screen to suit their current home. In addition, we collected details of respondents' loudspeaker arrangements, preferred room lighting, typical amount of time spent watching television and preferred programme genres, and asked about any other services for which they use their television screens. We also collected some basic demographic information: age, gender, region of abode, and whether respondents work in an industry related to broadcasting. The survey questions are shown in full in appendix A, in the same format as they appeared to respondents.

3   Collecting Results

To make it easy for people across the country to access the survey, all responses were collected using a managed online survey service. An explanatory page on the BBC R&D website was created

(see appendix B), with a link to to the survey itself. All advertisements for the survey pointed to this explanatory page.

The majority of responses (we estimate around 2200 of the 2633 responses collected before data pruning) were collected during two periods while the survey was publicised on the BBC homepage[1], once on a Wednesday morning (under "Knowledge"), and once overnight from Saturday evening to Sunday morning (on the front page). Appendix C shows screenshots of the promotions. The survey was also publicised using official BBC Twitter feeds[2], blog posts[3], LinkedIn, Facebook, internal BBC mailing lists and the BBC staff intranet, and contacts were asked by e-mail to take part and further advertise the survey within their networks.

The survey was open between 4th August 2014 and 2nd October 2014. In this time we collected 2633 complete responses. Some of these were not used (see section 4), leaving a total of 2416 responses that were included in the final analysis. The majority of results (those that ask specific questions about television measurements and viewing habits, reported in sections 5.3 to 5.8) are presented as proportions only of the 2185 respondents who have a television in their home.

4   Response Processing

Before analysing the results, we applied some processing to remove responses from outside the UK, to remove any nonsense responses or unrealistic measurements, and to interpret any free text responses.

4.1   Responses from Outside the UK

The BBC is primarily interested in optimising the viewer experience within the UK. Although responses from outside the UK are also of interest, we would like our results to represent our main audiences. Hence, we did not include the 41 respondents who reported that they live outside of the UK in the final analysis.

4.2   Nonsensical Free Text Responses

Many of the questions were in a multiple choice format, with an option to select "Other" and enter a response in a free text field for cases where respondents felt that their situation did not fit any of the categories provided. In some cases the text entries were either nonsensical or offensive. These 14 respondents were not included in the final analysis.

---

[1]`http://bbc.co.uk`

[2]@BBCRD, @BBCiPlayer, @bbcinternetblog, @BBC_Future, @BBCiWonder, @AboutTheBBC, @BBCWales, @DavidSillitoBBC

[3]`http://www.bbc.co.uk/blogs/internet/posts/BBC-Research-Development-survey-of-television-viewing-conditions`,
`https://girlinthearchive.wordpress.com/2014/08/05/survey-of-television-viewing-conditions`

4.3 Free Text Responses that Fit Multiple Choice Categories

Some of the responses given in the free text "Other" fields described specific cases of the more general categories given as multiple choice options. In these cases the answer was changed from "Other" to the appropriate category. Most responses had to be treated individually, but some systematic decisions were applied:

- Subwoofers were ignored in the loudspeaker arrangements described.

- Where respondents described different loudspeaker arrangements for different occasions, the arrangement with the largest number of loudspeakers was taken.

- Recordings of live television were counted as broadcast television.

Appendix D lists all the free text responses (after removing nonsensical and offensive ones), and shows the classifications made.

4.4 Unlikely Measurements

Respondents were asked to measure the width and height of their screen, and their normal viewing distance. For the cases where the height was reported to be greater than the width, the values were swapped. There were 161 cases for measurements of the respondent's current television and 46 cases for estimates of the respondent's ideal television. Although it is possible that somebody would ideally like to have a screen that is taller than it is wide, it was decided to impose the requirement on ideal television sizes because without it, the only reported aspect ratio narrower than 1:1 was 9:16. This is more likely to be a result of respondents accidentally entering the width and height of a 16:9 screen the wrong way round than it is to represent a true desire for a very narrow screen.

In some cases the measurements given were far smaller or larger than would be expected of domestic viewing environments, and some width and height measurements together resulted in highly unlikely values for the aspect ratio, even after correction to ensure the width is greater than the height. Responses from the 159 people whose measurements of their current television and viewing distance fell outside a specified range were not included in the final analysis.

Respondents were also asked to estimate the width and height of the screen they would ideally like to have in their current home. Limits were set on these values, but respondents' answers to other survey questions were kept. The aspect ratio for respondents' ideal televisions was not restricted beyond the requirement for the width to be greater than the height.

The process of limiting the measurements required some manual threshold setting. Tables 1 and 2 show the chosen values. The thresholds were chosen to be quite relaxed, whilst still removing obviously improbable measurements. Minimum screen sizes reflect the smallest portable televisions that are available, maximum screen sizes reflect the likely limitations imposed by domestic room sizes (and are much larger than the largest televisions that can currently be purchased, but could potentially be realised with a projector), and the maximum aspect ratio is slightly wider than the widest commonly available aspect ratio of 21:9.

4.5 Quantised Measurements

Respondents were asked to report their viewing distance to the nearest 10 cm. On inspection of the distribution of viewing distance measurements (figure 20), it was found that there were strong peaks at multiples of 50 cm. Viewing distances are continuous, hence we believe that these peaks do not represent the true distribution, but rather indicate that many people estimated the distance and rounded to the nearest half metre. To account for this rounding we added zero-mean random noise with a rectangular PDF and maximum value 25 cm to the viewing distance measurements. As well as smoothing the distribution, adding noise of ± 25 cm reflects the uncertainty in the measurements

Table 1: Thresholds set on measurements.

Threshold	Threshold Value (cm)	Number Outside Threshold
Minimum screen height	5	16
Maximum screen height	300	46
Minimum screen width	7	12
Maximum screen width	500	55
Minimum viewing distance	25	40
Maximum viewing distance	800	82
Minimum ideal screen height	5	7
Maximum ideal screen height	300	25
Minimum ideal screen width	7	8
Maximum ideal screen width	500	27

due to people typically not remaining completely still whilst watching television. The median value changed by only 3.3 cm as a result of adding the noise.

Similar peaks can be seen in the distribution of television height and width measurements at multiples of 10 cm (figures 11 and 15). However, since televisions can be purchased in only a limited number of sizes, we expected these distributions to have strong peaks at common sizes. No additional noise was added to the height and width measurements, in order to preserve the true peaks in the distribution.

Table 2: Thresholds set on aspect ratios.

Threshold	Threshold Value	Number Outside Threshold
Minimum aspect ratio	1:1	0
Maximum aspect ratio	24:9	32

5 Results and Discussion

In this section we present and discuss the results of the survey, after processing the data as described in section 4.

5.1 Demographics

The survey respondents are necessarily a self-selecting sample of people, who were willing to take the time to answer questions about television viewing conditions in their homes. We collected information about their age, gender and region of abode, and present the distributions here together with estimates of the UK population. All UK population statistics used here are estimates for mid-2013 reported by the Office for National Statistics [3]. We also asked whether respondents work in broadcasting, cinema, or a similar industry, to determine whether they are likely to have particular background knowledge about television. We discuss how the population biases may affect some of our key results in section 5.3.6.

5.1.1 Age

Figure 1 shows the age brackets for all survey respondents. The same information is presented in figure 2, separated according to whether respondents have a television in their home (answer to question 1). We can see that respondents aged 18–35 are less likely to have a television at home than those in other age brackets. However, people without a television made up only 9.6 % of our respondents (see figure 9), and hence have limited influence on the overall demographics.

Figure 3 shows the age distribution of all respondents as a histogram, which allows it to be compared to the age distribution of the UK population, also shown in the figure. In our survey, people aged between 18 and 55 are over-represented, with younger and older age groups comparatively under-represented.
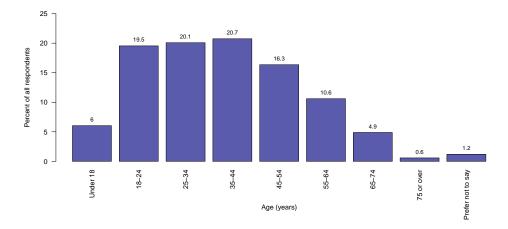
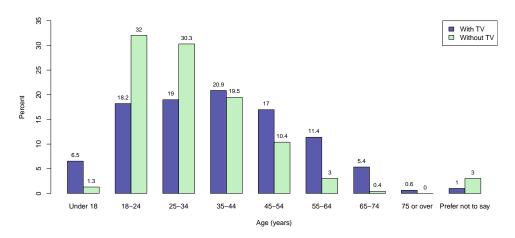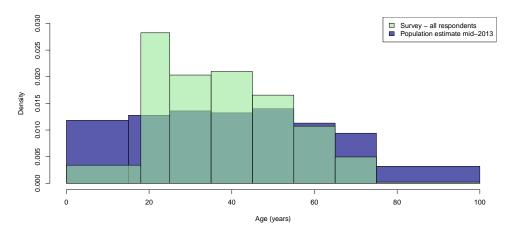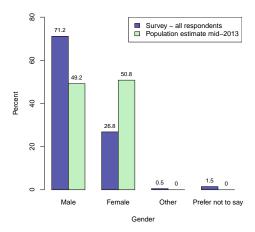**Figure 1:** Age brackets for all survey respondents.

Figure 2: Age brackets for respondents with and without a television in their home.

Figure 3: Comparison of the age distribution of all survey respondents with the estimated age distribution of the UK population in mid-2013. An arbitrary upper age limit of 100 years was used to calculate the density in the top age brackets.

5.1.2 Gender

Figure 4 compares the distribution of genders in our survey with that in the UK population. It is clear that amongst our survey respondents, there is a far greater proportion of men than women.

Figure 4: Comparison of the genders of survey respondents with the estimated gender distribution of the UK population in mid-2013. In the mid-2013 estimate, "Other" and "Prefer not to say" categories did not exist.

5.1.3 Region

Figure 5 shows the proportion of survey respondents living in each region of the UK. Figure 6 divides the respondents according to whether they have a television at home, and shows that a particularly high proportion of people who do not have a television live in London. Figure 7 compares the distribution of survey respondents to the population distribution across the UK, and demonstrates a slight bias towards London, the South East and South West amongst the survey respondents. All other regions are represented approximately in proportion to their population.

Figure 5: Survey respondents by UK region.

Figure 6: Survey respondents with and without a television in their home, by UK region.

Figure 7: Comparison of the distribution of survey respondents by region to that of the UK population.

5.1.4   Profession

Figure 8 shows that 8.8 % of survey respondents work in an industry that is related to broadcasting or cinema. Although this is likely to be a higher proportion than in the general population due to the advertising channels used, the majority of respondents are nonetheless not industry professionals.

Figure 8: Responses to "do you work in broadcasting, cinema, or a similar industry?"

5.2   Devices Used for Watching Television Content

Most of the survey questions would not be relevant to somebody who does not have a television, so to allow irrelevant questions to be skipped, respondents were first asked whether they have a television in their home. Respondents who said they do not have a television were further asked whether they watch television on any other devices (see section 5.2.2), then directed straight to the questions about demographics. All other questions (sections 5.3 to 5.8) were asked only of the respondents who do have a television in their home, and reported percentages and density values are proportions of those 2185 respondents.

5.2.1 Proportion of Respondents who Have a Television

Figure 9 shows the proportion of respondents who have a television in their home. People answering "yes" made up 90.4 % of respondents.
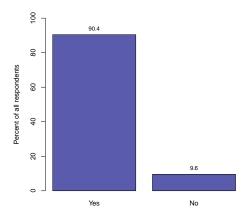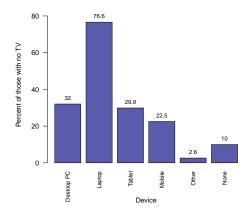

Figure 9: Responses to "do you have a television in your home?"

5.2.2 Television Viewing on Other Devices

Figure 10 shows that 90 % of those who do not have a television do, however, watch on other devices, meaning that less than 1 % of all survey respondents do not consume any television content at all. There may be a higher proportion than this of people in the general population who do not consume any television content, since these people are probably less likely to choose to fill out a survey about television viewing.

Figure 10: Responses to "Do you watch TV on any of the following devices?" Only respondents who do not have a television in their home were asked this question.

5.3 Current Television Measurements

The size of people's screens and the distance from which they watch determines how much spatial resolution is needed in the picture. The design viewing distance for high definition television (HD) is just over three times the screen height (3 H), which puts the pitch of one pixel at the limit of spatial resolution for the average viewer [4]. We asked respondents to measure their screen size and viewing distance, in order to determine how many people currently sit close enough to experience the full benefit of HD television, and how many might benefit from a possible upgrade to ultra-high definition (UHD), with its design viewing distance of just over 1.5 H.

5.3.1 Screen Heights

Figure 11 shows the distribution of screen heights as reported in centimetres. For convenience, we also present the distribution as the equivalent diagonal size in inches, assuming that all screens have an aspect ratio of 16:9 (figure 12). There are strong peaks both at intervals of 10 cm, which implies some degree of quantisation in the reported values, and at common screen sizes. In some cases, common screen sizes coincide with 10 cm intervals. Table 3 shows the equivalent diagonal screen sizes of screen heights where there are peaks in the distribution.

Table 3: Equivalent 16:9 diagonal screen sizes for commonly reported screen heights.

Screen height (cm)	Equivalent 16:9 diagonal (inches)	Multiple of 10 cm	Common size
20	16.1	✓	
30	24.1	✓	✓
33	26.5		✓
40	32.1	✓	✓
45	36.1		
46	36.9		
50	40.2	✓	✓
52	41.8		✓
57	45.8		✓
60	48.2	✓	✓
62	49.8		✓
70	56.2	✓	
80	64.2	✓	
90	72.3	✓	
100	80.3	✓	

The cumulative distribution of screen heights is shown in figure 13, with the cumulative distribution of equivalent 16:9 diagonals shown in figure 14. Tanton's study [1] reported a median screen height of 32.5 cm. The median height from our survey is 49 cm, so screen sizes have increased since 2004. A height of 49 cm corresponds to a 16:9 diagonal size of 39.3 inches, which is very similar to the 1 m (39 inch) optimal diagonal screen size for HD television reported by Tanton and Stone [2].
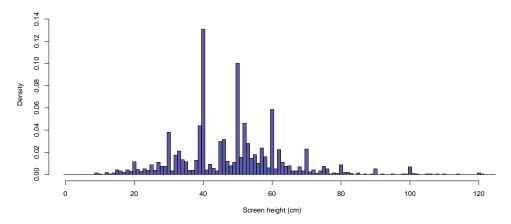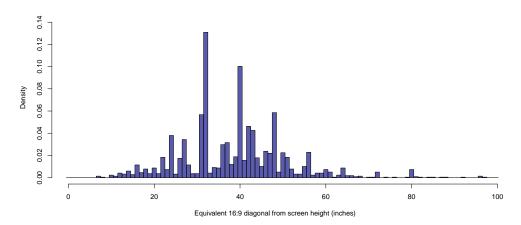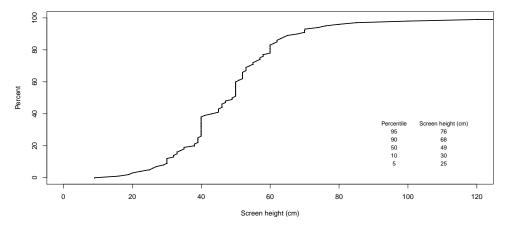
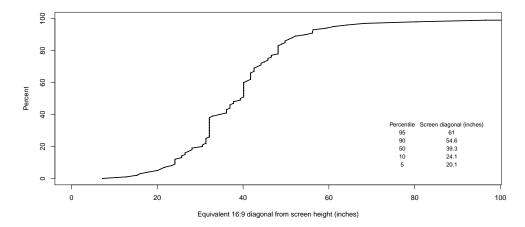**Figure 11:** Distribution of television heights.

Figure 12: Distribution of television diagonal sizes, calculated from height data and assuming a 16:9 aspect ratio.

Figure 13: Cumulative distribution of television heights.

Figure 14: Cumulative distribution of television diagonal sizes, calculated from height data and assuming a 16:9 aspect ratio.

5.3.2 Screen Widths

Figures 15–16 show the distribution and cumulative distribution of respondents' television widths, both as reported in centimetres, and as equivalent 16:9 diagonal sizes. The distribution of widths, like that of heights, shows peaks at common screen sizes and at multiples of 10 cm. Table 4 shows the equivalent diagonal sizes for the main peaks in the distribution. Our median width is 81 cm, corresponding to a median 16:9 diagonal size of 36.6 inches.

It is interesting to note that the median equivalent 16:9 diagonal size calculated from the reported height data is slightly greater than that calculated from the width data, although these values should theoretically be the same if everybody has a 16:9 screen. This implies that a number of reported screen sizes were narrower than 16:9, which is confirmed by calculating the aspect ratios from reported width and height measurements (see section 5.3.3).

Table 4: Equivalent 16:9 diagonal screen sizes for commonly reported screen widths.

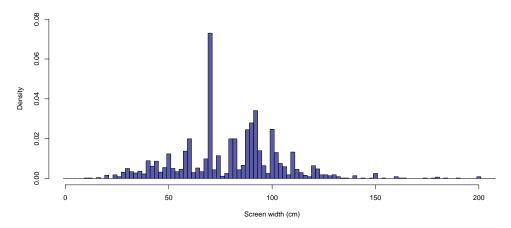| Screen width (cm)	Equivalent 16:9 diagonal (inches)	Multiple of 10 cm	Common size
40	18.1	✓	
44	19.9		
50	22.6	✓	
58	26.1		
60	27.1	✓	✓
70	31.6	✓	✓
74	33.4		
80	36.1	✓	
82	37.0		
88	39.8		✓
90	40.7	✓	
92	41.6		✓
100	45.2	✓	
110	49.7	✓	✓
120	54.2	✓	

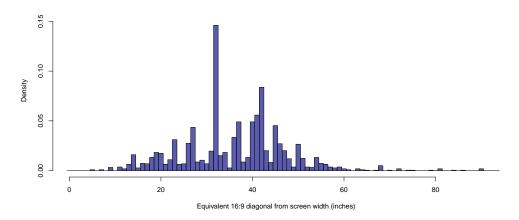**Figure 15:** Distribution of television widths.

Figure 16: Distribution of television diagonal sizes, calculated from width data and assuming a 16:9 aspect ratio.
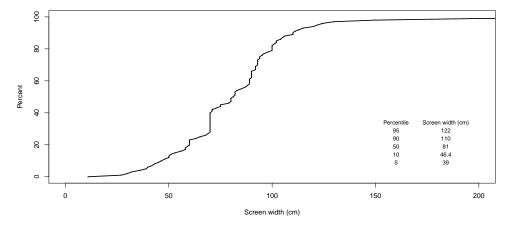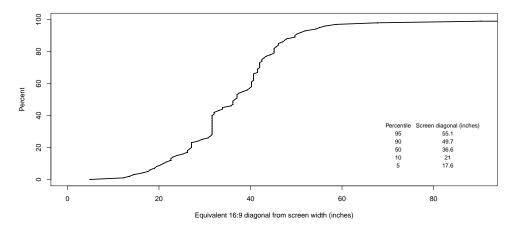

Figure 17: Cumulative distribution of television widths.

14

Figure 18: Cumulative distribution of television diagonal sizes, calculated from width data and assuming a 16:9 aspect ratio.

5.3.3 Screen Aspect Ratios

Figure 19 shows the distribution of reported aspect ratios. There is a strong peak at 16:9, and very small peaks at 12:9 (4:3), 13.5:9 (3:2) and 18:9 (2:1). It is likely that the peaks at 3:2 and 2:1 are due to some rounding in the measurements.

Figure 19: Distribution of aspect ratios.

5.3.4 Viewing Distances

As described in section 4.5, the distribution of reported viewing distances shows strong peaks at multiples of 50 cm. This data is shown in figure 20, and the cumulative distribution is shown in figure 21. Viewing distances are continuous, unlike screen sizes where we would expect to see peaks at the sizes that are commonly available. To smooth out the peaks, we added rectangular PDF noise (jitter) of up to ±25 cm to the measurements. The adjusted distributions are shown in figures 22 and 23. These adjusted values were used for all further calculations.

The median viewing distance is 2.63 m, very similar to the 2.7 m reported by Tanton [1]. Viewing distances have stayed approximately the same since 2004, even though screen sizes have increased.

Figure 20: Distribution of absolute viewing distances before application of jitter.

Figure 21: Cumulative distribution of absolute viewing distances before application of jitter.

Figure 22: Distribution of absolute viewing distances after application of jitter.

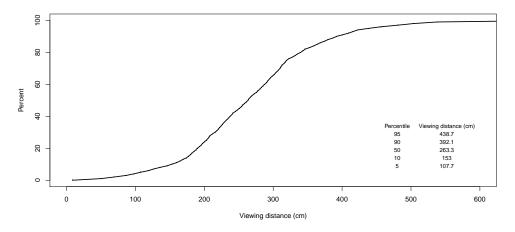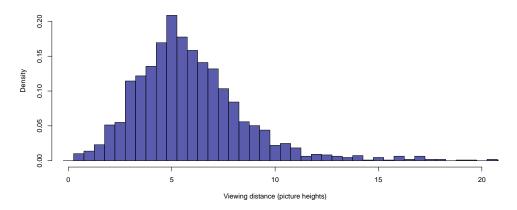| Percentile	Viewing distance (cm)
95	438.7
90	392.1
50	263.3
10	153
5	107.7

Figure 23: Cumulative distribution of absolute viewing distances after application of jitter.

It is of particular interest to understand how far people sit from their screens relative to the screen size, since this determines the angle subtended by each pixel at the eye, and is hence relevant to the choice of pixel format. Figures 24 and 25 show the distribution and cumulative distribution of respondents' viewing distances in terms of picture heights.

The median relative viewing distance from our survey is $5.5\,\mathrm{H}$. Tanton's study [1] reported a median relative viewing distance of $8.1\,\mathrm{H}$. Although absolute distances have stayed approximately the same since 2004, screen sizes have increased, so the relative viewing distances have reduced.

About $10\,\%$ of respondents watch from a distance of $3\,\mathrm{H}$ or closer. Beyond this point HD resolution becomes insufficient, and so these people would start to see some benefit from UHD resolution in their current viewing conditions. However, only those watching from $1.5\,\mathrm{H}$ or closer would experience the full benefit of a UHD service—$1.5\,\%$ of respondents. In section 5.6.6 we investigate how relative viewing distances may change if people upgrade their televisions.

Figure 24: Distribution of relative viewing distances after application of jitter.
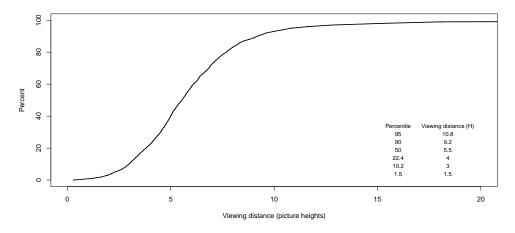

Figure 25: Cumulative distribution of relative viewing distances after application of jitter.

18

5.3.5 Viewing Distances According to Television Height

Figure 26 shows how the absolute viewing distances are distributed for different screen sizes. There are few people with extremely large screens who sit very close to the screen, and few people with very small screens who sit very far away, but within the main cluster of data there is no obvious correlation between the two variables. This means that the screen size has little influence over the chosen viewing distance.
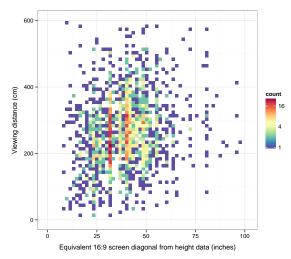

Figure 26: Joint distribution of screen sizes and absolute viewing distances.

Figure 27 shows how the relative viewing distances are distributed for different screen sizes. The triangular shape of the cluster implies that there is an upper limit on the viewing distance in absolute terms rather than relative to the screen size. Respondents with large screens do not sit further than a few screen heights away, whereas those with smaller screens watch from a wide range of relative viewing distances. The limit is probably imposed by the size of the room.
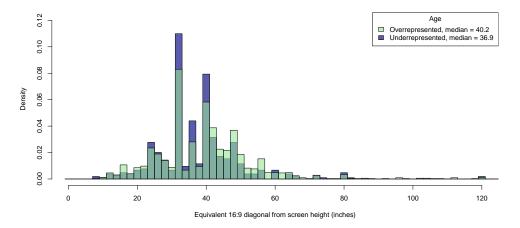

Figure 27: Joint distribution of screen sizes and relative viewing distances.

5.3.6 Demographic Considerations

In this section we investigate the effects of any differences between the demographics of our respondents and those of the UK population on our key results: the distribution of screen sizes and the distribution of absolute and relative viewing distances.

Figures 28 to 31 compare the distribution of screen sizes of over– and under-represented demographic groups. The under-represented age groups (under 18 and over 55) tend to have slightly smaller screens. Women, who are strongly under-represented in the survey, also tend to have slightly smaller screens. Those in under-represented regions (all except London, the South East and South West) tend to have slightly larger screens, as do those who do not work in broadcasting. Gender and age were the strongest biases in our survey, so we can expect the true median to be between the 36 inches for only female respondents and the overall sample median of 39.3 inches.

Figure 28: Distribution of screen sizes from height data separated by over– and under-represented age categories. Under 18s and over 55s were under-represented.
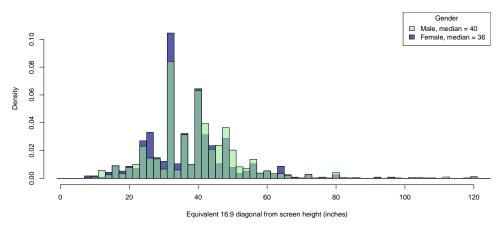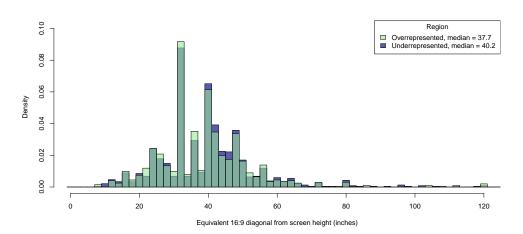

Figure 29: Distribution of screen sizes from height data separated by gender.

Figure 30: Distribution of screen sizes from height data separated by over– and under-represented regions. Those living in London, the South East and South West were over-represented.
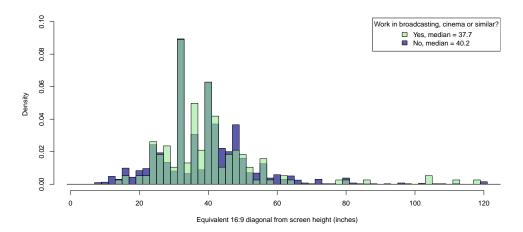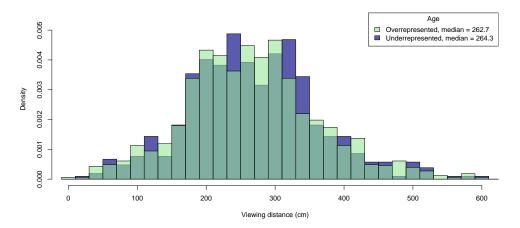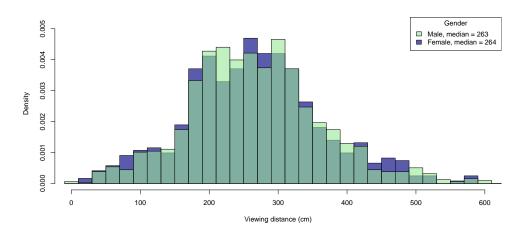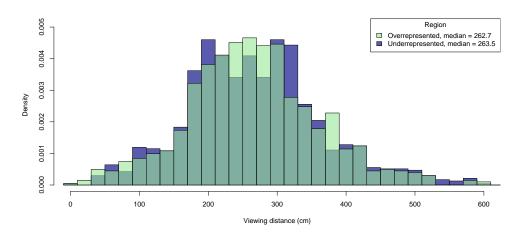

Figure 31: Distribution of screen sizes from height data separated by profession.

Figures 32 to 35 similarly separate the absolute viewing distances according to over– and under-represented demographic groups. Differences between the groups are of no more than a few centimetres, well within the margin of error we would expect from people's measurements. It is unlikely that biases of age, gender, region or profession have affected the overall median viewing distance of 263 cm presented in figure 23.

Figure 32: Distribution of absolute viewing distances separated by over– and under-represented age categories. Under 18s and over 55s were under-represented.

Figure 33: Distribution of absolute viewing distances separated by gender.

Figure 34: Distribution of absolute viewing distances separated by over– and under-represented regions. Those living in London, the South East and South West were over-represented.
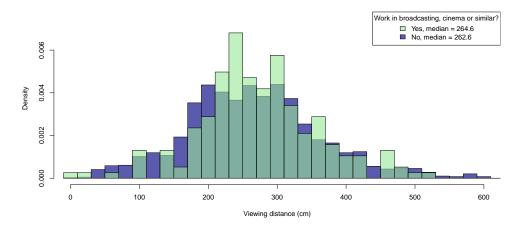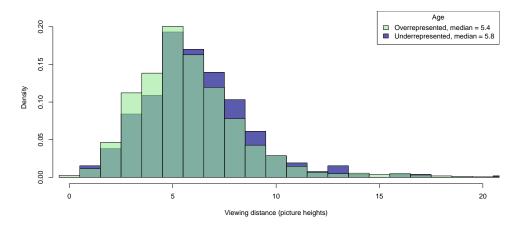

Figure 35: Distribution of absolute viewing distances separated by profession.

Figures 36 to 39 separate the relative viewing distances according to over– and under-represented demographic groups. Under-represented age groups and female respondents tend to have larger relative viewing distances, whereas those living in under-represented regions and those not working in broadcasting tend to have smaller relative viewing distances. This follows the trends in screen sizes. Median relative viewing distances for the different groups range between 5.4 and 5.8 H, with the overall median at 5.6 H (see figure 25). With our strongest biases in gender and age, we can expect the true median relative viewing distance to be between 5.6 and 5.8 H.

Figure 36: Distribution of relative viewing distances separated by over– and under-represented age categories. Under 18s and over 55s were under-represented.
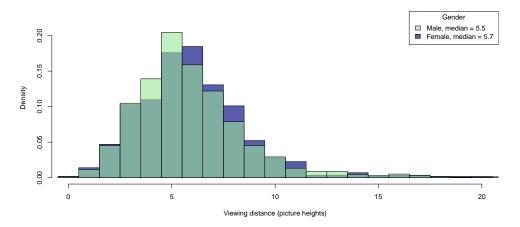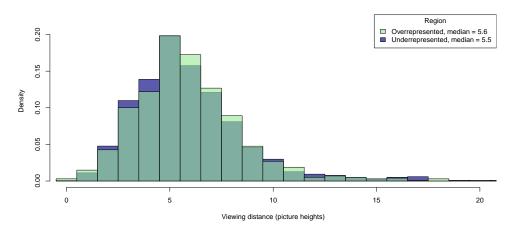

Figure 37: Distribution of relative viewing distances separated by gender.

Figure 38: Distribution of relative viewing distances separated by over– and under-represented regions. Those living in London, the South East and South West were over-represented.
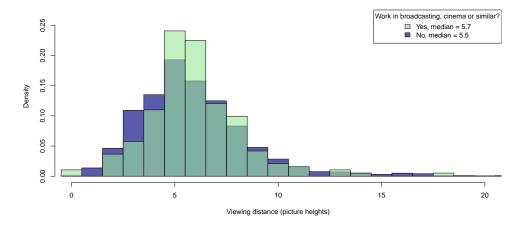

Figure 39: Distribution of relative viewing distances separated by profession.

5.4 Characteristics of Current Television

Figures 40 and 41 show characteristics of respondents' screens. Liquid crystal displays (LCDs) are the most common screen type, followed by plasma. Only 18.9 % of televisions are more than 5 years old, with 30.5 % less than 2 years old.
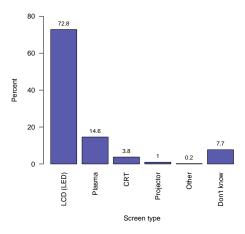

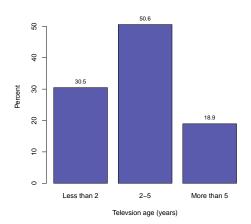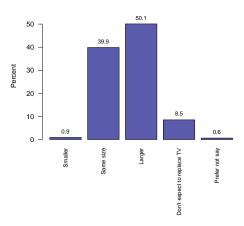**Figure 40:** Responses to "what type of screen is your main TV set?"

Figure 41: Responses to "how old is your main TV set?"

5.5 Expected Size of Replacement Television

Respondents were asked how they would expect the size of their next television to compare to that of their current one. Figure 42 shows that about half the respondents expect to buy a larger screen next time, and about half would either buy one that is the same size as their current one or do not expect to replace their television. Less than 1 % of respondents expect to replace their current television with a smaller one.

Figure 42: Responses to "Next time you replace your main TV set, how do you expect the new screen size to compare to your current screen size?"

5.6 Ideal Television Measurements

Respondents were also asked to estimate the ideal television size for their current home, assuming that money were no object. It should be noted that this question is subtly different from asking for expected size of respondents' next television, where the cost may limit the size of the television actually bought.

For convenience a table was provided in the survey showing conversions between common diagonal screen sizes in inches, and widths and heights in centimetres. The distributions therefore show peaks at these suggested screen sizes.

5.6.1 Ideal Heights

Figures 43 and 44 show the distribution of ideal screen heights in centimetres and converted to the equivalent 16:9 diagonal sizes, and figures 45 and 46 show the corresponding cumulative distributions. There is a small peak at 137 cm, or 110 inches diagonal, which was the largest size in the table of suggested values, and so can be interpreted as a desire for the largest screen possible. However, the majority of respondents would prefer a more modest screen size, the median value being about 48 inches. This is very similar to value reported by Tanton [2] for the optimal television diagonal size for the case where people were asked to adjust their furniture to suit the screen: 1.25 m, or 49 inches.
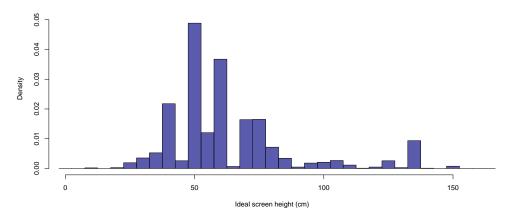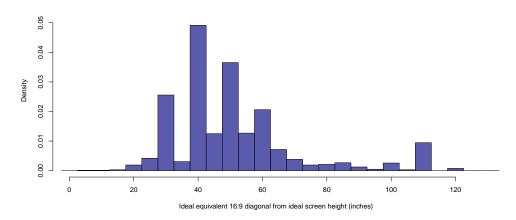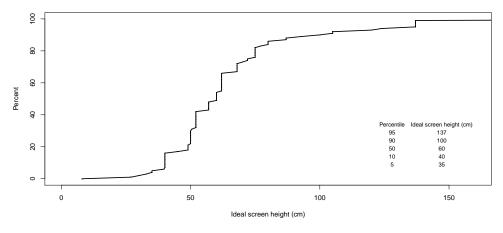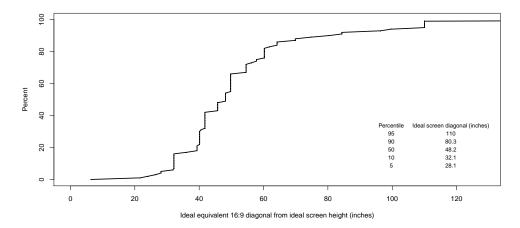
Figure 43: Distribution of ideal television heights.

Figure 44: Distribution of ideal television diagonal sizes, calculated from ideal height data and assuming a 16:9 aspect ratio.

Figure 45: Cumulative distribution of ideal television heights.

Figure 46: Cumulative distribution of ideal television diagonal sizes, calculated from ideal height data and assuming a 16:9 aspect ratio.

5.6.2 Ideal Widths

Figures 47–50 show the distributions of the widths of respondents' ideal televisions, as raw values and converted to the equivalent 16:9 diagonal sizes. They show the same trend as the height data, with a small peak at the largest suggested value, but the majority of respondents preferring a screen with a diagonal size between 30 and 60 inches. The median ideal screen size from width data was about 48 inches, the same as that from height data.
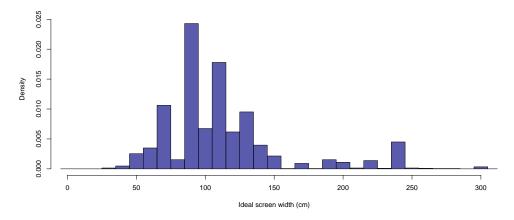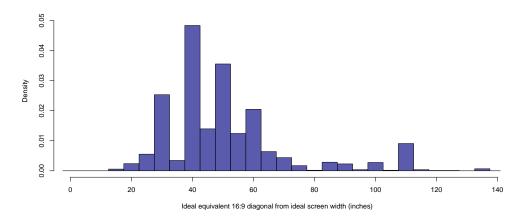

Figure 47: Distribution of ideal television widths.

Figure 48: Distribution of ideal television diagonal sizes, calculated from ideal width data and assuming a 16:9 aspect ratio.
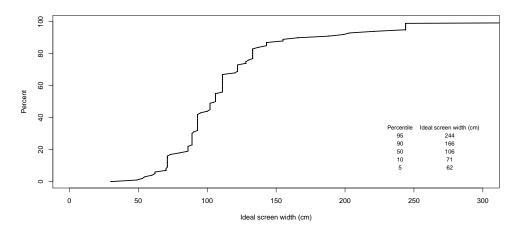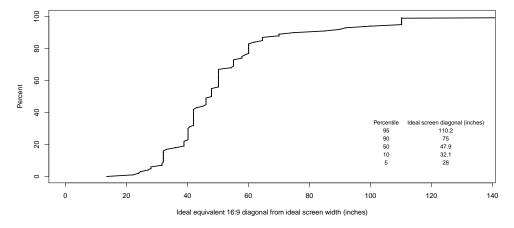

Percentile	Ideal screen width (cm)
95	244
90	166
50	106
10	71
5	62

Figure 49: Cumulative distribution of ideal television widths.

Percentile	Ideal screen diagonal (inches)
95	110.2
90	75
50	47.9
10	32.1
5	28

Figure 50: Cumulative distribution of ideal television diagonal sizes, calculated from ideal width data and assuming a 16:9 aspect ratio.

5.6.3 Ideal Aspect Ratios

Figure 51 shows the distribution of aspect ratios calculated from ideal width and height estimates. Almost all respondents have indicated a preference for a 16:9 aspect ratio, most likely as a result of the table of common screen sizes that was provided, which only suggested sizes with an aspect ratio of 16:9.
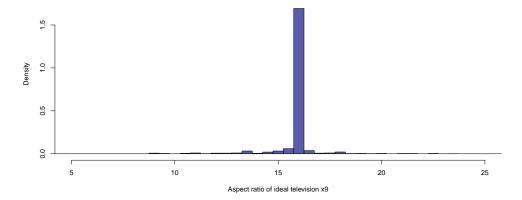
Figure 51: Distribution of ideal aspect ratios.

5.6.4 Comparison of Current and Ideal Television Size

Figure 52 shows respondents' ideal screen size according to their current screen size. Overall, very few people reported an ideal screen size that is smaller than their current one. This is especially true for those whose current screen is smaller than 32 inches. However, of the few people who report having a current screen size of over 100 inches, only one respondent estimated an ideal screen size that is larger than their current one.
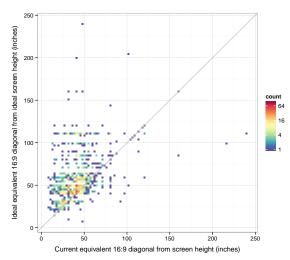
Figure 52: Distribution of ideal screen size according to current screen size.

5.6.5 People who would Move their Furniture to Accommodate their Ideal Television

We have seen that absolute viewing distances have changed very little since 2004 (section 5.3.4). To further build an impression of whether viewing distances might change in the future, respondents were asked whether they would move their furniture in order to accommodate their ideal television. Figure 53 shows the responses. For the 47 % who said they would not move their furniture, we can be relatively confident that their viewing distance would not change. For the 41 % who would move their furniture, there is some uncertainty about the likely viewing distance, should they acquire their ideal television.
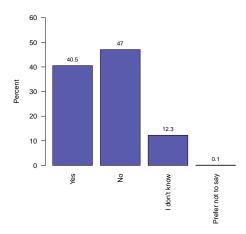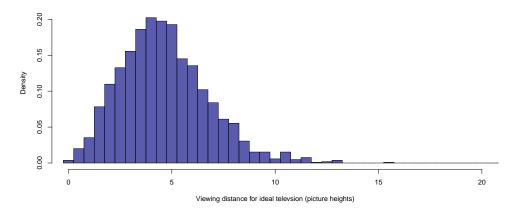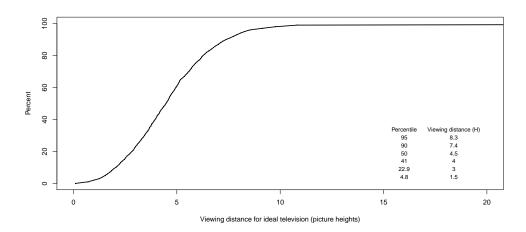

Figure 53: Responses to "would you move your furniture to accommodate your ideal TV screen size?"

5.6.6 Estimated Relative Viewing Distances for Ideal Television

For some indication of how the relative viewing distances might change if respondents were to upgrade to their ideal screen size, we calculated the relative viewing distances for the reported ideal screen sizes, assuming that the absolute viewing distance would remain the same. Figures 54 and 55 show the distribution and cumulative distribution of relative viewing distances for all respondents. The median relative viewing distance has dropped to 4.5 H. Those who would watch from 3 H or closer, and hence would see some benefit from UHD, make up 22.9 % of respondents, with 4.8 % of respondents standing to get the full benefit of UHD with estimated viewing distances of 1.5 H or closer.
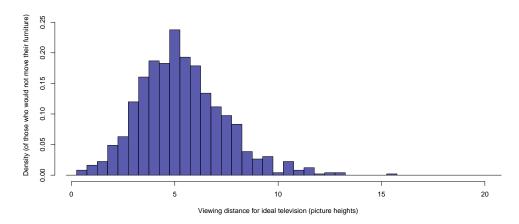

Figure 54: Distribution of relative viewing distances for ideal screen sizes, assuming the absolute viewing distance does not change.
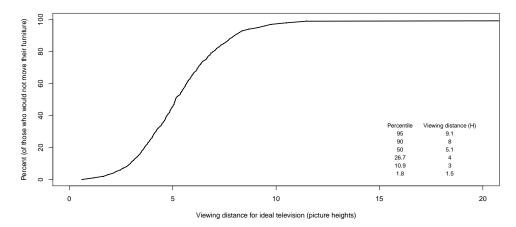

Figure 55: Cumulative distribution of relative viewing distances for ideal screen sizes, assuming the absolute viewing distance does not change.

Figures 56 and 57 show the same information for only those people who would not move their furniture in order to accommodate their ideal television. For this group of respondents we can be relatively confident that the absolute viewing distance would remain the same. Here the median relative viewing distance is 5.1 H, with 10.9 % of people watching from 3 H or closer and 1.8 % of people watching from 1.5 H or closer.

Figure 56: Distribution of relative viewing distances for ideal screen sizes, assuming the absolute viewing distance does not change, for only those who would not move their furniture to accommodate their ideal screen.

Percentile	Viewing distance (H)
95	9.1
90	8
50	5.1
26.7	4
10.9	3
1.8	1.5

Figure 57: Cumulative distribution of relative viewing distances for ideal screen sizes, assuming the absolute viewing distance does not change, for only those who would not move their furniture to accommodate their ideal screen.

5.7 Other Conditions

Respondents were also asked what kind of loudspeaker arrangement they use, and what level of room lighting they prefer when watching television. These factors will have an impact on requirements for immersive audio and high dynamic range, which are important aspects of the complete UHD experience.

5.7.1 Loudspeaker Arrangement

Figure 58 shows that most respondents use the loudspeakers built in to their television set. However, there is a significant proportion, 17.9 %, who have a surround sound system and hence have the capability to reproduce more immersive audio.
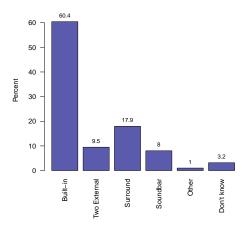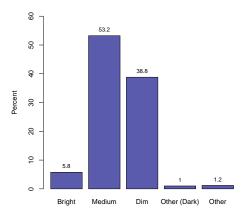

Figure 58: Responses to "what loudspeaker arrangement do you use when watching your main TV set?"

5.7.2 Preferred Room Lighting

Figure 59 shows respondents' preferred level of room lighting while watching television. A number of respondents who selected "Other" indicated that they would like complete darkness in the room. This is of particular interest for high dynamic range video, so we moved these responses into a separate category, called "Other (Dark)". Full details of the categorisation are provided in appendix D. Care should be taken when interpreting the proportion of people falling into this category, however, since some people who prefer complete darkness may have simply selected "Dim". The safest interpretation is to combine the two categories, and state that 39.8 % of respondents prefer the room to be either dimly lit or completely dark.

The majority of responses remaining in the "Other" category indicate that the room lighting varies depending on the time of day, other activities going on at the same time, or the kind of programme being watched. Medium or bright lighting is preferred by 59 % of respondents. Although it is not possible to associate these adjectives with absolute brightness levels, the results give an indication of the kind of lighting that is preferred for television viewing in the home environment.

Figure 59: Responses to "what is your preferred room lighting when watching your main TV set?" The category "Other (Dark)" was created from free text responses (see section 5.7.2).

5.8 Viewing Habits

This section presents the information collected about respondents' viewing habits.

5.8.1 Hours Spent Watching Television Per Day

Figure 60 shows the typical amount of time spent watching television per day. Most respondents watch for between 2 and 4 hours.
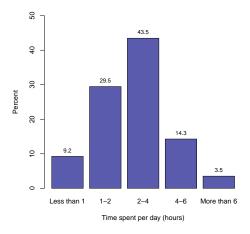

Figure 60: Responses to "typically, how many hours a day do you spend watching TV?"

5.8.2 Type of Content Watched

Respondents were asked what type of television content they watch the most. A list of categories was provided, from which they were able to select up to three. Figure 61 shows that the most popular types of content are drama, films, comedy, documentaries and sports, closely followed by entertainment and news. This is a very wide range of categories, each of which may have different requirements for their technical parameters.
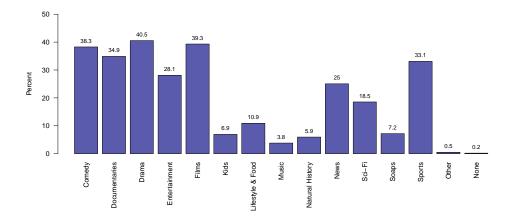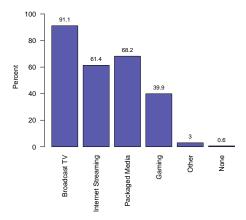
Figure 61: Responses to "what television content do you watch the most? Please select up to 3 options."

5.8.3 Services for which Television is Used

Figure 62 shows the services for which respondents use their televisions. The majority watch broadcast television, but 8.9 % of respondents reported that they do not. Significant numbers also watch streamed content and packaged media.

Figure 62: Responses to "which of the following services do you use your main TV set for? Please tick all applicable boxes, if none are applicable please leave the boxes blank."

6 Summary

We have conducted an online survey of television viewing conditions in the UK. Our key results are that the current median diagonal screen size (calculated from height data) is 39.3 inches, and the median viewing distance is 2.63 m. In comparison to results from 2004 [1], this indicates that screen sizes have increased, but viewing distances have changed very little. The median relative viewing distance is 5.5 H. Biases in the survey demographics suggest that the true median screen size is in fact slightly smaller, but not less than 36 inches, meaning that the true relative viewing distance is slightly larger, but not greater than 5.8 H.

Those watching from 3 H or closer, who could potentially benefit from UHD resolution, make up 10.2 % of respondents. 1.5 % of respondents currently watch from 1.5 H or closer, and are hence in a position to experience the full benefit of UHD.

There was little correlation between screen size and absolute viewing distance, but the distribution of relative viewing distances according to screen size indicates a viewing distance limit that is probably imposed by the size of the room.

The median ideal screen size for respondents' current homes is 48.2 inches. If it is assumed that the viewing distance would not change, the median relative viewing distance for respondents' ideal screen is 4.5 H, with 22.9 % of people at 3 H or closer and 4.8 % of people at 1.5 H or closer.

People with a surround sound system make up 17.9 % of respondents, and so would be able to benefit from more immersive audio. Medium or bright room lighting is preferred by 59 % of respondents, and a dimly lit or completely dark room is preferred by 39.8 % of respondents.

With 2416 respondents, this is the largest survey of its kind that has been conducted in the UK, and as such provides valuable information about how people watch television, that can be used to help tailor the technical parameters of our future services to suit home viewing conditions.
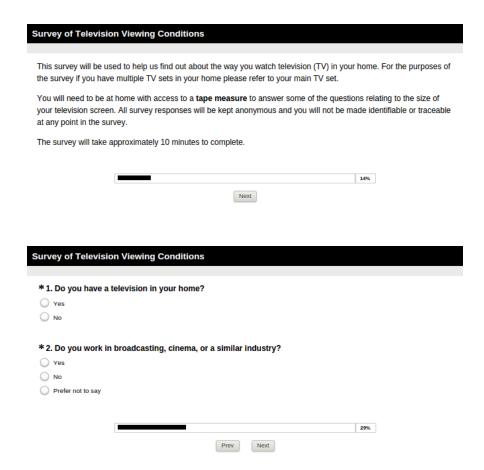
7 Acknowledgements

References

[1] N. E. Tanton, "Results of a survey on television viewing distance," BBC R&D White Paper 090, June 2004.

[2] N. E. Tanton and M. A. Stone, "HDTV displays: subjective effects of scanning standards and domestic picture sizes," BBC Research Department Report 1989/09, January 1989.

[3] Office for National Statistics, "Annual Mid-year Population Estimates, 2013," released 26 June 2014, http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk--england-and-wales--scotland-and-northern-ireland/2013/sty-population-estimates.html.

[4] ITU-R, "General viewing conditions for subjective assessment of quality of SDTV and HDTV television pictures on flat panel displays," Recommendation ITU-R BT.2022, August 2012.

---

[4]http://www.nuffieldfoundation.org/nuffield-research-placements
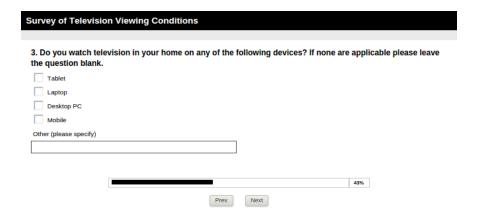
Appendix A   Survey Questions

This appendix shows screenshots of the web interface used to collect survey responses. All of the survey questions are shown. The survey had two branches, one for those who have a television at home and one for those who do not.
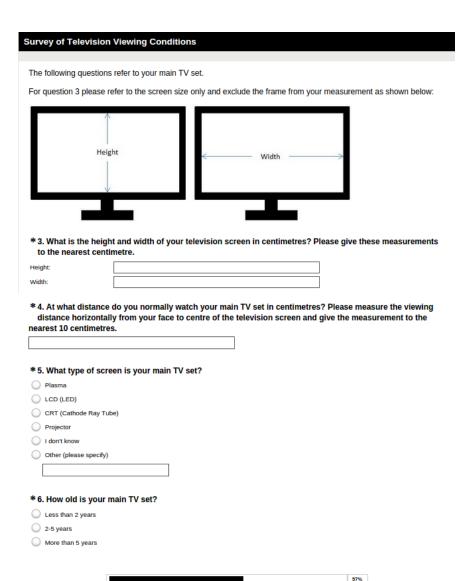
The introduction page and questions 1 and 2 were presented to all respondents.

The following question was only asked of those people who answered "No" to question 1 (people who do not have a television in their home):
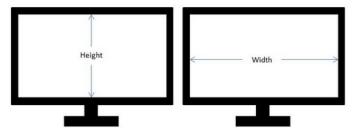

The following questions 3–14 were only asked of those people who answered "Yes" to question 1 (people who do have a television in their home):

Survey of Television Viewing Conditions

The following questions refer to your main TV set.

For question 3 please refer to the screen size only and exclude the frame from your measurement as shown below:

＊3. What is the height and width of your television screen in centimetres? Please give these measurements to the nearest centimetre.

Height: _____

Width: _____

＊4. At what distance do you normally watch your main TV set in centimetres? Please measure the viewing distance horizontally from your face to centre of the television screen and give the measurement to the nearest 10 centimetres.

_____

＊5. What type of screen is your main TV set?

○ Plasma
○ LCD (LED)
○ CRT (Cathode Ray Tube)
○ Projector
○ I don't know
○ Other (please specify)

_____

＊6. How old is your main TV set?

○ Less than 2 years
○ 2-5 years
○ More than 5 years

57%

[Prev] [Next]

Survey of Television Viewing Conditions

For question 8 please refer to the screen size only and exclude the frame from your measurement as shown below:
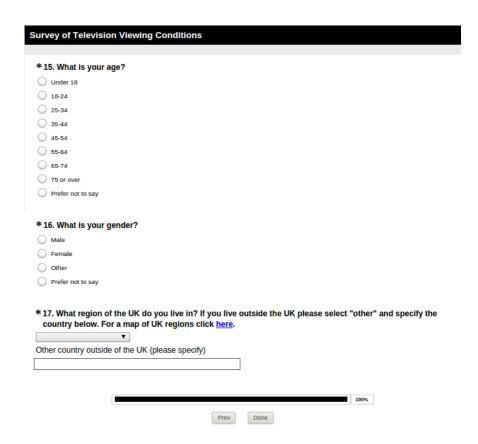

For reference in question 8, the table below lists some common diagonal screens sizes and their heights and widths in cm.

Diagonal Size (inches)	22	24	28	32	39	40	42	46	48	50	55	58	60	62	65	70	75	85	90	100	110
Height (cm)	27	30	35	40	49	50	52	57	60	62	68	72	75	77	80	87	93	105	112	124	137
Width (cm)	49	53	62	71	86	89	93	102	106	111	122	128	133	137	143	155	166	188	199	221	244

40

* 7. Next time you replace your main TV set, how do you expect the new screen size to compare to your current screen size?

◯ Smaller

◯ Same size

◯ Larger

◯ Don't expect to replace TV

◯ Prefer not to say

When answering question 8, you may find the table above helpful for converting diagonal screen sizes in inches to heights and widths in centimetres.

8. If money were no object, what size TV would you ideally like to have in your current home in centimetres? Please give the height and width to the nearest centimetre.

Height: [   ]

Width: [   ]

* 9. Would you move your furniture to accommodate your ideal TV screen size?

◯ Yes

◯ No

◯ I don't know

◯ Prefer not to say

	71%

[Prev] [Next]

Survey of Television Viewing Conditions

* 10. What loudspeaker arrangement do you use when watching your main TV set?

◯ Loudspeakers built into the TV

◯ Two external speakers (two-channel stereo)

◯ Soundbar

◯ Surround sound with 5 or more loudspeakers

◯ I don't know

◯ Other (please specify)

[   ]

* 11. What is your preferred room lighting when watching your main TV set?

◯ Dim

◯ Medium

◯ Bright

◯ Other (please specify)

[   ]

12. Which of the following services do you use your main TV set for? Please tick all applicable boxes, if none are applicable please leave the boxes blank.

☐ Broadcast TV

☐ Packaged media (e.g. DVDs and Blu-Ray)

☐ Internet streaming (e.g. BBC iPlayer, Netflix, etc.)

☐ Gaming

☐ Other (please specify)

[   ]

13. What television content do you watch the most? Please select up to 3 options.

- ☐ Lifestyle & Food
- ☐ Sci-Fi
- ☐ Comedy
- ☐ Sports
- ☐ Entertainment
- ☐ News
- ☐ Kids
- ☐ Films
- ☐ Documentaries
- ☐ Music
- ☐ Soaps
- ☐ Drama
- ☐ Natural History
- ☐ Other (please specify)

[_____]

14. Typically, how many hours a day do you spend watching TV?

- ○ 1 hour or less
- ○ 1-2 hours
- ○ 2-4 hours
- ○ 4-6 hours
- ○ More than 6 hours

[████████████████████████████] 86%

[Prev] [Next]

The following questions 15–17 were asked of all respondents (for those who answered "No" to question 1, they appeared as question numbers 4–6):

Survey of Television Viewing Conditions

15. What is your age?

- ○ Under 18
- ○ 18-24
- ○ 25-34
- ○ 35-44
- ○ 45-54
- ○ 55-64
- ○ 65-74
- ○ 75 or over
- ○ Prefer not to say

16. What is your gender?

- ○ Male
- ○ Female
- ○ Other
- ○ Prefer not to say

17. What region of the UK do you live in? If you live outside the UK please select "other" and specify the country below. For a map of UK regions click here.

[_____ ▼]

Other country outside of the UK (please specify)

[_____]

[████████████████████████████] 100%

[Prev] [Done]

42

Appendix B   Survey Web Page

This appendix shows a screenshot of the explanatory page on the BBC R&D website[5].

---

[5]http://www.bbc.co.uk/rd/projects/survey-of-television-viewing-conditions

Appendix C   Publicity on the BBC Homepage

This appendix shows screenshots of the advertisements on the BBC homepage[6], which coincided with the majority of survey responses being collected.

[6] http://www.bbc.co.uk

Appendix D   Free Text Responses

This appendix lists the responses given in the "Other" text fields that were merged with existing categories, and those that were left as "Other". Nonsensical and offensive responses have been removed.

Text response	Category
Do you watch television in your home on any of the following devices?	
ipad	Tablet
no none	All unticked
Chrome cast on to TV/ Monitor (rarely) Game console Projector Projector connected to laptop Raspberry pi + projector xbox 360	Other
What type of screen is your main TV set?	
3D LCD IPS Monitor LCD (not LED) TFT computer monitor	LCD (LED)
A flat screen but dont know type Bush Flat Screen 30" Diameter Flat screen 32 inch HD HD3D It is very old panasonic Pioneer Smart TV We use MythTV through a TV card in a computer. Our screen is a flat computer screen.	I don't know
laptop lap top oled	Other
What loudspeaker arrangement do you use when watching your main TV set?	
Just the tv just tv ones just tv sound just what the tv provides The standard speaker on LG tv TV Speakers built in	Loudspeakers built into the TV
2.1 (2 external plus bass speaker) 2.1 Bose system 2.1 Speaker System 2.1 two speakers plus Bass woofer 2 channel stereo through external amp 2 external speakers + 1 sub woofer 2 L+R speakers plus woofer - external Built in mostly but have connection to 2-speaker hifi for special programmes! Depending on content, built in speakers or external two channel stereo	Two external speakers (two-channel stereo)

External 2:1 speakers for movies, inbuilt speakers for day to day watching
Mainly built in but occasional use of external stereo speakers
THX AV receiver, currently configured to reproduce qusai-surround with 2 large
    front speaker cabs
Tv speakers for TV, but plug into stereo for movies and music programmes.
two speakers + sub

9.1
at least 7 very loud speakers
Built in for regular viewing, 5.1 for film/sport
Built in loudspeakers most of the time, 5.1 surround sound for movies on DVD/blu-
    ray
Either built in speakers or surround sound with 5 speakers
normally use built-in, but have SS for the blueray eves
Standard TV = speakers in TV, film/bluray = 7.1DTS
surround sound for movies but bult in TV speaker rest of the time
tv speakers for tv, home cinema surround for everything else (films games etc)
Use 5.1 only for 5.1 programmes, e.g. Doctor Who

Surround sound with 5 or more loudspeakers

Bose Solo TV sound system
Denon soundbase - v. expensive but could not hear dialogue using just the tv
    speakers
Single Bose speaker
Sonos with sound bar, sub and 2x Play:3
Soundbar + Subwoofer
soundbase - built in bass woofer

Soundbar

3.1 (i.e. centre, Left right and Sub. to improve clarity of dialogue
3 external speakers (L,C,R)
3 speakers plus a subwoofer
built in digital sound decoder
do not have any
Harman Kardon
headphone
headphones
Headphones
I dont have any
I don't use loudspeakers
I run a 5.1 amp into three LS, so I have centre, L, R. and sub.
multiple speakers
none
not loud speakers built into the TV - stop drowning speech with raucous back-
    ground effects
often use wireless head phones, when moving around the house ie. kitchen
Surround sound headphones (Turtle Beach PX4)
Surround Sound Headset
two external speakers for front L & R, two external speakers for surround L & R
    - no centre or sub

Other

What is your preferred room lighting when watching your main TV set?

Natural light during the day & normal room lighting during the evening
normal
Normal
ordinary room light

Medium

A dim light behind the TV
Dim light Room
dim, mood lamp behind tv
Fairy lights only
Low-level lamps
Low light positioned behind TV

Dim

black
Completely dark
dark
Dark
dark no lights
I like the lights off
lights off
Lights off.
Lights out
no light at all
No light! I'm not a savage
no lights on
none
No other light at all.
No room lighting
off
Off
off. no lights on.
pitch black
Pitch black
Pitch Black

New category:
Other (Dark)

---

any kind of light is fine
can be anything from bright to no light - have no preference
Can't find a suitable lighting arrangement as tv programmes these days are so
    dark I can't see them a lot of the time
Depends if I am knitting!
Depends on genre. Films dark, documentaries medium, "moving wallpaper" while
    doing other things bright
Depends on the external lighting.
depends on the programme type
depends wether it is dark or not
Depends what else am doing, sewing or ironing!
Depends what we watching
Depends whether daytime or evening
evening movies we dim the lights, other is medium
Generally medium, but sometimes dim when watching a film, for example.
It does not matter
Medium for tv, lights out for movies.
"Natural" (this is a terrible question, fire the compiler)
Never thought about it.
no preference
No Specific lighting
Position reasonable light beside / behind the screen to reduce reflections
Side lights, not centre light
spot lights
TV Backlighting
varies
Varies according to program/purpose
Whatever the lighting is at the time!

Other

Which of the following services do you use your main TV set for? Please tick all applicable boxes, if none are applicable please leave the boxes blank.

all of the above
All of the above
All of the Above

all categories

Broadcast only for live sports, which should move to internet streams anyway
Cable
foeeign satellite tv
free sat
freeview

Broadcast TV

Interactive (red button) news feed / recording broadcast TV
None. Just watch broadcast TV
PVR
PVR (XBMC)
Recorded Broadcast TV
satelite
Satellite
sky
Sky
Time shifting with pvr
Tivo
tivo recorder
We very rarely watch LIVE TV, we normally record on the sky box and watch
      when convenient.

Apple TV
Apple TV and iTunes
Casting from Mobile Device
Chromecast
Display connected to streaming devices & other platforms
HD & 3D movies rented through sky or apple tv
hooked to laptop to stream films/series. I don't watch live tv
Internet browsing, email, social media, short video (YouTube etc)   Internet streaming
Movies on demand, catch up services
Photos and music (Apple TV)
TwitchTV
You Tube
Youtube. Better program's than the bbc and yet I have to pay the licence for
      channels I don't watch

PlayStation 3   Gaming

vhs
video, cds, photos   Packaged media
viewing photographs & home produced DVD's

Anything I want the Raspberry Pi that's attached to it to display
Broadcast radio
computer display
Computer screen
Computer work
computing
Computing
Desktop monitor, occasional use
DLNA video streaming
Downloaded content
Download from hard drive
Expansion Drive Files
extended desktop with my laptop computer connected
external computer screen
Hard disc recorder
Home movies
home network streaming
home video
I have my Windows PC connected
internet browsing
Internet downloads (for content not available on streaming)
Laptop Mirroring
Link to laptop for large screen presentations
Link to PC for presentations
local network streaming   Other
Media center PC
Media content from local server

Media on HDD / PC
media player
Media player (e.g. XBMC)
Media Streamer
Media Streaming (Hard Drive and PC)
media viewing - photos
monitor for PC
Music CD
other stuff
pc
PC
Pc monitor
PC monitor
PC monitor, photos, home video on SD card/USB drive
PC Work & 'Jukebox' with Titles
Personal Media Server (Plex)
Photography, but All limited by poor colour balance REDS very badly done
Playback of home video and photos
radio
Radio
second monitor to laptop
showing holiday photos I have taken myself
Streaming files from PS3
Streaming from laptop
Streaming from media server (PC)
the red button
Video and audio streamed from network PC and external HDD
video editing and home computer usage.
viewing pictures
View photo-images on SD memory card
web browsing
Western Digital Media Player with stored content
XBMC
Xbmc media player

What television content do you watch the most? Please select up to 3 options.

action crime, thriller, police procedural, mystery Fiction/Fantasy TV series: Game of Thrones, Grimm, Dexter, Hannibal, True Blood. historical adaptations of novels Horror Sherlock Twin Peaks	Drama
Adult animation, eg Family Guy Family Guy.... Intelligent quizzes, ie University Challenge Quizes Quizs quiz shows Quiz shows Quizzes	Entertainment
Top Gear and Have I Got News For You	Entertainment, Comedy
BBC Formule 1	Sports
Cookery, Travel	Lifestyle and Food

Hardly watch anything, mainly kids programmes for the children using internet streaming	Kids
history History history and art (as on bbc 4) History/Archaeology science	Documentaries
Science/Technology & Nature	Documentaries, Natural History
I do not watch television content at all-i only use a tv for watching films	Films
Music but NOT pop or rock. Classical, opera etc.	Music
Regional programmes and news	News
Don't watch broadcast TV just gaming, no television watched none None	All unticked
3 options is too narrow. News, Sports, Film, Documentaries, Comedy, Natural History also watch news, docu, music, drama, and comedy 3 options only is bad marketing Anime BBC 1 Broadcast radio Foreign services from DTH satellites in Europe Old TV radio channels shopping channels We watch all EXCEPT SPORT, kids and films!	Other

What region of the UK do you live in? If you live outside the UK please select "other" and specify the country below. [...]

Isle of Man	North West
east anglia	East of England
Channel Islands Jersey Jersey Channel Islands West (as in "BBC West"!)	South West
THANK YOU for the "other" gender option. <3	"Other" region box unticked, region was already indicated
I don't have a fixed location I travel prefer not to say	Other