A Survey of Television Viewing Conditions at Home in Japan

Nobuyuki Yagi† (member), Yasuhiro Itou†† (member) and Shuichi Fujisawa†† (member)

Abstract The distance at which TV is viewed in the home is analyzed in terms of the conditions of the surroundings. Newly developed survey method makes it possible to collect a lot of reliable data at a considerably cheaper cost and in a shorter period than in a field survey although based on a questionnaire survey. The results show that the relative viewing distance is around 5 screen heights (H), which is 1 H shorter than before. This change is primarily because the screen size of TVs at home have become bigger despite that the room area has not changed. Absolute viewing distance depends on room area, but screen size does not depend on room area so much. The viewing distance is shorter than the average if the viewer is closely focused on the TV or if interactive services are frequently used.

Keywords: TV viewing, home, viewing distance, screen size, research method, and program production technique.

1. Introduction

Every television format is designed for an optimal viewing distance. ITU-R Rec. BT.2022\(^1\) specifies relative viewing distances of 3.2 H (H is the screen height) for 2K television system, 1.6 H for 4K, and 0.8 H for 8K. However, such viewing distances are rare in ordinary homes in Japan. Viewing conditions in Japanese homes have been surveyed and analyzed in the past (2004 to 2008)\(^2\)-\(^4\). The studies based on surveys and questionnaires indicated that absolute viewing distances are rare in ordinary homes in Japan. Viewing conditions in Japanese homes have been surveyed and analyzed in the past (2004 to 2008)\(^2\)-\(^4\). The studies based on surveys and questionnaires indicated that absolute viewing distances for most televisions range from 2 to 3 m. They were conducted after digital terrestrial broadcasting had started in Japan, but analog terrestrial broadcasting had not yet been terminated. Around half of the homes still had CRT televisions, even in the latest survey\(^5\). Most were around 30 inches in size, and average relative viewing distances were approximately 6 H.

Since then, sales of CRT televisions have stopped, analog broadcasting has ended, and large flat-screen television receivers for digital broadcasting have become common. According to JEITA statistics\(^5\), annual television shipments reached 4.28 million in 2017; units in the range of 37-49 inches accounted for 30% of shipments, which is highest range. Those 50 inches or larger accounted for 19%. Growth was greatest in shipments of 50 inch or larger televisions, and 4K-compatible television with larger screen size accounted for 35%; thus, purchase of large-screen televisions for homes can be expected to continue. In fact, provisional figures for 2018 show a spurring of this trend. This can be attributed mainly to the effect of reductions in the prices of 4K-compatible televisions to the point that they now have similar prices to 2K televisions.

The start of digital broadcasting has also brought with its data broadcasting, so television receivers are no longer simply for viewing video content. Video content can also be viewed from the Internet and is no longer only available from television broadcasters. In Japan, 4K and 8K broadcasts have also begun in December 2018.

As such, television viewing environments in homes have changed greatly since the previous surveys. This prompted us to conduct a new survey of television viewing distances and surrounding conditions in homes.

2. Research Method

2.1 Survey Method

Two methods were used in the past studies\(^2\)-\(^4\): field studies and questionnaires. Reference 4) used a field study, reference 3) used a questionnaire, while reference 2) used both methods. Field studies produce highly reliable data because researchers visit homes and conduct a survey according to a fixed procedure. However, because such surveys are expensive and time-consuming, they cannot cover a large number of homes. On the other hand, questionnaires can cover many
homes because respondents conduct the measurements and reporting themselves, but there may be doubts regarding the reliability of their data. The study in reference 3) ensured reliability by limiting the households surveyed to employees of the television manufacturer to which the researchers belonged. However, some doubt remained as to whether this data was representative of ordinary households. Some means of ensuring the reliability of data in questionnaires given to ordinary households is needed.

In this study, we conducted a questionnaire survey to collect data from many ordinary households, and we devised the following method to ensure the reliability of the data. We sent a measurement kit, including a manual, to the surveyed households and had the respondents take measurements using the kit. In the homes being surveyed, a special marking sheet from the kit was placed on a chair (for example) at the viewing location, and the measuring tape from the kit was used to measure its distance from the television. Here, the end of the measuring tape was attached to the edge of the television using an adhesive hook from the kit. It was extended over the marking sheet, and the respondent took a photograph that included the marking sheet and the scale of the measuring tape. The household members then submitted the photograph to us, and we read the scale with the precision of cm in the photograph. They also submitted a photograph of a diagram illustrating the overall room including room area and locations of the television and viewers, with which we could confirm the measurement conditions clearly. This procedure thereby increased the reliability of the data. Rather than having respondents directly reply about the screen size of their television, respondents submitted a photograph of the label showing manufacturer and model number on the television, and we used the photograph to obtain accurate data on the model, screen size, and panel type. This also enabled us to obtain accurate data regarding the television set.

### 2.2 Survey Items

The survey items are shown in Table 1. We surveyed current television set and viewing environment at home. We also surveyed changes in television screen size and the location of television set when the respondent installed the current television set. To analyze whether interactive viewing affected the viewing location, we also surveyed viewing conditions for data broadcasts and Internet video.

<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Television set</td>
<td>Photograph of label showing manufacturer and model number</td>
</tr>
<tr>
<td></td>
<td>Purchase date</td>
</tr>
<tr>
<td></td>
<td>Reason of selection (price, screen size, brand, etc.)</td>
</tr>
<tr>
<td>Viewing environment</td>
<td>Photograph of viewing location including measuring tape</td>
</tr>
<tr>
<td></td>
<td>Type of room (living room, dining room, etc.)</td>
</tr>
<tr>
<td></td>
<td>Photograph of the overall room showing television set, location of viewers, and measuring tape</td>
</tr>
<tr>
<td></td>
<td>Photograph of diagram illustrating overall room including room area and location of television set and viewers</td>
</tr>
<tr>
<td></td>
<td>Family configuration (age and gender of each person)</td>
</tr>
<tr>
<td>Change from before</td>
<td>Location of television set (no change, same room, different room, etc.)</td>
</tr>
<tr>
<td></td>
<td>Screen size (larger, same, smaller)</td>
</tr>
<tr>
<td>Usage</td>
<td>Frequency of viewing television broadcast (daily, weekly, etc.)</td>
</tr>
<tr>
<td></td>
<td>Frequency of using interactive services such as data broadcasting and Hybridcast (daily, weekly, etc.)</td>
</tr>
<tr>
<td></td>
<td>Connection of television set to Internet (connected, not connected)</td>
</tr>
<tr>
<td></td>
<td>Frequency of viewing Internet video (daily, weekly, etc.)</td>
</tr>
<tr>
<td></td>
<td>Type of Internet video viewed (YouTube, etc.)</td>
</tr>
<tr>
<td></td>
<td>Frequency of Internet video viewed on television set</td>
</tr>
</tbody>
</table>

### 2.3 Respondents to the Survey

We recruited respondents of ordinary household through a research company that frequently conducts market research in the fields of electronics and information technology. To make the residential conditions similar in the targeted homes, we limited the survey to residences within the 23 wards of Tokyo and conducted it in October of 2018, when 4K and 8K broadcast did not begin, but 4k-compatible televisions were in the market. For homes with multiple televisions, we surveyed the most frequently used television. The submitted photographs and diagrams were checked carefully, and data from unreliable measurements were not used. This included cases such as measurements not taken as instructed (e.g.: having slack in the measuring tape or positioning it incorrectly) and when inconsistencies appeared in photographs, diagrams, and other data. As a result, we obtained valid results from 296 households, and we used that data in our analysis. 13% of the 341 collected data were not used. The submitted photographs and diagrams of the viewing location and test environment enabled us to filter the data, keeping only the most reliable.
3. Research Results and Discussion

3.1 Screen Size

The distribution of screen sizes in the surveyed households is shown in Fig. 1, Fig. 2, and Table 2. Fig. 1 and 2 show histograms in 5-inch steps. Fig. 1 also shows a comparison between 2K and 4K. Fig. 2 also shows a comparison between single-person households and others. The average size was 37.4 inches, and the median was 37 inches. These represent increase of approximately 7 inches from the previous data\textsuperscript{2)-4)}, collected about ten years earlier. Looking only at 4K televisions, which represented 12% of the households, the average size was 50.2 inches, and the median was 49 inches. The overall average size was smaller compared to a breakdown of televisions shipped in 2017\textsuperscript{5}). In our survey, only 22% of households had purchased a television within the last three years, so sizes will probably increase further as people replace their older televisions in the future.

There seems to be a weak relationship between room area and screen size, as shown in Fig. 3. The correlation coefficient for all households is 0.198. It rises to 0.331 for households with room area less than 40 m\textsuperscript{2}. In reasons given for selecting the current television, cost performance ranked second, and a larger screen ranked third, suggesting a tendency to increased size in the future will be controlled by price. Note that the top-ranked reason for selecting a television was brand (name of the manufacturer).

Conventionally, it has been thought that large-screen televisions would not be installed because of the limited size of rooms in Japanese homes, but our study has shown that 66% of people have replaced their previous television with a larger one in the same location or the same room. Room area has not necessarily been a factor inhibiting replacement of larger televisions. We expect that there will eventually be limits to this trend, but the shift to large-screen televisions will continue for some time.

The type of panel was LCD in 90% of the cases, PDP in 9%, and OLED in 1%.

3.2 Viewing Distance

The distribution of viewing distances is shown in Fig. 4. Respondents could give up to two viewing locations of the most frequently used television, so in total 589 viewing locations were given. The average distance was 2.3 m, and the median was 2.1 m. Selecting only the main viewing location from among these, the average viewing distance of the 296 viewing locations was 2.2 m.

These distances are somewhat shorter than in the previous survey\textsuperscript{2)-4). We think that there are two reasons. One is survey method. This may partly depend on the

![Fig.1 Distribution of screen sizes with a comparison between 2K and 4K](image)

![Fig.2 Distribution of screen sizes with a comparison between single-person households and others](image)

![Fig.3 Relationship between room area and screen sizes](image)

![Table 2 Distribution of screen sizes](image)
measurement method. In our survey, we read the scale on the measuring tape under the assumption that viewers were sitting upright on the marking sheet placed at the viewing location and watching television, but in some cases, viewers could have been resting on their sofas and leaning back on them. In such cases, there is a possibility that the viewing distance would be about 10 cm longer. On the other hand, there may have been cases in which slack in the measuring tape could not be observed in the photographs. As such, the actual viewing distance may have been shorter. These considerations indicate that further means are needed to improve accuracy.

The other reason is because many of the respondents were in single-person households. There was a significant difference between the average viewing distance for single-person households and others. The average for single-person households is 1.9 m, 2.4 m for the others. This difference may be because the average size of rooms in single-person households averaged 14.3 m², smaller than in other households which averaged 18.7 m². Note that, combining the two groups, the average room area was 17.7 m². 90% of televisions were installed in the living room, dining room, or living-dining room.

The relationship between room area and viewing distance is shown in Fig. 5. As has been pointed out, there appears to be a moderate correlation between room area and viewing distance. Although the correlation efficient for all households is 0.243, it rises to 0.420 for households with room area less than 40 m². It is more correlative than between the area of the room and the screen size. The average screen size in single-person households was 32.9 inches, while it was 38.7 inches for the other households. Thus, while it is smaller for single-person households, the difference is not as large as for viewing distance. There was also a tendency for younger viewers to have a shorter viewing distance, but this corresponds to their room area in single-person households.

Fig. 6 shows the distribution of the relative viewing distances with the screen height ratio. The average distance is 5.1 H (H is the screen height), and the median is 4.8 H. This is shorter than in the previous survey, which was about 6 H. Since the absolute viewing distance has not changed much, it is the relative viewing distance that has been shortened because of the increase in the screen size.

There is an inclination toward larger screens, so it is possible that this trend will continue, depending on prices, and will approach the optimal relative viewing distances for their television formats.

On the other hand, some people say that the optimal viewing distance for viewers at home is not the design viewing distance (optimal viewing distance) defined in ITU-R BT.2022, but rather the viewer's preferred viewing distance, which is also written in ITU-R BT.2022. According to reference 6), given freedom to choose the best viewing location in a large room, viewers selected distances of 4.2 m on average for a 42-inch television (4.5 H), and 2.7 m for a 53-inch television (4.2 H). However, these results may simply reflect what
viewers are accustomed to, and users may change their habits to watching large-screen televisions from closer positions. In fact, older experimental data collected when screen sizes were smaller showed a tendency to prefer longer viewing distances\(^1\). As well, our data does not show that viewers move back when the television is replaced a larger one. It appears that viewing distance is determined more by the room conditions than by preference. Reference \(^6\) also examined the shortest tolerable viewing distance. It was 1.25 m for a 42-inch television (2.3 H), and 1.4 m for a 52-inch television (2.0 H). We cannot rule out that viewing distances will decrease to these values in future households either.

### 3.3 Viewing Distance due to Viewing Style

We also examined differences in viewing distance due to viewing style. The average relative viewing distance for viewing style of "Focused" and "More focused than not" was 4.7 H (average absolute distance was 2.1 m), and the average relative viewing distance for viewing style of "Accompanying" meaning watching television while doing something else at the same time, and "More accompanying than not" was 5.5 H (average absolute distance was 2.5 m). There was a tendency to view the television from a closer location when focusing on viewing.

For people using interactive services such as data broadcasting and Hybridcast\(^7\) almost every day, the average viewing distance was 4.4 H, while the distance for those that did not use such services was 5.2 H. Broadcast television programs (video content) are push media, meaning that once the user has selected a channel, the service is provided with no further input from the user. On the other hand, interactive services like Web content on the Internet are pull media, requiring users to take action to retrieve them before they can be viewed. They are viewed actively using a remote control, and users appear to move closer, as they would when using a PC.

The average relative viewing distance for people who watch Internet video on their televisions almost every day was 4.4 H, while the distance for people that did not do so was 5.5 H. This tendency is very similar to viewing when using interactive services. This may be because most Internet video is short and viewing requires frequent use of the remote control, which is similar to viewing interactive content. In fact, the top video site reported in this survey was YouTube, where most of the videos are short. People who watched Internet video almost every day constituted 37% of respondents, but only 6% watch Internet video on their television almost every day. As the number of samples is small, the thought that viewing distance of people who watch Internet video almost every day is shorter is not conclusive. 41% of respondents had their televisions connected to the Internet, but most of them did not watch Internet video on their televisions frequently. However, the proportion of users rises to 17% if responses of more than once or twice a week are included. These users also reported using services from TV broadcasters such as TVer\(^8\) and AbemaTV\(^9\), and video services like Netflix\(^10\) and Amazon Prime Video\(^11\), which provide longer programs.

### 4. Conclusion

We conducted a study regarding television viewing conditions including screen size, viewing distance, and viewing room in homes. We were able to collect a lot of reliable data at a considerably cheaper cost and in a much shorter period than in earlier field studies by devising new survey methods although based on questionnaire.

The results of the study indicated that relative viewing distances in households are getting shorter and closing optimal viewing distance due to the increasing screen size of televisions. The trend is that televisions in homes are still increasing in size, so we expect relative viewing distances to decrease further in the future.

From the results, we have remembered the era when the 2K production facilities were introduced in to the broadcasting station. When 2K television systems were first being implemented, producers tried to keep camerawork fixed to as wide angle as possible and viewers had moved their line-of-sight to what they wanted to see. It was the design concept of the 2K. The migration from standard television to 2K entailed unifying the production methods with those of standard television, meaning that production practices for standard television continued. 4K and 8K televisions have adequate resolution, even close to the television. As we enter the age of 4K and 8K broadcasting, relative viewing distances may become even shorter in response to the evolving conditions in households. We have felt that it may be that we have reached a time when methods of shooting video and producing program need to be reconsidered.

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