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# Viewing distance requires large characters to ensure legibility on TV-set

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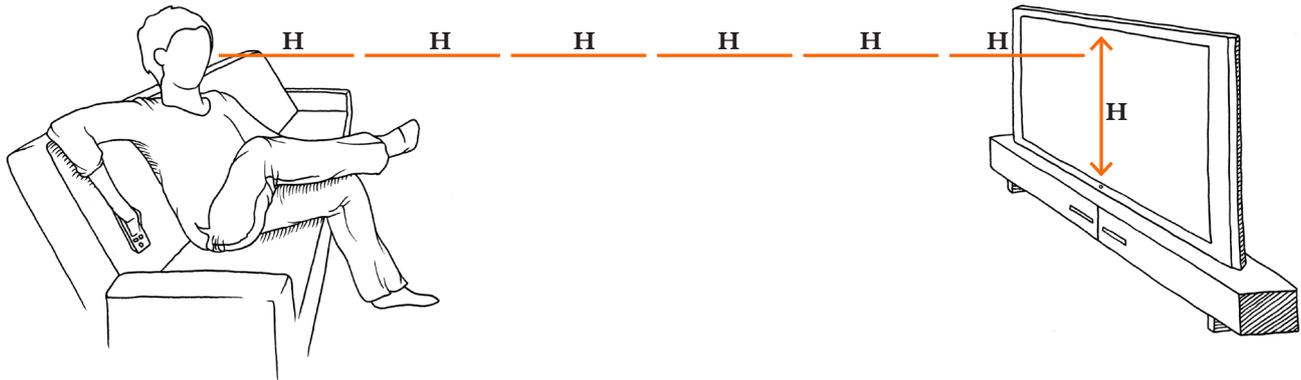


Figure 1. Distance relative to the image height ( $H$ ). In this illustration, the distance is  $6H$ . This corresponds to the median of the study. Indeed, just under 50% of households watch their TV at 6 times its height or more.

## ABSTRACT

The use of interactive services on the television set (TV-set) remains low. This may come from user interfaces (UIs) that are poorly suited to the context of use, in particular the distance of use of the TV-set. To verify this, 1,054 users representative of French households with both Internet access and TV-set are asked to make measurements to determine this distance of use. The results of the survey show that the distance of TV-set use makes it impossible or difficult to read present UIs dedicated to the TV-set. Knowledge on reading in cognitive science, presented in ISO 9241-303: 2011, enables to verify that the character sizes used are too small. These results question the “10-foot user interface” commonly used for the TV-set. This involves rethinking the UIs, and maybe even reconsidering the interactive services generally offered on the TV-set.

## ACM CLASSIFICATION KEYWORDS

H.1.2 User/Machine Systems: Human Factors; H.5.2 User Interfaces: Screen design (e.g., text, graphics, color); J.4 SOCIAL AND BEHAVIORAL SCIENCES: Psychology

## KEYWORDS

Interactive television; UI design; Character size; Legibility; Viewing distance; TV; Television set.

## RÉSUMÉ

L’usage des services interactifs sur le téléviseur (TV) reste faible. Cela peut provenir d’IHM mal adaptées au contexte d’usage, notamment à la distance d’utilisation TV. Afin de vérifier cela, nous avons demandé à 1054 utilisateurs représentatifs des ménages français accédant à Internet et équipés de TV de procéder aux mesures permettant de déterminer leur distance d’utilisation. Les résultats de l’enquête montrent que la distance d’utilisation TV rend impossible ou difficile la lecture des IHM actuellement proposées pour le téléviseur. Les connaissances sur la lecture en provenance des sciences cognitives, présentées dans la norme ISO 9241-303:2011, permettent en effet de montrer que les tailles de caractères utilisées sont trop petites. Ces résultats remettent en cause le modèle de conception « 10-foot user interface » généralement utilisé pour le téléviseur. Cela implique de repenser les IHM, et peut-être même de reconsidérer les services interactifs généralement proposés sur le téléviseur.

## MOTS-CLEFS

Télévision interactive; Usage; Design IHM; Taille de caractères; Lisibilité; Distance; TV; Téléviseur.

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## 1 INTRODUCTION

Distance in the use of a smartphone or computer is consistent and known. Most importantly, users can easily reduce it to the minimal focus distance beneath which the picture is fuzzy, either by bending their arm to bring their smartphone closer, or by leaning closer to their computer. In the context of TV-set use this is not possible because the distance is too large and does not seem to be the same from one household to the next. These characteristics of TV use, that are verified here, induce unusual constraints in UI design for TV-set. These constraints are not generally followed by current TV UIs, which may partly explain the low increase of use of interactive services on this equipment.

The character sizes usually available on UI for TV-set can pose problems of legibility for users. The question is: what character sizes – probably bigger than those generally used – would be required to ensure legibility on TV-set? The designers of UIs for TV need an answer to this question. An approach based on objective data of use is proposed here. Since legibility depends on TV-set viewing distances, it is first necessary to determine this distance precisely. Data related to user satisfaction or feelings are not discussed here. Indeed, international standardization (ISO) relies on a state of the art in cognitive science to make recommendations of comfortable reading. References of the last revision (2011) are presented in the Appendix F of the standard [16].

First the knowledge identified on this subject is presented. The survey undertaken to determine the precise distance between the main TV-set in a home and the place from which it is usually viewed is then described. Based on the findings, the different character sizes that correspond to the legibility of different proportions of population are deduced. Finally, ideas for the design of adapted UIs are introduced.

The pixel size varies widely on TV-set. The larger the TV-set, the larger the pixel will be. Text size therefore varies according to TV screen size.

The “10-foot user interface” [28] design model is a UI intended for TV, in which the viewing distance is set at about three metres. This model is based on the absolute distance between the viewer and the TV-set. Yet this absolute distance does not enable to know the size of what the user sees, and thus to design a UI adapted to use. What the user sees also depends on the dimensions of the image on his or her TV screen.

Several TV guidelines give information about font use on TV-set. For example, Apple Corp. advises in the tvOS Human Interface Guidelines [1]: “Choose the appropriate system font at design time. Above all, text must be legible at a distance. Use San Francisco Text for text 39 points or smaller. San Francisco Display is a better choice for text 40 points or larger.” Nothing is precisely recommended for the character size according to the distance of use.

Google for Android TV [10] relies on the “10-foot user interface” design model and recommends the following: “The text and controls in a TV application’s UI should be easily visible and navigable from a distance. The minimum recommended font size for TV is 12sp<sup>1</sup>. The default text size setting should be 18sp.

We recommend the following guidelines for TV apps:

- Card Titles: Roboto Condensed 16sp
- Card Subtext: Roboto Condensed 12sp
- Browse Screen Title: Roboto Regular 44sp
- Browse Category Title: Roboto Condensed 20sp

- Details Content Titles: Roboto Regular 34sp
- Details Subtext: Roboto Regular 14sp”

For Hansen [12], which provides guidelines for interactive TV, the character sizes are « *not generally smaller than 24 point for Body text* » and « *no text smaller than 18 point in any circumstances* ». However, these guidelines don’t provide any explanation as to how these sizes are defined.

With regard to TV-set, it is the distance relative to the image height that is used to describe the distance between the viewer and the TV-set. This relative distance is measured as an image height  $H$  (Figure 1), unlike absolute distance, which is expressed in metres. For example, for the same absolute distance of 2.5 metres, the relative distance will differ if the height of the TV image is 25cm or 50cm. In the first case the relative distance is 10H (10 image heights, being 2.5 divided by 0.25), whereas in the second one it is 5H.

The ITU-R BT.500-13 [17] standard proposes a methodology in which quality tests are carried out in the laboratory: “*Methodology for the subjective assessment of the quality of television pictures*”. Before 2002, this standard recommends a distance corresponding to 5H. Today it proposes a relative distance that varies between 3 and 9H, depending on a nonlinear correlation with the size of the TV-set. These values derive from laboratory experiments [2] intended for evaluating the most comfortable distance for viewing TV. In situ, viewing distances are very different, as described below.

In 1975 [24], then in 1993 [29], studies are undertaken in Japan to determine the viewing conditions of the main TV-set in a household. As expected, it is found that the relative distance varies from one household to another, with a cluster around an average value. Yamamoto and al. write that “29% of the 200 households that answered the questionnaire watch TV from a distance of 5H and 20% from a distance of 6H [...] with a mean of 5.7H”. In the 1975 survey, the mean is found to be 7.1H. In the 1993 survey, barely more than 50% of the households view TV at 5H or less. By cross-comparing relative distance with other values obtained during the survey, the authors find that this distance does not depend on the size of the room, does not increase with the size of the screen, and is not influenced by the user’s visual acuity.

A similar survey is carried out in the spring of 2004 [26] on a hundred households of BBC R&D employees in the London area, in the form of a paper questionnaire. Here again, the distribution of relative distances is fairly broad and dispersed. But this time the mean is 8.5H (with a median of 8.1H). Only one household watches TV from less than 5H (until 2002 the distance recommended by the BT.500 [17]) and only 10% view it from less than 6H. The author concludes that great caution has to be exercised in generalizing these results to the entire English population, as the sample used is not fully representative.

In France a survey is conducted at the end of 2005 [4] by France Télécom R&D and Médiamétrie (<http://www.mediаметrie.com>), in which the respondents are interviewed in their homes, usually in the main living room (in France the TV-set is traditionally in this room). The sample consists of 2,262 households, representative of the French population. Here too, differences between relative distances are large. The mean is close to that found by the BBC R&D survey (8.5H), and 20% of households are above 10.3H.

<sup>1</sup> Scale-independent Pixels - unit of characters measurement used in Android.

In 2010 another survey is undertaken in France via a Web questionnaire on 1,857 subjects belonging to the Orange's LabExplorer community (<https://laborange.fr>) [3]. The distribution of relative distances is wide here too. The mean is lower than that of the two previous surveys (7.3H), and 20% of the households are at more than nine times the image height of their TV-set screen. The authors note that the decrease in relative distance has to be confirmed by a more robust study, as the sample used is not representative of the TV user population in France.

In 2014 another survey is carried out in the United Kingdom via a Web questionnaire on 2,633 subjects [23]. The distribution of relative viewing distances is broad and dispersed. The median is 5.5H. Those watching from 3H or closer make up 10.2% of the respondents. According to the authors, "*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 5.8H*".

The precise distance of TV-set use in today's households must first be known to be able to calculate the size of the characters to be displayed on the TV-set. Appropriate objective data on the TV-set use are therefore first collected.

## 2 METHOD

First of all the distance of TV-set use (absolute distance), the length of the TV-set image diagonal and its format are collected by means of a questionnaire. Then the TV-set image height and the relative distance of use are calculated from the collected data.

The survey is undertaken in 2015 in collaboration with Médiamétrie. A questionnaire that asks users to make measurements about their TV-set context of use of the television in their home is administered via Internet (a Web form), on a sample representing French households equipped with Internet access and TV-set (TV+Internet households). For each household, the image height is calculated from the image format (ratio) and the length of the image diagonal, which is measured by the user. The relative distance is computed based on the absolute distance, which is measured by the user and on the image height. For the absolute distance, the image height and the relative distance, the means and their confidence intervals, the deciles, including the medians, minima and maxima, the proportions of households and the confidence intervals around these proportions are calculated.

### 2.1 Sample

The sample of 1,054 French households is recruited by telephone by means of the quota sampling method. The following quota variables of the reference person in the household (as defined by INSEE [13]) are used:

- Sex in two modalities (Woman; Man)
- Age in five modalities (15-24; 25-34; 35-49; 50-64; 65 and over)
- Occupation (farmer; artisan; manager; intermediate profession; office worker; labourer; retired; other unemployed or student)
- Region in five modalities (Paris and surrounding areas; North West; North East; South West; South East)
- Mode of TV reception in two modalities (ADSL/optical fibre connection; no ADSL/optical fibre connection).

The target proportions of these different modalities, which correspond to the population of TV+Internet households, are drawn from Médiamétrie's Home Devices study [20].

The sample is adjusted, in view of the slight difference in its representativeness compared to the target population after recruitment. The individuals are weighted by means of a raking ratio, using the SAS macro called CALMAR [14], in order to be able to draw inference from this sample to the target population.

### 2.2 The questionnaire

The questionnaire consists of four modules:

- Socio-demographic module to determine age, sex, socio-professional category (Level 1), habitat, composition of the household
- Screening module to identify the household's TV-set
- Internet and TV reception module to identify the type of TV service
- TV-set module which asks to specify the TV-set image format (16/9 or 4/3 ratio), and to measure the length of its diagonal, and the viewing distance. For example, for the length of the diagonal, the question is:

« *What is the size, in centimeters or inches, of the diagonal of your main TV-set screen? Using a meter or other measuring object, you can measure the diagonal of the screen and select the size closest to the measurement you have done. Please take into account only the size of the screen and do not include the thickness of the TV frame to the measurement.* »

The viewing distance is also found to vary widely within the same household. It is the distance from the favourite viewing spot that is chosen here, which is generally the distance from the couch.

### 2.3 Character size

ISO 9241-303:2011 [16] establishes image-quality requirements, as well as providing guidelines, for electronic visual displays, based on the state of the art of the corresponding scientific field. Properties of the characters allowing a comfortable reading on different supports are well known in this field [16].

In the field of ocular psychophysiology, the sizes are expressed as an angle (Figure 2), generally in arc minutes [16]. For example, 16 arc minutes are denoted as 16'. Normal visual acuity is set at 1', which in France corresponds to 10/10 in vision tests.

On screen, the "*minimum Latin character height shall be 16 arc minutes [...] Character heights subtending from 20 to 22 arc minutes for Latin characters [...] are recommended for most tasks*" [16]. So, that is: 16' for occasional reading (for example the reading of a text in a UI) and 21' for regular reading (for example the reading of subtitles in a video).

For ISO 9241-302 [15] character height means the "*number of pixels in the height of a capital 'M' without accents*". But on graphic screens, when the text is displayed with a program (in software development for example), height corresponds to the distance between the lower edge of the sign that descends the furthest, such as a 'j' or a 'ç', and the upper edge of the one that goes the highest, including accents, for example an 'Ê' (Figure 3). The dimensions calculated from the Standard must

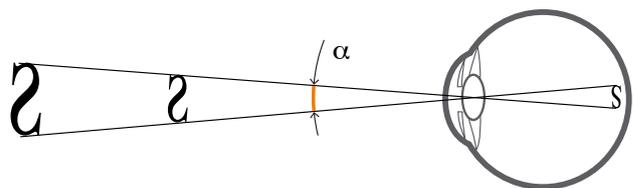


Figure 2. Angle of projection of a letter on the retina.

thus be increased to be directly applicable in the screen design. From the indications supplied by ISO 9241-303: 2011 standard [16], the corresponding multiplying factor is 1.44.

### 3 RESULTS

#### 3.1 Absolute distance

Figure 4 presents the distribution of the number of households expressed as a percentage, according to the absolute distance expressed in centimetres. The histogram shows this breakdown by the number of households in percentages, and the curve shows it by the cumulative number of households in percentages. The respondents report that they watch TV from a distance ranging from 1 to 15 metres. Yet slightly more than 80% of respondent households report that they view it from a distance of 2 to 4 meters. The median is 3 metres: just over 50% of the sample mention that they watch TV from a distance of 3 metres or more. The mean is 2.95m (95% CI [2.87, 3.02]).

#### 3.2 Image Height

Figure 5 presents the distribution of the number of households expressed as a percentage, based on the image height of the TV-set, expressed in centimetres. The histogram shows the breakdown by the number of households in percentages, and the curve shows it by the cumulative number of households in percentages. Image heights range between 17 and 180 cm. The mean is 45.9cm (95% CI [45.1, 46.7]) and the median is 46.6cm.

Note that the limit values are very rare. Just under 80% of the respondent households report using a screen with a height of 31 to 60cm.

#### 3.3 Relative distance

Figure 6 presents the distribution of the number of households expressed as a percentage, based on the distance relative to the TV-set image height. The histogram shows this breakdown by the number of households in percentages, and the curve shows it by the cumulative number of households in percentages. The distance relative to the image height ranges from 1.3 to 51H. These extreme distances concern very few households. Slightly

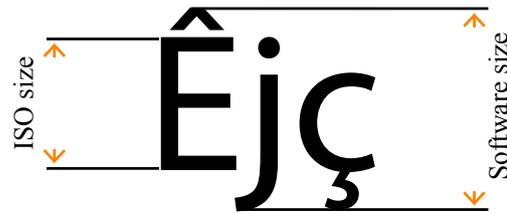


Figure 3. Size for ISO 9241-303 and for software.

fewer than 80% of the respondent households in the survey report that they are situated between 4H and 10H.

The mean is 6.9H (95% CI [6.7, 7.1]) and the median is 6H: slightly under 50% of the households view TV at 6 times its height, or more. Just under 20% of the respondent households report a distance of 8.5 times the image height of their TV-set, or more.

#### 3.4 Character size

As the survey shows, not only is the distance large, it also varies widely. The adapted character size depends on the proportion of households for which legibility on the TV screen from the viewers' favourite position has to be guaranteed.

As the survey shows, not only is the distance large, it also varies widely. The adapted character size depends on the proportion of households for which legibility on the TV screen from the viewers' favourite position has to be guaranteed.

As described before the minimal character height is 16' for occasional reading. For example for 80% of TV+Internet households consisting of individuals with visual acuity of 10/10 (with corrective glasses if required) to have access to the information presented on the home's main TV, from the user's favourite position, this information has to be legible from a maximal distance of 8.5 times the image height (H). At this distance a 16' character 'M' is approximately  $1/25 H (2 \times 8.5 \times \tan(\pi \times 16/2/60/180) \times H)$ . The character size must therefore

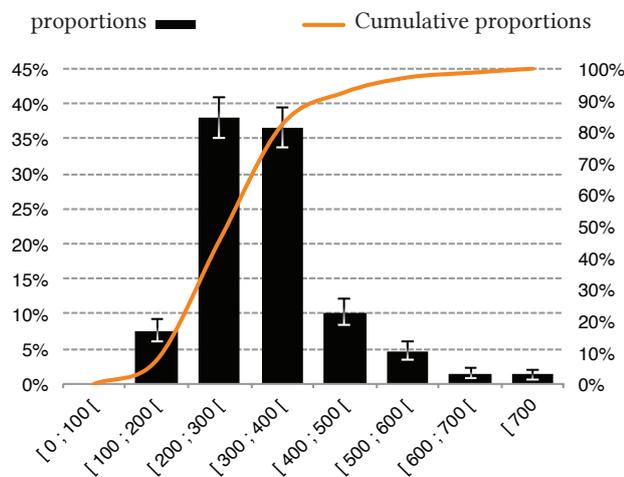


Figure 4. Distribution of the sample households proportions according to the absolute distance between the TV-set and the favourite viewing spot, with a 95% confidence interval around the proportions.

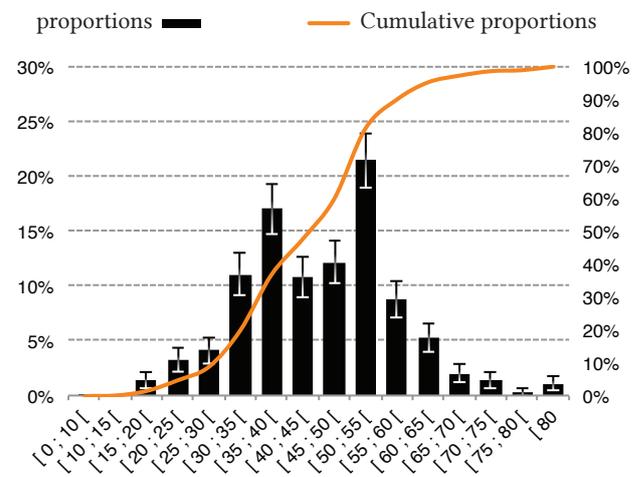
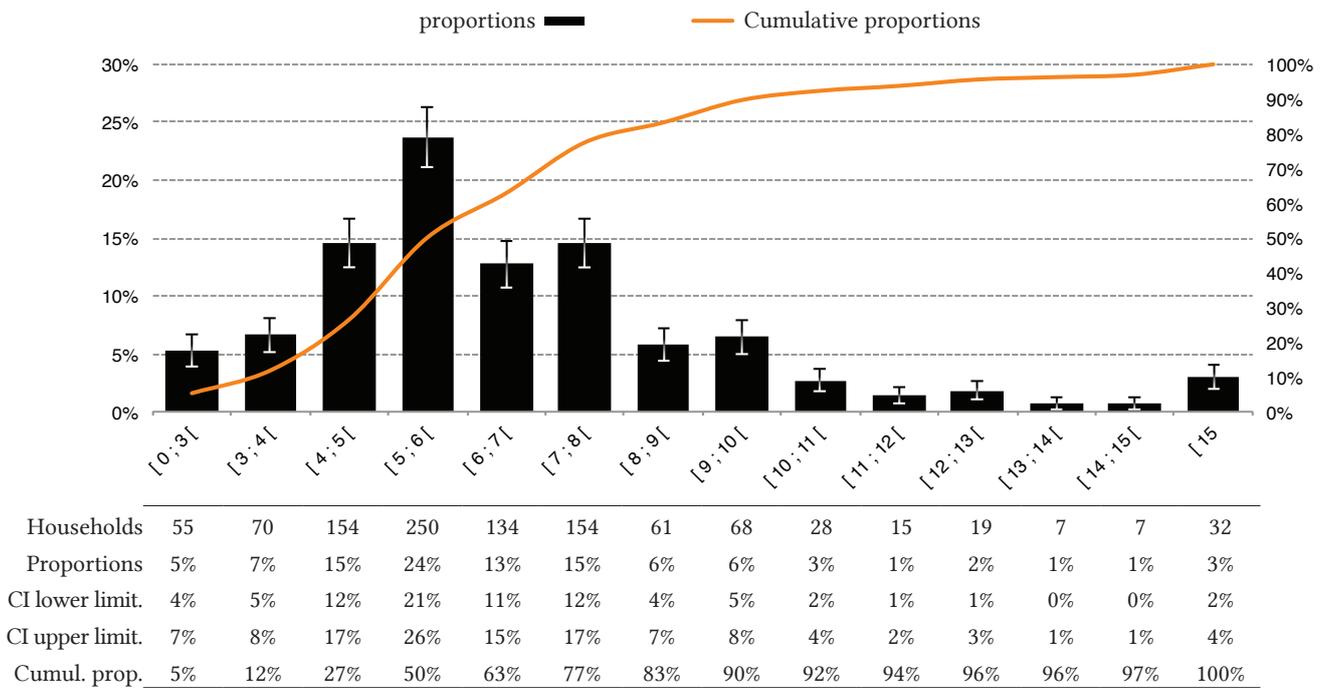


Figure 5. Distribution of the sample households proportions according to the TV-set image height, with a 95% confidence interval around the proportions.



**Figure 6.** Distribution of the sample households proportions according to the distance relative to the TV-set image height, with a 95% confidence interval around the proportions. Key: 24% of the sample reported viewing TV at a distance of between 5 and 6 image heights of their TV-set. There is 95% certainty that between 21% and 26% of the French TV+Internet households would say they view TV from a distance of 5 to 6 image heights of their TV-set. 50% of the sample reported viewing TV from a distance of less than 6 image heights.

be near  $1/17 H$  ( $1.44 \times 1/25 \times H$ ). For a 720-line image (HD720 format, so 720 pixels), this results in a character size of at least 41 pixels ( $1/17 \times 720$ ). For regular reading, according to ISO Standard [16], it is preferable to propose a character height of 21'. For each relative distance the corresponding character sizes are calculated from the recommendations of ISO 9241-303-2011 [16] and according to each standard TV-set image height, as shown in the example given above. Table 1 presents these

character sizes according to the households breakdown as a result of the measures collected using the questionnaire (TV-set module) described in the section on method. These sizes can be used as such in TV-set UI design.

#### 4 DISCUSSION

The TV-set is primarily used to watch live programmes (TV channels) [21]. In this context, interaction requires little or

**Table 1.** For each proportion of TV+Internet households, the minimum character size calculation in pixels for occasional reading (16') and for constant reading (21') according to each standard image height. Key: for 80% of the French TV+Internet population, the rounded minimum character size with a 720 HD image is 41px for occasional reading and 54px for constant reading.

Household	NTSC 640 pixels		SECAM 576 pixels		HD720 720 pixels		HD1080 1,080 pixels		UHD 2,160 pixels	
	16'	21'	16'	21'	16'	21'	16'	21'	16'	21'
10%	13	17	16	20	20	25	29	38	58	75
20%	15	20	18	24	23	30	34	44	67	88
30%	17	22	20	26	25	33	37	49	74	97
40%	19	24	22	29	28	36	41	54	82	108
50%	20	26	24	31	29	38	44	57	87	114
60%	22	29	26	34	33	43	49	64	97	127
70%	25	32	30	39	37	48	55	72	110	144
80%	28	36	33	43	41	54	62	81	123	162
90%	33	44	40	52	50	65	74	97	148	194

**Table 2. Means of the three variables studied, drawn from the three surveys undertaken in France.**

	Relative distance	Absolute distance	Image height
Survey 2005	8.3H	2.90m	36cm
Survey 2010	7.3H	2.94m	43cm
Survey 2015	6.9H	2.95m	45,9cm

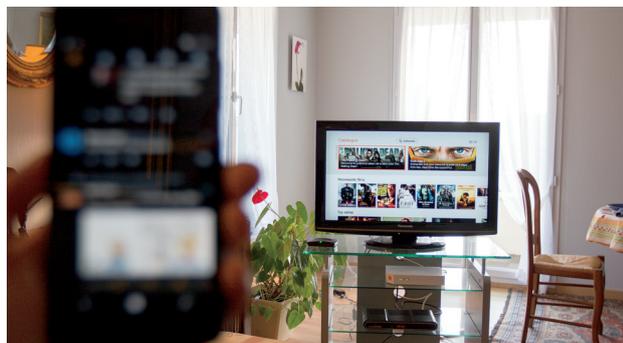
no reading on the screen. Therefore, the distance of use is not, in this case, a barrier for watching TV on TV-set, which lasts more than 3 hours per day on average per individual worldwide (almost 4 hours in Europe) [21]. In contrast, access to on-demand content such as VOD usually requires the use of a graphic UI displayed on the TV-set screen. In the second quarter of 2016, Orange IPTV network logs show, for example, a daily mean of use of 25 minutes of video on demand (mainly TV on demand) and of 6 minutes for music services (use of other interactive services being anecdotal: less than 16 seconds per day) [25]. The lack of legibility linked to a large distance of use can therefore restrict its use.

#### 4.1 Viewing distance

The observation of TV-set use in some households reveals that the viewing distance sometimes varies within the same household. Watching TV is not always the main activity. The viewer may be at the table eating, for example; that is, often farther from the TV-set than when sitting on the sofa [7]. Yet to calculate the suitable character size a reference distance is needed, and the distance from the favourite viewing spot is chosen. It is nevertheless important to bear in mind that TV can be viewed from other places which are often even further away from the TV-set [19; 6; 27].

On the whole, the distance from which TV is viewed is large. Figure 7 simulates the distance corresponding to the survey median. The subjective size of the TV-set is smaller than that of a smartphone (here a Lumia 650 by Microsoft), whereas half of the study sample reports being even further away.

The survey shows that viewing distance relative to the TV-set image height lowers since the preceding two French surveys in 2005 and 2010 (Table 2). The decrease in the average relative distance is 1.4H, compared to the 2005 survey, and 0.4H compared to the 2010 survey. This decrease stems from an increase in the size of the TV-set image, whereas the absolute distance is similar. This may be explained by the commercialization and acquisition of increasingly large TV-sets in the past few years.



The samples of the 2005, 2010 and 2015 surveys do not however represent exactly the same population. The first one concerns French households equipped with a TV, the second one corresponds to a community of users with more technical skills than the average French population, and the third one concerns households with TV and access to Internet. Due to these differences in representativeness, in terms of socio-demographic criteria (sex, age and socio-professional category) and also because of various times, this comparison is only descriptive. Nevertheless, we postulate that these slight socio-demographic differences between the populations represented have no significant effect on the absolute distance. They can probably affect the type of equipment and therefore the average size of the screen, which induces a possible variation of the relative distance. Thus the interesting comparison to look at here concerns the absolute distance. An update of the survey would be appropriate in a few years.

From a methodological point of view, note that the data collection is carried out via a questionnaire and therefore relies on the respondents' answers. For example, no researcher is present in the respondents' home at the time of viewing, which would yield more precise data.

Although the part of the questionnaire concerning the TV-set viewing distance asks for a distance in metres with a decimal (e.g. 3.3 metres), 92% of the distances reported are in full or half metres (e.g. 3 or 3.5 metres). As a result, the numbers of households according to the absolute TV-set viewing distance are grouped into a few levels. The respondents most probably round off the figures when reporting them. It is estimated that they round off to the closest half-metre, both upwards and downwards, relative to the real distances existing in the households. The incidence therefore remains very marginal.

#### 4.2 Character size

TV guidelines for TV-set used in the industry don't seem to be based on actual distances of TV-set use for the computation of recommended character sizes. For example, according to the survey, a character size of 24px, as recommended by Hansen [12] would be suitable for the occasional reading of around 50% of households equipped with TV-sets displaying a PAL-SECAM image (768 x 576) and less than 30% of households equipped with TV-sets displaying a 720 HD image. These proportions would be even lower for regular reading.

Based on the measurements made by the users in order to obtain the actual distances of use, the study aims to define which character sizes must be taken into account for the legibility on TV-set, according to cognitive science (on which ISO 9241-303: 11 [16] is based). Thus, TV industry players are



Figure 7. Subjective view of a TV-set situated at 6 times the TV's image height and of a smartphone visualized at 50cm.

able to know what proportion of population is covered in terms of legibility when choosing a character size for a TV-set UI. To achieve this, the computations rely on ISO 9241-303: 2011 [16] requirements. The study doesn't discuss the requirements given by this standard.

To date no study appears to have both produced a collection of a large data set of actual distances of TV use on a representative sample and deduced character sizes suitable for readability on TV-set, strictly following ISO 9241-303: 2011 [16]. To qualify the particular context of TV-set use, only objective measurements are collected. This allows TV-set UI designers to rely on character sizes calculated from the actual distances of use, which seems unprecedented in the TV-set UIs field and more suitable than the existing guidelines in this area. Respondents' feelings about this distance and the corresponding character size are not asked. Work on reading from cognitive science deals extensively with reading in general and screen reading in particular. For the latter context, ISO 9241-303: 2011 [16] defines the minimum character sizes to ensure good reading in terms of effectiveness, efficiency and satisfaction.

The character size to be used should ideally cover 100% of the population. The study shows that for such a population coverage, a minimum character size of 247px should be used on 720 HD image for occasional reading, which is huge because of the extreme distances of some households and seems very difficult to reach. For a coverage of 80% of population, the minimum character size would be 41px on the same screen for occasional reading, which is still quite large. In the industrial context, the use of such a character size would enforce significant limitations to the amount of information presented on each screen. And observation of the various UIs currently used in France and worldwide (Apple, Android TV, Fire TV), which are based on the guidelines and requirements quoted in the introduction (for example, 24px for BBC TV text size according to Hansen [12] or 18sp for Android TV [10]), shows that the characters displayed are far from meeting the size of 41px. This size is nevertheless necessary for the reading of the texts by the users in accordance with the knowledge coming from cognitive science. The legibility of texts displayed on the TV screen is therefore not currently guaranteed for most households.

UI design with big character sizes may seem very difficult, because the information that can be displayed on a screen is therefore very small (for example, only 7 lines of text in 50 pixels size can be displayed on an HD720 image). Various routes enabling to take this aspect into account in the economic constraints of TV over IP (low-cost infrastructure) are currently being explored.

### 4.3 Near-vision use

In some cases it is not necessary to have text that is legible from the couch. The phases of interactions that take place outside of the usual context of use of TV viewing can for example be treated differently. This is the case of the phases of installing the product and more generally of maintenance. These infrequent phases can force the user to move closer to the TV-set (for example for connecting cables or for operating controls).

Considering the capacities of the human eye [16], the optimal theoretical distance is the distance that enables to obtain the largest image on the retina, without the pixels being visible. For this, one chooses a distance for which the height of a pixel is 1' (see visual acuity presented above). As described before the minimal recommended size is 16' for a capital M. For a pixel with a height of 1', one needs 16 pixels to obtain a height of 16'. The capital letters must then be 16 pixels high.

The character size must be 23 pixels (16 x 1.44; as explained in the section on method) for reading at the theoretically optimal distance, irrespective of the screen definition.

### 4.4 Variable text sizes

If the possibility given to the user to choose the text size is common on PC and mobile, this is the exception on the TV-set. In the case of the PC and the mobile, this above all allows to adapt the text size to the visual capabilities of the users. For the TV-set, this would enable to adapt the character size to the TV-set distance of use.

With the shift to radio remote controls (Bluetooth Low Energy Standard seems to be generalized: Android TV, Apple TV, Fire TV, Free, Bouygue, Orange), it becomes possible to know the distance that separates the TV-set from the remote control and therefore from the user who holds it. This could allow automatic adjustment of the texts size according to the distance of use.

This is possible by relying on the Received Signal Strength Indication or RSSI [9]. It is a measure of the power of a received signal collected by an antenna (conventionally a radio signal). Its utility is to provide an indication of the intensity of the received signal. This intensity varies with distances. This information is presently used by the Bluetooth-based location systems often called Beacons [8].

### 4.5 Using images

The use of images instead of text is an interesting solution although it implies a heavy load for the system and for the editorial teams (in terms of production and management of images). This is especially true for film posters, traditionally intended for display in the urban space, and the legibility of which is provided either by text or by visuals. They can be seen at variable distances and often from far off, as for whatever is presented on TV-set. As the use of TV is above all for broadcasting, a UI built around this element is relevant. Many posters are already available. TV programmes and especially fiction films have posters representing them on DVD covers or during advertising campaigns outside. These types of images could in future be produced for content that does not yet have them, such as certain TV programmes.

If legibility for a maximum number of households has to be ensured, only one poster should be presented in the full TV screen height, so that its maximum size can be shown, as Figure 8 illustrates. But even if posters take up the full height of the screen, some will not be big enough to be legible in all households, as some of users view TV from a significant distance.

Moreover, an approach of this kind limits the use of text, as it reduces the space occupied by large texts. For example in Figure 8, the title of the section is 75 pixels high, on a 720 lines image. This text is then legible at a relative distance of 15H and for 97% of the Internet+TV households.

### 4.6 Increase the useful area

On cathode ray tube (CRT) TV-sets, the edge of the image is fuzzy. That is why the frame of the TV-set covers the screen slightly, so that the edge of the image is not visible. This is called Overscan. The central area of the image that is always visible on all brands of TV-sets is called the Safe Area. On flat-screen TV-sets, even though the technology no longer requires it, manufacturers retain an Overscan, although it is smaller than on CRT TV-sets. Even though recommendations exist that increase the Safe Area size, as for Android TV [10], there are more generally recommendations for UI that preclude the use of 5 to 10% of the screen [18; 22] – even when the product



Figure 8. UI model for TV-set based on visuals; videogram.

cannot be used on CRT TV-sets [1]. This lack of consistency in recommendations could be the sign of a lack of reliable knowledge on this subject. An analysis of Safe Areas on the flat screens currently in use could make it possible to draw up a uniform recommendation for a larger Safe Area, and so, more space to display the UI.

#### 4.7 Shifting the UI

If the constraint related to text size is thought as excessive on TV-set, all or part of the UI can be shifted onto various “connected” devices: laptop, smartphone and now tablets.

The most extreme example of the shifting of the UI onto devices that are already available to the user is probably Google’s Chromecast which is a miniature decoder. It proposes no UI as such on the TV-set screen: all the interaction takes place on a device that the user already owns, such as a tablet, with applications that are already available, as Figure 9 shows with Netflix. Chromecast thus turns the TV-set into a simple video projection screen. By removing the UI from the TV-set screen, the problem of legibility related to distance from the TV-set no longer exists.

#### 4.8 A minimalist UI on TV-set

Yet a laptop, tablet or even a smartphone prove to be ill-suited to performing elementary functions repeatedly. For instance, to change channels by means of an App on a smartphone, the user has to switch it on, display the screen for keying in the password, key it in, and so on. With a TV remote control the user simply has to press a button – and users change channels over 50 times a day, on average [5].

In this context, the functions that require only elementary interaction, that are used very frequently, and whose feedback is essentially given to the user by audio or video, should be offered on TV by means of a very simple remote control. These



Figure 9. Netflix on Apple tablet, screen shot [11].

functions do not require a graphic UI and the feedback is materialized by the action requested, as for channel hopping or turning the volume up or down.

The graphic UI can then be reduced to the rare functions and content frequently used, which necessitate this type of UI, such as the playing back of videos, switching to the next episode of a series busy playing, or access to on-demand TV. As the UI on the TV-set is reduced to the essentials, it becomes possible to use large text adapted to the TV-set viewing distance. In addition, the result is extreme simplicity, better adapted to the people who do not yet use digital devices.

## 5 CONCLUSION

The survey shows that the distance separating the TV-set from the favourite viewing spot is still variable and usually large. The calculation of the character sizes necessary to ensure legibility, according to cognitive science, indicates that, in many households, viewers are currently unable to read the text on UIs intended for TV-set, from this favourite viewing spot. This attests to the limits of a UI that is based on TV-set only. One option is to shift most of the UI onto the digital devices that currently surround the TV-set in the living room (laptop, tablet, smartphone). This would make it possible to dedicate the TV-set screen to people who do not yet use digital devices, by adopting a TV UI reserved for the functions and content that are used extensively. In addition to considerably reducing production and management costs, such minimalism allows for UIs that present only a very limited number of elements per screen: large elements which can therefore be read from far away.

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