Notification Mechanisms In Second-Screen Scenarios

Towards a Balanced User Experience

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***Abstract*—As technological devices surrounding the television are changing, so are viewers' habits. When the interactive Television industry turns its focus to the development of second-screen applications, this paper reports on a study aiming to analyse the impact, on users, of notifications in second-screen scenarios. As part of the study, the research team developed a prototype that simulated an application able to deliver synchronized information related with TV content, notifying the user – through visual, audio and haptic stimuli - whenever new content was displayed in the tablet. The study included observation sessions, conducted in laboratory settings, with participants (N=12) being invited to watch a 15-minute film while using the application. Tests were conducted under a cognitive walk-through methodology, and data collected through direct observation and questionnaires. Results show that to achieve a balanced user experience in second-screen scenarios notifications on tablet should be combined with visual notifications on TV.**

Keywords; notifications; user experience; television; second-screen applications

I. INTRODUCTION

The growing success of devices such as tablets and smartphones is changing users' relation with one of the main sources of entertainment, the television. In the actual TV ecosystem, viewers are adopting companion devices (acting as second-screens) while watching television, either to perform generic web searches, to look up for information related with the content they are watching or to receive enhanced synchronized information [1], [2].

Aware of these trends, the iTV (interactive TV) industry is focusing on the development of second screen applications designed to provide additional information related to TV content [2], [3], achieving new levels of user experience. Nevertheless, and despite technological evolutions, in the aforementioned scenarios the user's attention is still vulnerable to the excess of disturbances and interruptions [4]. In this framework, one of the major challenges lies in the ability to provide a solution able to enhance the users' engagement with the TV program – rather than reducing it – while taking into account cognitive and emotional effort and attention selectiveness. To target this challenge, notifications – visual, audible or tactile signals designed to alert for the existence of new information – are often used as a strategy to direct the user's attention to the second screen. The user's perception regarding notifications, however, varies, with recent research indicating that notifications are both valued by users and considered as a source of interruption of the on-going task [4], [5], [6]. In this framework, this paper describes a study designed to analyse the emotional impact, on users, of notifications on second-screen applications with the aim to contribute to its development.

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II. RELATED WORK

A. Managing Attention Between Multiple Screens

The growing adoption of second screen devices while watching TV [7] highlights the importance of finding solutions able to balance the user's attention between two or more sources (screens) of information [8]. Although prior studies in the area were not specifically aimed to analyse the contribution of notification mechanisms, it is worth to consider their main outcomes.

Attention management between two different screens was studied by Valuch et al. [9]. Despite their research being focused on the effect of cinematic cuts on attention, authors sustain that their findings can be relevant for the iTV and second-screen environment, stating that the inclusion of repeated visual elements between screens may ease the user experience and minimize the time and effort necessary for shifting between screens. Also in this field of study, Vatavu and Mancas [10] analysed the use of multi-screen TV layouts and its impact on visual attention and cognitive load, concluding that visual attention (measured in viewing time) is related not only to the size of the screen but also to the content being broadcasted/streamed.

Regarding the management of attention when using second-screen applications while watching TV, Basapur et al. [11] developed an application that enabled the creation and consumption of content about and synchronised with TV shows, by the user's social circle. After a four-week field trial, researchers found that the participants both felt motivated to use the application and concerned regarding the created social dynamics. The trial revealed that the prototype provided a better connection with the TV show and enriched the

participant's social life, but it also contributed to increase distraction from the televised programme.

Holmes et al. [12] examined TV viewers' visual attention management between two television shows while using a second-screen device. By analysing participant's eye-movement patterns while interacting with synchronized second-screen applications, researchers found that the second screen gathered considerable visual attention, even in the absence of interactive or advertising content on the television screen. The study also concluded that the presence of the second screen device significantly decreased the average gaze length on the TV. A similar study was conducted by Brown et al. [13], who used two eye-trackers to monitor viewers shifting attention between a television and a tablet. While the study results demonstrated that participants focused their eyes mainly on the TV screen, rather than on the tablet, it also showed that participants shifted their attention to the tablet each time an update occurred, while audio cues brought back the viewer to the television screen. Also in this field of study, Morales and Shekhawat [14] introduced a study focused on the development and evaluation of a companion app that provided information synchronised with the TV content; they found that consumers both felt better connected to and distracted from the TV show. Geerts et al. [3] developed a study based on viewers and producer perspectives on a companion application, observing how participants experienced the attention they had to pay to the second screen app and worked on finding a balance between engagement and distraction by the application. Researchers found that, as participants applied a form of self-regulation in order not to get distracted, they managed to keep their main focus on the TV program.

B. *The pros and cons of notification mechanisms*

In a scenario where multitasking can be understood as a process of switching rather than dividing attention [2], notification mechanisms emerge as an effective way of helping users to keep information awareness [2] while reducing some of the cognitive stress and effort [4]. Defined as "visual cues, auditory signals, or haptic alerts generated by an application or service that relays information to a user outside of the current focus of attention" [4], notifications are triggered by applications in order to alert the user about the existence of new information – e.g. a system or application updates, a new message or content update. Amongst its benefits, there is the rapid availability of important information, the access to instantaneous communication and awareness of the availability of personal contacts [15]. According to Shirazi et al. [16], notifications can be based: on the sharing of an interaction that occurs on social media, on gamification, and presentation of extra content such as TV-Guides or editorially generated content; or based on expanded experiences such as music/artist identification, related news or related content. The last category introduced by Shirazi et al. [16] and named as expanded-experience apps, includes applications designed to provide additional information (enhanced information) often synchronized with the content being displayed on the TV.

Notification systems are adopted as a way to alert the user to new events, a situation not always compatible with the users' dedication to an on-going task. Users tend to drop the task they are working on in order to check the received notification [4], [5], [16]. Nevertheless, they value the awareness provided by notifications and are comfortable to experience some disruption in order to maintain that same awareness [5]. Finally, the users' perception regarding notifications can also depend on their current engagement and interest. According to Shirazi et al [16], users value notifications from applications they use to communicate and interact with others, as well from calendar interfaces, but not from operating system applications.

III. The Impact of Notifications on Second-Screen Applications

Although not necessarily in the entertainment field, the management of attention between multiple screens and the impact of interruptions in user's attention and effort has been largely studied (cf. section II, Related Work). Nevertheless, few studies focus on the emotional impact, on users, of notifications on second-screen applications. When developing applications designed to promote the engagement between the consumer and the television content designers must take into consideration the boundaries and limits of the users' cognitive capacities and their emotional reactions to disturbance and interruptions. In order to analyse the user's perception regarding notifications triggered by second-screen applications – namely on those designed to deliver synchronized content related with TV programs – the authors developed a study in laboratory settings aiming to identify: (1) what type of notification (visual, audio or haptic) is more efficient in balancing awareness, engagement and the user's emotional effort; and (2) the interference, if any, of notifications' cadence (i.e. frequency) in the user's TV consumption experience.

A. *Development of the Prototype*

To achieve the aforementioned goals, a prototype of a second-screen application was developed, simulating an app able to identify content being displayed on the television screen and present related synchronized information. The application – running on a second-screen device (tablet) – mimicked the automatic detection of content by presenting on the tablet

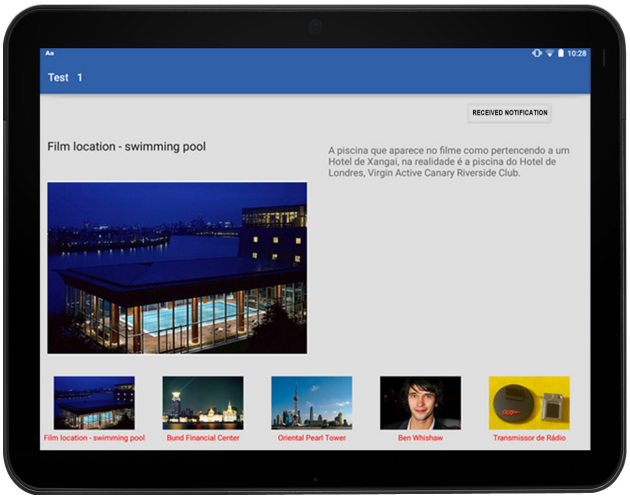

Figure 1 – The Application Prototype

several sets of images together with short paragraphs of text related with the content being shown on the television (Fig.1). Each set of image and text (hereafter referred to as marker) relates to the content being exhibited on the TV at that specific time, therefore replicating the performance of a real application and contributing to a more engaging experience. Each time new content was identified and additional information was displayed in the tablet screen, the previously presented marker was miniaturized and saved in a timeline placed at the bottom of the tablet screen, creating a string of images/thumbnails – a timeline of the detected content.

The prototype included a notification system designed to alert the user when new information was presented in the tablet, including visual notifications (a message triggered on the Television, on the tablet or on both devices); audible (on the tablet); and haptic (on the tablet, through vibration). The prototype was developed by Outsoft, and the application presented in a Nexus 9 (8.9-inch, 4:3 aspect ratio, 1536x2048p resolution) with the latest version of Android, 5.0 Lollipop.

B. Laboratory Settings

To achieve the aforementioned research goals (i.e. analyse the user's perception regarding notifications) individual observation sessions were conducted in laboratory settings. The laboratory was adapted to replicate a living room, with three sofas, a table with snacks, and a television screen (40-inch, Full HD). The need for intimacy and lack of disturbance was assured by placing folding screens between the simulated living room and the researchers' observation point. Sofas were placed at a 10 feet distance from the television, but participants were told to move them if they wanted to. During the sessions, participants were invited to watch a short film – 15 minutes total length, in English and subtitled in Portuguese, participants' native language – while using the second-screen application prototype. Each time new content was detected and displayed on the second-screen device, a notification (visual, audio or haptic) was triggered. Participants could keep the tablet on their lap or put it down on the table or on the sofa, explore the new content, navigate between newer and older content, scroll through the timeline, select older markers and display its related information. They could not, however, search for information, correlate information between markers or perform any other operation.

C. Participants

Participants were randomly selected amongst University students and researchers, and visitants with no relation with the University (convenience sampling): 8 male, 4 female, aged between 18 and 35 years old, 4 graduation students and 8 with Master Degree courses (attending or completed).

D. Test Design and Specifications

At the beginning of the test session, the research team introduced the prototype and explained its main functionalities (notifications and timeline), and participants were asked to answer a short questionnaire, aiming to collect information regarding age, gender, academic degree and occupation, as well as TV viewing and second-screen usage habits. Test sessions included two different tests, each one corresponding to one of the research goals. In order to accomplish research goal 1 (to identify what type of notification was more efficient in balancing awareness, engagement and the user's emotional effort), participants were invited to watch a segment of the film – 10 minutes length – during which visual, audio and haptic notifications were triggered on the television and/or on the tablet. Visual notifications were triggered either on the television and the tablet simultaneously or only in one of these devices. On the TV, they were presented through a small horizontal rectangle with the message "This content has additional information". On the tablet, they were presented through a white rectangle with the message "This content has additional information". Audio and haptic notifications were triggered only in the tablet. The sound used for the audio notifications was the default sound of the Android 5.0.

Notifications were triggered independently or simultaneously combined (see Fig. 2, e.g. V: visual notification on the tablet; VH: visual plus haptic notification on the tablet), randomly, and with no regular time intervals. This way, participants could not predict when a new notification would be triggered, and to what kind of notification they would be exposed to. Every time the participant perceived a notification, he/she should press a button integrated in the prototype interface, acknowledging its reception. As the application recorded the timestamps of each notification and corresponding reaction (process invisible to the participant), it was possible to record each participant's response time. In order to study the interference of notifications' cadence (i.e. frequency) in the user's TV experience (research goal 2), the second test consisted in the visualization of the remaining 5 minutes of the film while receiving notifications in three different time intervals: every 1-minute, every 10-seconds and every 30-seconds. In the second test, participants were only asked to watch the film while the application was running and triggering notifications; they did not have to press any button or perform any other action.

At the end of the test session participants were asked to answer a second questionnaire, regarding the experience they just had. Participants were asked: if receiving notifications while watching the film was annoying; if it disturbed the TV experience; if it led him/her to deviate his/her attention to the tablet; if it alerted to the existence of new information; and if it had improved the experience of watching TV. Specifically for the second test, they were asked if receiving notifications within each one of the time intervals (10, 30 and 60 seconds) allowed them to: read the information presented on the tablet; to manage attention between the movie and the information presented on the tablet; if notifications were annoying; if it made him/her lose the engagement with the movie; if it made it difficult to follow the content on the TV. To collect participants' opinion, a 5-point Likert scale was adopted (1=totally disagree, 5=totally agree).

Although tests were conducted under a cognitive walk-through methodology, at the end of the tests participants were invited to give a more detailed opinion about the experience they just had (i.e. receiving notifications while watching TV). All these qualitative data was recorded, and main conclusions are presented in the following section.

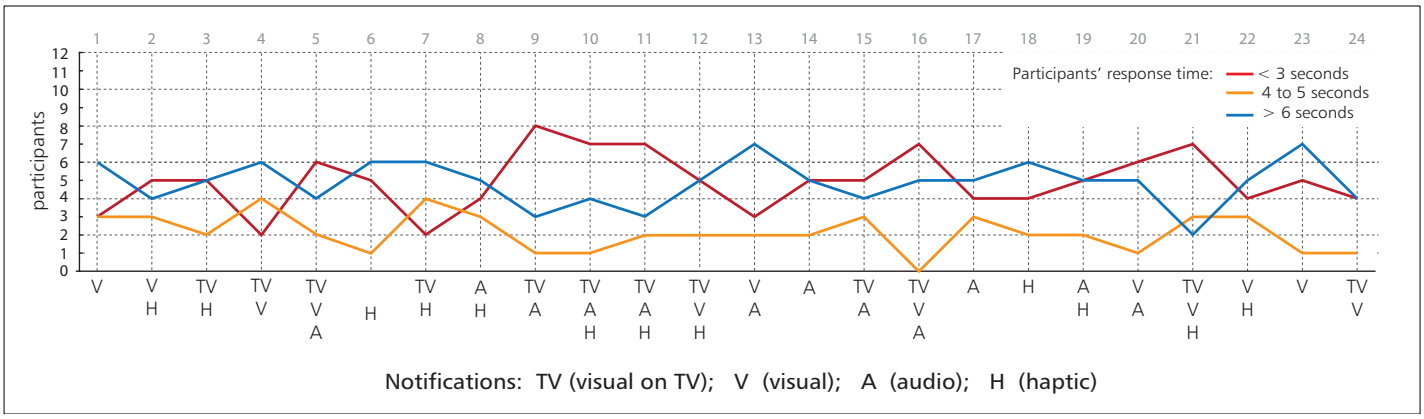

Figure 2 - Participants response time to notifications

IV. Discussion of the Results

A. *Participants' TV and second-screen habits*

Before performing the tests, participants were asked to answer two questions about their TV viewing habits and second-screen device usages. According to collected data, 10 of the 12 participants watch TV mainly with their family, 8 watch alone and 6 with friends. As for second-screen devices usage, 8 mentioned not to use it while watching television. As for the ones who do (4 participants), they use it mostly while watching TV with family (to check e-mail or social networks, and to search for related or random information) or when alone. Only one participant mentioned to use second-screen devices while watching TV with friends.

B. *Participants' reaction to notifications*

In order to identify what type of notification was more efficient in balancing awareness, engagement and the user's emotional effort, data was collected from the participants' response time to notifications; their response to the questionnaire; and their opinion, expressed at the end of the test sessions. Fig. 2 shows the participants' response time to notifications, with the Y-axis indicating the total number of participants (N=12) and the X-axis indicating the notifications number and type. Response time values were grouped in: less than 3 seconds; between 4 and 6 seconds; more than 6 seconds. In the figure, spacing between notifications is equally distributed, i.e., it does not represent the notifications' cadence. Data shows that when exposed to the combination of audio and visual notifications displayed on the TV (n5, n9, n10, n11, n16 and n21), participants had a faster response time. As for data collected through questionnaires, it revealed that receiving notifications while watching TV did not necessarily provoke a generalized negative emotional reaction (3 participants mentioned to be annoyed by notifications, to 5 it was indifferent and to 4 receiving notifications was not an annoying situation). All participants agreed that notifications were useful in alerting for the existence of new information on the tablet. Nevertheless, 8 of the 12 participants pointed out that notifications disturbed the TV viewing experience. Asked to share their opinion regarding the experience they just had, 3 participants mentioned that receiving notifications (namely the audio ones) made them loose the engagement with the film, especially during the action scenes. Visual notifications displayed on the TV were considered as the less intrusive. When displayed on the tablet, notifications were often unnoticed. With respect to the interference, if any, of notifications' cadence (i.e. frequency) in the user's TV experience and engagement, the analysis of data related with test 2 – collected through the questionnaire and presented in fig. 3 – shows that participants were able to read the information displayed on the tablet independently of the time cadence. Nevertheless, it was easier to do it when notifications were triggered in the 30 seconds and 1-minute interval. Managing attention between the two devices was also easier on the 30-seconds and 1-minute intervals. When triggered at closer intervals (every 10 seconds), notifications became more wearying than in larger time intervals: to the statement "Notifications became tiring when triggered every/ 10 seconds", one participant chose "totally agree" and 4 "agree". When triggered every 10-seconds notifications also increased the loss of engagement with the movie playing on the TV (3 participants totally agreed and 6 agreed with this statement)

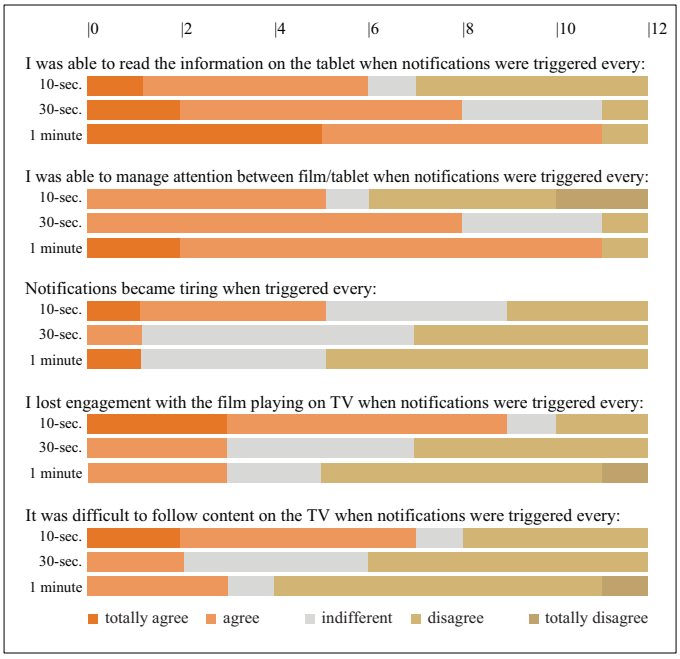

Figure 3 - Participant's opinions regarding notification's cadence

and made it difficult to follow content being emitted on TV. To the majority of the participants (8 participants), the 1-minute notification cadence made it easier to follow the TV content.

C. The Emotional Impact of Notifications

One sensitive and crucial aspect when designing a second screen companion application is to find a balance between engagement (with the TV program) and distraction, namely the one caused by inadequate notifications systems. Through the analysis of data collected during the first test and presented in fig. 2, it is possible to conclude that the combination of visual (on TV) and audio notifications is the most perceived by the participants. Nevertheless, at the end of the test session, 11 of the 12 participants mentioned that audio notifications interfered with the experience of watching TV, while visual notifications on the TV were considered as the less intrusive and annoying ones. Haptic notifications were considered to be useful to alert to the existence of new content and interfere less with the TV viewing experience. Also according to collected data, the frequency of notifications affected the TV viewing experience and the users' perception. When triggered every 10-seconds, notifications become tiring, disturbing the engagement with the TV program and making it difficult to follow content playing on the TV. At the end of the test session, 2 participants pointed out that, when notifications were triggered with short time intervals, it was difficult to follow either the film either the information presented on the tablet. When triggered with a 30-seconds interval, notifications allowed users to read the information displayed on the second-screen device and to manage attention between screens while maintaining the engagement with the TV program. As for more spaced stimuli, they increased the users' ability to read content on the tablet and to manage attention between the two devices, making it significantly easier to follow content on the TV.

V. CONCLUSIONS

The research introduced in this paper is a part of a major project, aiming to develop a second-screen application able to deliver synchronized information related with TV content, notifying the user whenever new content is added to the tablet. The study to analyse the user's perception regarding several combinations of notifications to be used in such entertainment scenarios revealed that is possible to achieve a balanced trade-off between the several variables at stake (engagement, distraction, awareness and emotional effort). Despite its limitations (namely the small number of participants), the study's results make it possible to advance that – in order to provide a balanced user experience in a second-screen scenario such as the one described in this paper – the most suitable strategy for integrating notifications (considering type and cadence) should be: (1) based on a combination of a visual notification (displayed only on the TV screen) along with an haptic notification (prompted on the tablet); and (2) with an interval of at least 30 seconds. Considering the method and procedures adopted during the study, it is believable that the reported results may bring positive insights to stakeholders involved in the development of entertainment second-screen scenarios.

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