Assessing the User Experience of Visual Navigation

Jurian de Groot

j.j.g.w.t.degroot@students.uu.nl

Utrecht University

ICA-3631516

August 21, 2016

Supervisor I

dr. W. O. Hürst

Utrecht University

Supervisor II

dr. ir. J. Egges

Utrecht University

Abstract

Many people have access to large amounts of digital movie data. In order to maintain overview over the data, a proper way of browsing is important. Furthermore, the amount of data complicates the search for something to watch, and might lead to a choice overload. Common movie browsing approaches to solve these problems exist. We refer to them as 'List-style Browsing' and 'Visual Browsing'. The former allows users to browse sorted lists of mostly textual data, representing movie data. Visual Browsing, still allows users to browse a sorted list of movie data, albeit more visually appealing. However, these browsing techniques limit the user when they are unsure of what to watch. Therefore, we introduce a new concept called Visual Navigation. Visual Navigation enables users to navigate the movie database, by using visual elements from the data. In this work, an initial version of Visual Navigation is implemented and evaluated, where actors' faces on movie posters are used as navigation points to navigate between movies that feature them. Two experiments have been conducted to find the influence of Visual Navigation on the users' emotional state and to determine if user experience increases over Visual Browsing. Results show limited effect on the emotional state of the users from Visual Navigation. However, users do become more positively affected on average as a formal analysis using the PANAS framework showed. Qualitative feedback obtained via an informal interview and a standard questionnaire suggests that Visual Navigation leads to an improved user experience compared to Visual Browsing.

Contents

1 Introduction

Due to the amount of digital data contained within video applications, there is an evident need for a clear, and easy to use, browsing method. Over the years, several commonly used approaches have emerged. Depending on the type of data, two often used browsing methods exist, we refer to these as 'List-style Browsing' and 'Visual Browsing'. The former is often used when the browsed data is mostly textual. An example is the Internet Movie Database (www.imdb.com), which contains browseable information about actors, movies and directors. Even though the site contains a lot of pictures, the data is mostly textual. The dominant interaction is scrolling through the list(s) of text. Furthermore, by clicking items, they can be accessed. This interaction is widely used, and therefore, due to habit easy to understand. However, due to the sheer amount of text, most users do not read everything and might miss information. This can be considered as a result of too much information being shown at once. Which may overwhelm users, something that can be overcome by changing the way users navigate this type of database.

Currently, video databases already have a more visual interface, containing snapshots of a movie, for example, Youtube (www.youtube.com), or movie posters - e.g. the on demand video streaming service Netflix. This, visually oriented database, allows for a more visually based interaction. This form of interaction, which we refer to as Visual Browsing, is similar to List-style Browsing. However, where List-style Browsing is used for mostly textual interfaces, Visual Browsing is used for more visually oriented interfaces. The interaction is still predominantly based on scrolling. The data, however, consists of movie posters and hardly any text is used. On the homepage, in addition to movie thumbnails, the Netflix application only contains text informing the users of the collection he or she is looking at, e.g. Drama. The homepage contains a minimum amount of text, allowing users to browse the database based on visual information, clicking visually appealing thumbnails. Additionally, the rating of movies is often taken into account, which is, due to the usage of icons (e.g. stars), a visual cue as well. Only if one of the movies was interesting enough to be clicked, the user gets the chance to read the synopsis, on a separate detail page. This kind of navigation overcomes the need to read much. However, scrolling through a large amount of movies clutters the overview a user has over the data. This might complicate the search for a movie when users are unsure of what to watch.

To overcome the problems that can be perceived when using one of the above explained methods when browsing to find a movie, we propose Visual Navigation. Visual Navigation enables users to navigate a movie database by using visual elements from the data. For the current work, a version is implemented that allows users to navigate a movie database by clicking movie posters, annotated with actors' face positions. This will be explained in more detail in Section 3.2. Scrolling a list might be perceived as dull, therefore this method of navigation is not based on scrolling through lists of data, but rather on *moving*

through a universe of movies, by clicking movies of interest and visiting them. In this way, searching for a movie becomes more than just scrolling through a list of movies, which might result in an improved experience. Additionally, at any given time the users only see the information they directly requested, that is, the movies featuring the clicked actors. This lowers the visual load, and might allow users to more easily find new works from a favored actor, or even discover new actors.

The goal of this work is to provide users with an enhanced user experience while browsing a movie database when they are uncertain of what to watch. This experience will be measured with the Positive and Negative Affect Schedule (as found in [1] and Appendix A), the System Usability Scale (see [2] and Appendix B) and a semi-structured interview. To assess if the user experience is improved, the scores of the two questionnaires will be considered as well as the answers provided during the semi-structured interview.

Following this section, the research questions are proposed and motivated. In Section 2 related work is discussed, explaining related navigational methods, questionnaires and research. Thereafter, in Section 3, the proposed navigational method is elaborated, starting with definitions of the different screens of the application. The method itself is explained in Section 3.2, whereafter the devised designs are discussed in Sections 3.3 and 3.4. In Sections 4.3 and 4.4 the experiments are discussed. Firstly, the database is elaborated, whereafter, in Section 4.2 the task as executed by the participants in the experiments is discussed. The sections describing both experiments are composed the same way. That is, both sections start with the purpose and task of the experiment. Following this explanation, the proposed hypotheses are elaborated. Thereafter, the procedures are explained in Sections 4.3.3 and 4.4.3, respectively. Demographics and material and location are discussed in the following two sections. Whereafter, results are listed and, in the last part of the sections, discussed. Lastly, in Section 5 the conclusion and possible future work are deliberated.

1.1   Research Questions

Visual Navigation was implemented with multiple designs, these designs will be explained in Sections 3.3 and 3.4. To determine which design provided the best user experience, two experiments have been devised (see Sections 4.3 and 4.4). In order to asses the implemented designs, the following research questions are proposed. Hypotheses with respect to these questions can be found in section 4.3.

RQ 1 How does the related items arrangement influence the perceived performance?

Perceived performance, in this work, is not related to how users perceive their own performance with the application, but rather the 'performance' of the application itself. That is, if users think they are able to use the application to execute the main use case, which is the discovery of beforehand unknown content. An example of bad perceived performance would be users having the idea they miss certain information, leading to the believe they bypass possibly interesting movies. Additionally, this might influences the user experience, since if users are unable to find what they are looking for, they are more likely to have a bad experience. Therefore, the perceived performance is necessary to determine the usability and user experience of Visual Navigation.

RQ 2 How does the related items arrangement influence the emotional state of users?

The emotional state of a user is related to the user experience. That is, if users do not feel positively affected, the emotional state might negatively effect their experience. Therefore, assessing the emotional state of users when they browse the application is interesting to determine the overall user experience.

In addition to **RQ 1** and **RQ 2**, more informal questions were devised. These focus more on the usability of Visual Navigation for first time users.

1. Do users understand Visual Navigation?

2. Do users like Visual Navigation?

3. Can users handle Visual Navigation?

4. Do users use Visual Navigation?

These more informal questions are relevant to help us discover if users understand the concept, but more importantly if users are able to use it. In other words, we want to unravel if the concept is not too overwhelming. Hypothesized is that users understand Visual Navigation, since the interaction is based mostly on clicking and swiping, which are interactions that comprise the most used actions of current smart devices. Additionally, we expect that users can cope with the amount of information, since only the relevant information is shown at any

given time. Therefore, the visual load is low, and not likely to be overwhelming. Furthermore, we assume that users use Visual Navigation for the specific task of discovering an as of yet unknown movie that suits their interest. However, when users have a specific movie in mind, they are not likely to use Visual Navigation, but rather use a search function or they scroll through the lists of movies available in the database. Since Visual Navigation is a new concept, we also expect users to like it. It is however, difficult to assess if users like Visual Navigation in the long term.

Most importantly, we want to know if Visual Navigation is better for finding beforehand unknown movies than the Visual Browsing method as used in, for example, the Videoland applications. Therefore, we devise the following research questions:

RQ 3 Is Visual Navigation a usable navigation technique to find beforehand unknown movies?

Discovering new content to watch is the main use case of Visual Navigation. That is, users are likely to use it if they are uncertain of what to watch. Visual Browsing already features a way to discover content, that is by scrolling through lists of movies. However, that interaction might be perceived as dull and maybe even overwhelming. Therefore, it is interesting to discover if users are better able to discover new movies that suit their interest by using Visual Navigation, compared to Visual Browsing.

RQ 4 How does Visual Navigation influence the emotional state of users?

As explained before in the accompanying text of **RQ 2**, the emotional state of a user influences the user experience. Therefore, the emotional state is once again assessed. However, whereas the first iterations of design options (see Section 3.3) were clearly distinguishable, the design options of the second iteration (cf. Section 3.4) are more subtle. Therefore, the emotional state with respect to Visual Navigation is now measured. The variability of emotions between the different designs is therefore expected to be lower.

RQ 5 Is Visual Navigation a good addition to Visual Browsing when users are uncertain what to watch?

Firstly, a definition is needed. That is, the word *"better"* is vague. In this context, the term is related to the perceived ease with which users can find new movies. That is, are users better able to find a movie which they would likely watch, when navigating the posters (Visual Navigation) as opposed to when they navigate lists of posters (Visual Browsing). Expected is that Visual Navigation is not the way to navigate a movie database for known content. Therefore, it is important to unravel if Visual Navigation is a good addition to Visual Browsing. Combining the two navigational methods, enables users to scroll and search the database, while also being able to easily discover new

content to watch. To this end, the answers to **RQ 3** and **RQ 4** are used to answer **RQ 5**. Additionally, all comments users made in both experiments (see Sections 4.3 and 4.4) are taken into account when answering **RQ 5**.

Hypotheses with respect to **RQ 3**, **RQ 4** and **RQ 5** can be found in Section 4.4.

2 Related Work

2.1 Browsing

List-style Browsing

As mentioned before in Section 1, List-style Browsing is a popular method to navigate (movie) databases. List-style Browsing involves mostly textual data, which can be scrolled through. From an overview list, any item can be selected to be examined in depth. From this in depth view of an item, other items might be visited, by clicking other (textual) links.

The amount of scrollable textual data, might be perceived as too much. Furthermore, since people tend to scan textual data, possible important information might be missed. A solution to this problem is to reduce the amount visible text, a solution applied by Visual Browsing, explained below. In addition to the possibility of the amount of text being overwhelming, the interaction with it might be perceived as dull, because the interaction is mostly based on scrolling. Therefore, database interaction could be more intriguing, a solution is offered by the here proposed navigation method, Visual Navigation (Section 3.2).

In general, List-style Browsing is based on scrolling and clicking. Within List-style Browsing, navigation of the database can be either vertically or horizontally oriented, depending on the direction of the application. Pages contain scrollable text fields, which can be the result of an executed query. During the interaction with the database, other queries can be fired or the resulting data can be browsed. From any page, clicking any of the items leads to the detail page containing detailed information of the clicked item.

Visual Browsing

Visual Browsing is, as opposed to List-style Browsing, more visually oriented. That is, applications utilizing Visual Browsing as a navigation method are often visually more appealing and contain less text. Similarly to List-style Browsing, users are able to scroll through the database. However, the data is now less textual and more visually appealing. Here, the overview page predominantly features thumbnails of the data, and only several text fields that elucidate which category the data belongs to.
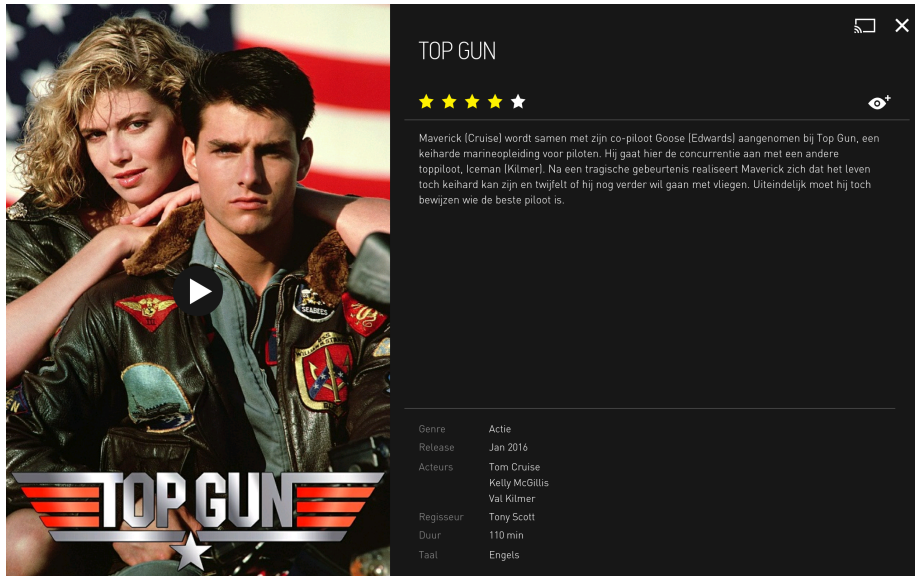
Figure 1: Detail page of the current Videoland application, containing information corresponding to the visited movie, shows the rating and a synopsis, among others. Visual Browsing is the main navigation method that is used in the current Videoland applications (Videoland is available for web, Android, iOS, Apple TV, Playstation 3 and 4 and for smart TVs).

Often, Visual Browsing applications feature a main page, containing (parts of) the available data, and detail pages for the content. On the main page, users are able to scroll either horizontally or vertically to browse the data. Similarly to List-style Browsing, it is possible to click items to visit corresponding detail pages. Furthermore, users are often facilitated to sort and filter the data, which lowers the visual load, by showing only requested data. In addition, users are able to search the database with a search function.

Both Visual and List-style Browsing, feature a search function, allowing users to search the content for specific information. However, when users do not know what to watch, they are not able to do a directed search anymore. Therefore, once users are uncertain of what to watch, they have to browse the database, which can be a time consuming effort. Some applications, e.g. Netflix or Videoland, solve this problem by suggesting content. However, the suggestions are based on content previously viewed by the user and are therefore often closely related to that content. This hinders the search when different content is desired. In addition to suggestions and browsing a database, facilitated by Visual Browsing, Visual Navigation enables the discovery of new content by relating movies to actors and showing these on demand. Using Visual Navigation, movies in the area of interest can be visited, while new content is ready to be discovered. During this process, the visual load remains low, since only a

limited amount of interesting content is shown at any given time.

2.2 Related Research

Two parts from the Human Computer Interaction field are related to this work, that is, the Video Browsing and the Video Retrieval fields. Both are terms posed by Schoeffmann et al. in their survey of the Human Computer Interaction field [3]. Video Retrieval focuses on directed search, i.e. a search with a specific goal in mind, while Video Browsing is used for both directed and undirected search. Undirected search, often called browsing, can be defined as searching without a specific goal.

The area of Video Browsing often focuses on intra movie browsing, that is browsing within a movie. An example, where the goal is to find certain scenes of a video sequence as fast as possible, is the ZoomSlider introduced by Hürst and Jarvers [4]. This video browsing interface was build for a PC, involving mouse movement. Here, the entire screen is usable as a seeker bar, i.e. wherever the users click the seeker bar appears and the video can be navigated. The granularity of the search can be changed by moving the mouse vertically. However, the focus of the ZoomSlider lies on scene selection. This can nevertheless, be seen as a form of undirected search when no particular scene is intended to be visited. Yet, more often a seeker bar is manipulated to find specific content. Visual Navigation however, focuses on enabling an undirected search to discover new content. Another example that helps users retrieve scenes in a movie, is the work by Kent Wittenburg et al. [5]. It features a set of Rapid Serial Visual Presentation techniques, which showed that users could find intended sections of a video sequence more accurately than employing a standard fast forwarding technique as is available for most digital movie players. They proposed a technique combining the keyhole principle - a sequencing method that displaces old images with new ones - with a spatial context, showing parts of the sequence as if they were moving in 3D. Their technique relied, among other things, on the amount of data present on the screen at any given time. For the experiment, they chose to show 8 frames on the screen. This number of items present at the screen is in compliance with the amount of related movies shown in Visual Navigation, which also shows eight related movies at most at any given time. This amount of related movies allows, on one hand to lower the visual load, and on the other hand to show them in an enclosing circular set around the selected face.
Both previously mentioned works aim to as quickly as possible select an item from a database, i.e. a scene from a movie. In contrast, Visual Navigation focuses on finding new content, but does not concentrate on the time it takes to find it, but rather on the experience of the search. This work focuses more on browsing a database containing movies, as opposed to the search within a movie, which is more related to the works in the (automatic) Video Retrieval field.

Other works in the Video Browsing field, however, do focus on browsing a database of movies. An example is the video browsing application for young

children, YooSee, by Azzopardi et al. [6]. This work focuses on providing a clear and more content driven browsing experience for young children by providing them with a visually appealing interface, following a globe metaphor. Children are presented with a set of carousels showing at most nine different videos at a time. Children are able to scroll vertically for different content and horizontally for similar content. Visual Navigation, proposed here, is similar, but aimed at a more diverse audience. That is, the concept should enable people, interested in movies or series, to discover new content. Additionally, as mentioned before, intended was to lower the visual load with respect to Visual Browsing and List-style Browsing, therefore a relatively low amount of visual content is chosen to be shown at any given time. The number of visible related movies, is in line with the amount of content shown in the work of Azzopardi et al. Furthermore, Azzopardi et al. showed the ability of children to handle nine different movies at a time, indicating the visual load of Visual Navigation is sufficiently low for users to focus on the important information at hand.

Another approach is proposed by Barthel et al. [7]. They proposed a graph based video selection tool (ImageMap), which was used to browse large databases containing video content. This tool was tested at the 2015 Video Search Showcase. Their work focuses on displaying as much information as possible without confusing the user, by creating a pyramid like graph. Enabling the *traversal* of a path through the database to find a predefined item. Although, the tool was intended for directed search, it can be used for undirected search, by simply traversing the database. However, where Visual Navigation focuses on discovering new content without a time limit, the goal of the ImageMap is to find an image - depicting key frames of movies - as fast as possible. Additionally, with each step through the database, the amount of video frames that can be inspected decreases, which contradicts the second goal of this work, namely allowing users to browse the entire database.

Most other research in the field of Video Browsing feature browsing a database for a known item, examples are shown in the works of Hürst et al. [8] and Lokoč et al. [9]. These approaches often involve directed search for a movie (or other objects), and aim to be as fast as possible. Furthermore, the approaches are regularly assisted by annotations, or a data structure. For example, the work of Lokoč et al. allows users to draw scenes they remember whereafter the system finds similar scenes. Visual Navigation assists by ordering the information in such a way that the displayed information is within the area of interest of the user. That is, related movies are only shown once a user clicked an actor, implying their interest for this actor. The methods previously mentioned are often purely interested in increased efficiency. In contrast, even though Visual Navigation might be able to speed up the task of finding a beforehand unknown movie, it is not the goal. The goal of Visual Navigation is to casually browse the movie database and to eventually find a movie to watch. More importantly, the path towards this goal has to be pleasant. More specifically, the experience of browsing the database is part of the goal, as opposed to being the means to reach a goal.

2.3 Measuring Emotion

To answer the research questions, posed in Section 1.1, several methods to measure emotion have been considered. This section elaborates on them, and motivates the choice for the Positive and Negative Affect Schedule, which is explained later in this section and can be found in Appendix A.

Firstly, the Semantic Differential has been considered. The original differential scale, proposed by Mehrabian and Russel in 1974 [10], contains 18 opposite adjectives, e.g. controlled - controlling, which are rated on a nine-point scale. Later the number of adjectives was reduced to seven adjectives, separated by a seven-point scale, by Hassenzahl et al. [11]. These scales are used to rate ones feelings regarding certain objects of interest, for example an application. The scales generate scores for three dimensions, namely pleasure, arousal and dominance. The seven-point Semantic Differential scale as proposed by Hassenzahl, was however, too prone for missing out on all facets of the hedonic quality of the application, due to the low amount of adjectives, and therefore, it was not chosen. Additionally, the results related more to the application rather than to the feelings regarding it, e.g. *Unique - Ordinary* invites users to rate the application, whereas ones feelings should be rated with as little interference as possible.

After the Semantic Differential, the usability of the Repertory Grid Technique (RGT) [12] was examined. Similarly to the Semantic Differential, RGT contains a number of opposite adjectives separated with a certain uneven sized scale. However, whereas for the Semantic Differential the researchers have to devise a set of interesting and useful adjectives, the RGT allows for participants to devise them. According to a study by Marc Hassenzahl et al. [11] only 10 participants devised over 150 adjectives. An advantage over the Semantic Differential is that these adjectives are personally interesting to the participants. Therefore, the set of adjectives are more relevant to the participants which possibly improves the willingness to participate in the study. However, the additional step of creating the possible adjectives with participants induced the need for another test with users. Before commencing the experiments as described in Sections 4.3 and 4.4, subjects should have elaborated important aspects of a browsing application. However, as will be obvious from the attendance of both experiments, resource-wise this was impossible.

A more *playful* method to assess ones feelings, the Self-Assessment Manikin (SAM) as proposed by Lang in 1980 and later by Hodes, Cook and Lang [13, 14], was considered. This non-verbal, visual differential scale, which highly correlated to the Semantic Differential, as shown by Bradley and Lang [15], enables people that are functionally illiterate to assess their feelings. Similar to the Semantic Differential, it allows users to assess their feelings on the pleasure, arousal and dominance dimensions. An example of the scale is shown in Figure 2. The SAM can be rated from a five to an eleven-point scale. The possible scale divisions are a result of only the pictures being valid points, giving five possible values, or additionally using the imaginary points in between the pictures, leading to an eleven-point scale. However, the scale itself seemed to be

too arbitrary and could lead to confusion and the need for explanation. This might, in turn, influence the users in choosing the rating of their emotion. Due to these drawbacks the SAM was not chosen.
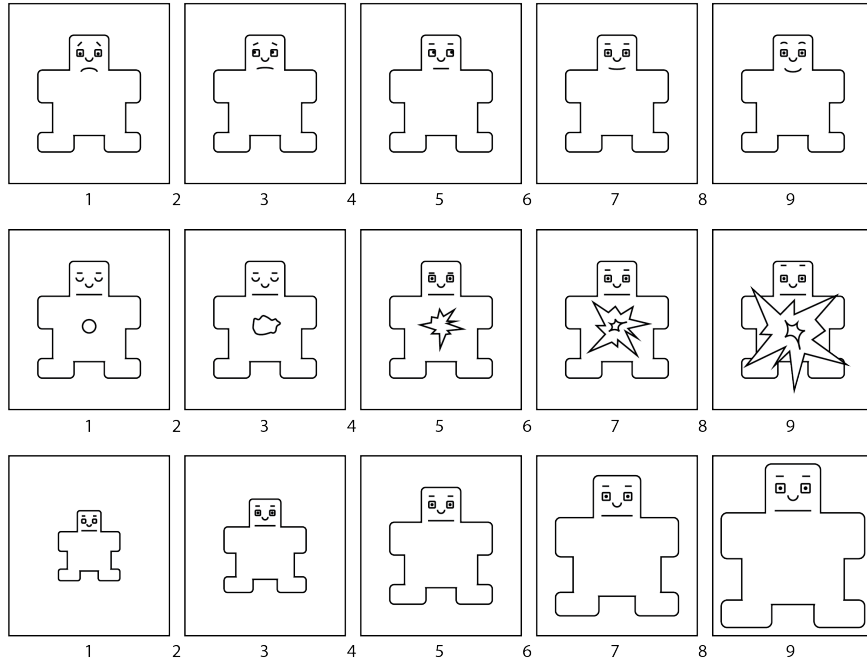

Figure 2: Self Assessment Manikin

Lastly the Positive and Negative affect Schedule (PANAS) was examined. This 20-question method, originally proposed by Watson et al. [16], allows users to rate their feelings on two scales, i.e. the Positive Affect (PA) and Negative Affect (NA) scales. According to Watson et al. the scales are not strongly negatively correlated, but rather orthogonal dimensions that rate different aspects of ones feelings. That is, PA reflects enthusiasm, active and alert states. Whereas, the NA scale mirrors unpleasant feelings. More specifically, according to Watson and Tellegen (1985) [17], high scores on the PA scale correspond to a state of high energy, pleasurable engagement and full concentration. Low scores indicate sadness and lethargy. High scores on the NA scale indicate users experiencing aversive mood states, e.g. anger. Whereas, low scores correlate to a calm and serene state. The PANAS features different time instructions, ranging from *right now*, to *during the past year* and even *in general*, for which users have to assess their emotions. Additionally, the PANAS is translated and validated in several languages, including Dutch (cf. [18]), which was the native language of most participants in the experiments (cf. Sections 4.3 and 4.4). A well validated version in the Dutch language, together with the option of in-

cluding different time instructions finally led to the PANAS being chosen as the emotion assessment questionnaire used in the experiments.

2.4 Measuring Software Usability

In addition to measuring users' emotions with respect to the application, usability of Visual Navigation is assessed. Again, different methods of assessment have been considered. Firstly, the Software Usability Measurement Inventory (SUMI) was examined. The SUMI is a 50 statement questionnaire, first proposed by Kirakowski [19]. The statements can be responded by *agree*, *don't know* or *disagree*. The SUMI questionnaire contains statements like *'This software responds too slowly to inputs'*. SUMI is validated in three different studies and is shown to be reliable. However, the size of the SUMI questionnaire, containing 50 statements, combined with the administration of four PANAS questionnaires during the experiments (see Section 4) compelled to search for different usability measurement methods.

One of these methods was the User Experience Questionnaire (UEQ) by Laugwitz et al. [20]. UEQ contains 26 opposite adjectives which have to be rated on a 7 point scale. The UEQ was validated by Laugwitz et al. and showed moderate values with respect to reliability and validity. However, the values corresponding to the reliability and validity of the UEQ were considered too low, leading to the UEQ to be discarded for a more validated questionnaire.

To this end, the Questionnaire for User Interaction Satisfaction (QUIS) was studied. This questionnaire originally proposed as a paper based questionnaire by Chin et al. [21], and later validated as an online version by Harper et al. [22], assesses users' satisfaction of applications or parts of applications. Most importantly, the QUIS focuses on the user interface of an application. Additionally, the questionnaire was shown to be correlated with the SUMI questionnaire [23]. The questionnaire is very elaborate, with the standard version containing over 100 questions in different categories, e.g. Compatibility, User guidance. Categories which are not of use in a given interface can be left out. While being very complete, QUIS is too comprehensive to administer after multiple emotion assessment questionnaires have been conducted.

Therefore, a well validated, but shorter questionnaire was required. To this extend, the System Usability Scale (SUS), developed by Brooke et al. [2] was considered. SUS is highly correlated to other usability scales, for example, to SUMI [2, 23], which shows the validity of the SUS questionnaire. Additionally, SUS was validated in a ten year empirical study by Bangor et al. [24]. The SUS questionnaire can be found in Appendix B. As opposed to the QUIS and SUMI questionnaires, SUS is a small questionnaire. The questionnaire contains 10 item that have to be rated on a five point scale, from *strongly disagree* (1) to *strongly agree* (5). Additionally, the questionnaire provides a single value representing the usability score, which allows for easy comparison. Due to these

reasons, the Software Usability Scale was selected as the measuring tool for the usability of Visual Navigation.

3 Method

This section elaborates on the proposed Visual Navigation method. Firstly, the different screens of the demo application, with their respective interactions, are defined in Section 3.1. Thereafter, the idea behind Visual Navigation is explained in Section 3.2. Lastly, in Sections 3.3 and 3.4 the different design options for Visual Navigation are explained.

3.1 Definitions

This section elaborates on the different screens the demo application features, which we refer to as 'spaces'. Users start in the *Overview space* as will be explained in next section. After this explanation, the *Detail space* , accessible from the Overview space, and the *Poster space*, in turn reachable from the Detail space, are elucidated.

Overview Space

After starting the application, users see the *Overview space*. The Overview space contains an overview of the content available in the application. In Figure 3, the Videoland Overview space is shown for reference. Since the focus of this work is on the interaction within the Detail and Poster spaces (cf. Sections Detail Space and Poster Space), the decision was made to eliminate any form of ordering on the main page. This way, users are more likely to properly inspect the Visual Navigation interactions as opposed to scrolling through the database looking at different genres to assess if it contains anything of interest.

The demo contains a list of movies (cf. Section 4.1) which can be scrolled through vertically. Clicking on any of the movies shifts the application to the Detail space that contains an enlarged poster as well as information about the movie. No interactions other than these are possible in the Overview space.
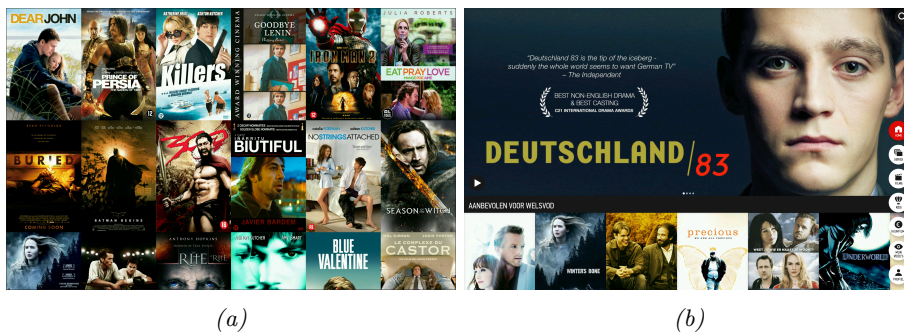

(a)   *(b)*

Figure 3: (a) Overview space of the demo application. (b) Overview space from the Videoland application for reference.

Detail Space

The *Detail space* contains information about the movie, selected in the Overview space. Details of the movie that are shown, contain the rating, synopsis, genre, release date, featuring actors, director, duration and language of the movie. Additionally, it shows a movie reel, that depicts whether a trailer is available for the chosen movie. However, the movie reel is always shown in the demo application.

Upon entering the Detail space, a blink is shown around each clickable object. With it, the user is notified of the clickability of the actors. As a result form the first experiment it became apparent that the visibility of the blink was insufficient. Therefore, in the second iteration of the design, users were shown a yellow text box in addition to the blink, further encouraging them to click an actor. From the Detail space, users can return to the Overview space by pressing the cross shaped icon in the top right corner of the screen. Additionally, this action can be executed by swiping downwards. Within the Videoland application, pressing the movie reel icon starts the accompanying trailer. However, since all playback abilities are stripped from the demo, the movie reel icon is purely cosmetic and has no attached action when pressed. Two more icons exist in the Detail space, being the *add to watch-list*-icon, depicted by a small eye with a plus sign, and the >-button. The former, as the name suggests, allows users to add the movie to their watch-list. Adding a movie to the watch-list is however, not executed since no account is attached to the application. The visual cue showing an action has been executed is, however, still shown. The >-button allows the user to dismiss the information and proceed to the Poster space (see next section). Once the information is dismissed this icon transforms into an *i*-icon, depicting a more information button that can be used to call back the information. The first experiment showed that the *i*-icon was often missed, therefore, the choice was made to exclude it in the second iteration of the designs.

In addition to clicking the >-button, users are able to swipe horizontally to dismiss and call back the information. Additionally, executing this action, changes the currently visited space. That is, if the information is dismissed, the application transits from the Detail space to the Poster space and vice versa. Most importantly, Visual Navigation enables users to click actors' faces, to reveal other movies that feature the actor (*related movies*). Clicking an actor's face shifts the application to the Poster space. Additionally, clicking the poster on an unannotated place shifts to the Poster space as well.

In addition to the other interactions in the Detail space, a user study (executed by a fellow student) showed that clickable text was an often requested feature. Therefore, clicking the actors' names - shown in the information area - produces the same functionality as clicking on their faces on the poster. However, since not all credited actors are visible on the poster, this increases the amount of visitable movies from a starting movie. That is, if users are able to click credited actors who are not featured on the poster, they are additionally able to visit the movies related to that actor. This might improve the amount

of perceived control a user has over the application.

Poster Space

As evident from last sections, the design for the demo is based on the Videoland application, however, the *Poster space*, which will be explained in this section, is only available for Visual Navigation.

The Poster space contains two states, namely the *browsing state*, when users clicked an actor and related movies are shown, and the *normal state*, when the application moved to a new movie after a related movie was clicked. In the browsing state, the movie information is absent from the Poster space to ensure users notice the at that time important information. Since users are inspecting a certain actor, the related movies of that actor are at that time the information of interest. In the normal state, the visibility of the information depends on the design chosen in the experiment. These designs are elaborated in Sections 3.3 and 3.4.

To interact with the Poster space, users can execute swipe and click actions. First, users can click the face of an actor to see his related movies. This action additionally switches the state of the Poster space from *normal* (*as depicted in Figure 4*) to *browsing*, which is shown in *Figures 6 to 8*. Once the browsing state is activated, clicking anywhere but on the related movies, reverses the state. Clicking on one of the related movies redirects to a new Poster space, containing the clicked related movie. Additionally, this action reverts the state of the Poster space.

Depending on the design, which were different for the first and second experiment, two or three buttons allow users to execute certain actions. In the first design iteration, three buttons are visible in the Poster space, namely the *info button* (shaped like an *i*) the *previous-movie button* (resembling a downwards arrow), and the cross shaped *close button*. The previous-movie button, only available if more than one movie is visited using Visual Navigation, allows users to revisit the previously visited movie. Navigation to a previously visited movie can also be done by swiping downwards. Pressing the close button shifts the application back to the Overview space. In addition, this action can be executed by swiping down, when no more previous movies are available. The info button moves the application back to the Detail space, which can also be done by swiping left.

In the second design iteration of Visual Navigation, the information button is left out. Navigating back to the Detail space is now done by clicking the close button. Clicking the close button again in the Detail space, returns the application to the Overview space, The previous movie button, however, remains the same and also executes the same action when pressed. Additionally, the swiping actions remain the same as in the first design iteration, except in the Shrink/Enlarge design (cf. Section 3.4), where swiping horizontally is left out.
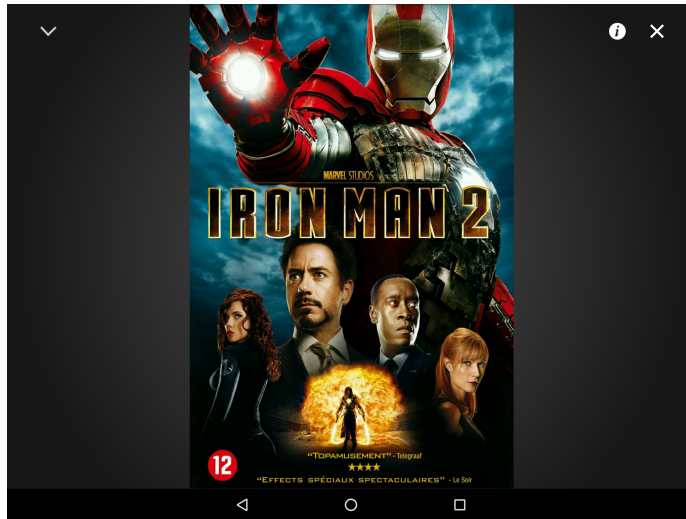
Figure 4: Normal state of the Poster space
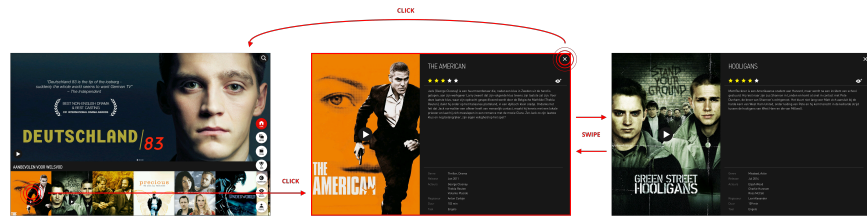
(a)
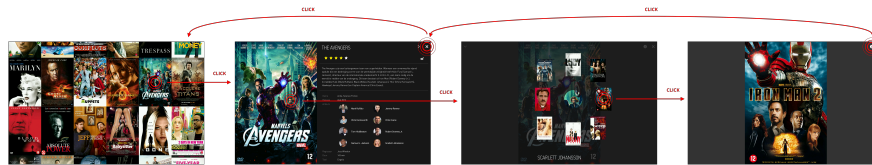
(b)
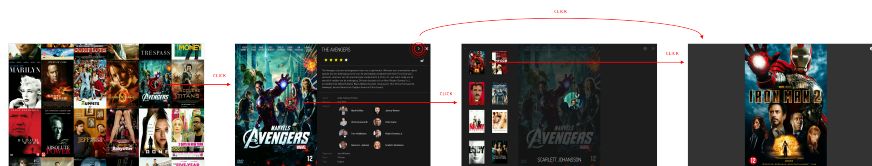
(c)

(d)

(e)

Figure 5: The possible navigation paths of the different designs as explained in Section 3.1. Note, for clarity not all arrows are drawn in each design but buttons behave the same in each of them. (a) Videoland standard navigation paths, for reference. (b) Circular design option. (c) Empty Space design option. (d) Information Space design option. (e) Information Space design option, with persistent related movies

3.2 Visual Navigation

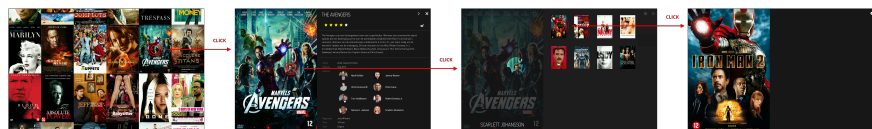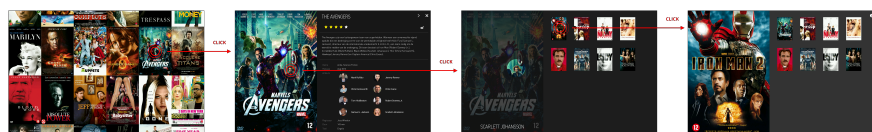Users often find themselves wanting to watch a movie, however, not knowing which one beforehand. Normally, scrolling through the database and looking at suggested movies could lead to users finding a movie to watch, which is a possibility of the Visual Browsing navigation method. However, this is a time consuming process and users are likely to be watching content closely resembling other, previously seen, content. Visual Navigation tries to solve this problem by allowing users to navigate between movies directly. This kind of navigation is possible within the Videoland application. That is users are able to swipe horizontally to move between movies. However, the ordering of the movies is the same as seen on the overview page. Therefore, the interaction executed is essentially the same as scrolling through the list of movies on the overview page. Thus, while navigation between movies seems possible, it is a different place that allows users to scroll through a sorted list ordered in some way. Therefore, users are not able to directly navigate the entire database, but just the movies related to the currently visited one. Note that these relations can be of any kind, ranging from release date to genre. Visual Navigation, however, enables navigation based on the data contained within the movie posters, that is, actors featured in the movie can be clicked. Other movies featuring the actor are fetched and displayed on screen once the actor is clicked. The linearity of scrolling through a list is overcome this way, since actors not necessarily play in the same genres every time.

Visual Navigation uses annotated posters to include clickable areas. These clickable areas, for now only actors' faces, contain links to other movies the actor features in. These movies can then be visited directly by clicking them. This way the users stay within their area of interest, a certain actor, and see only movies related to that actor. This significantly reduces the amount of information on a screen, while still allowing the users to browse the entire database. Since multiple actors are featured in one movie, users have the opportunity to *enter* and *exit* that movie in different ways, i.e. multiple actors may lead to the same movie while other movies are exclusive to these actors. This way, a closed network of movies can be formed, which can be navigated by clicking on actors and related movies.

Different designs are implemented that apply Visual Navigation. The first iteration, as used in the first experiment (cf. Section 4.3), differ in the positioning of the related movies. An elaborate explanation of these designs can be found in the next section. The three possibilities are circular ordering around the face (cf. Figure 6), placement in the empty space (cf. Figure 7) - that arises when the movie poster moves to the center - and positioned in the information space (cf. Figure 8), the space that normally contains the detail information on the currently visited movie. These spaces are not to be confused with the spaces as discussed in Section 3.1.

The second design iteration, which is used in the second experiment (Section 4.4), differs in the presentation of information of the visited movie. Once again, three designs are devised which differ in the way information is presented

to the user. The possibilities are handled in depth in Section 3.4.

3.3   Designs: Related Movies

Three different variations exist of the related movie positioning, the ordering of the movies can be in a circle around the actor's face (called Circular design), in the *empty space* or in the *information space*. The related movies only show once an actor's face is clicked (cf. Figure 5), that is if the *browsing state* is the active state of the Poster space. The reasoning behind the orderings are explained in the following sections.

Circular Design

In this design option, related movies are shown around the clicked actor's face. The related movies form a circular set around the face of the actor, which is visually appealing and resembles a strong relation between the clicked actor and the related movies. A maximum of eight related movies is chosen to be displayed. This way, a visually appealing circular ordering can be shown around the face, see Figure 6. Additionally, it limits the amount of data available to the user, lowering the visual load. However, since the related movies are still covering part of the visited movie poster, it can be perceived as cluttering. In order to facilitate the circular ordering of the related movies, the poster that users clicked on moves to the center of the screen. Additionally, this gives the feeling of being inside a different *universe* we named the *omniverse*. This, to give the users the feeling of executing different actions than normally possible within related applications.
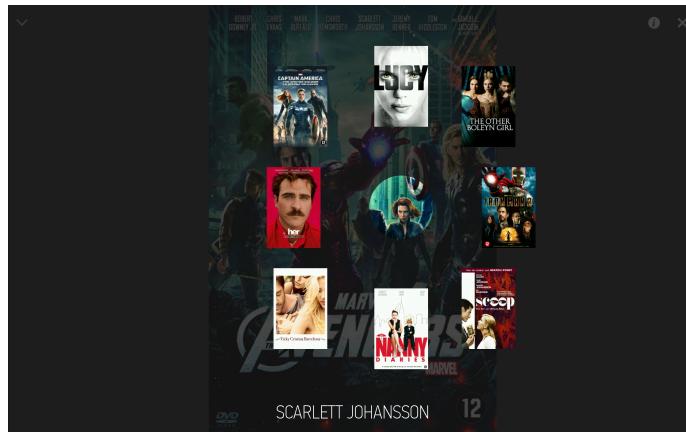

Figure 6: Design option: show related movies around the clicked face

Empty Space Design

The related movies displayed in the empty space - the space around the centered movie poster - are structured according to a grid. Using a grid structure to display the related movies, enhances clarity. Furthermore, users are often presented with grid based structuring, which may lead to a smaller learning curve. Again the movie poster is centered when the application is in the browsing state, preserving the idea of the *omniverse*. However, since the poster is not cluttered by the related movies, it is more clearly visible which other actors feature in the movie, this could encourage the user to explore movies from them as well. However, the empty space is divided by the movie poster, which might create an information overload since users have to switch their glance to both sides of the poster to see all movies.
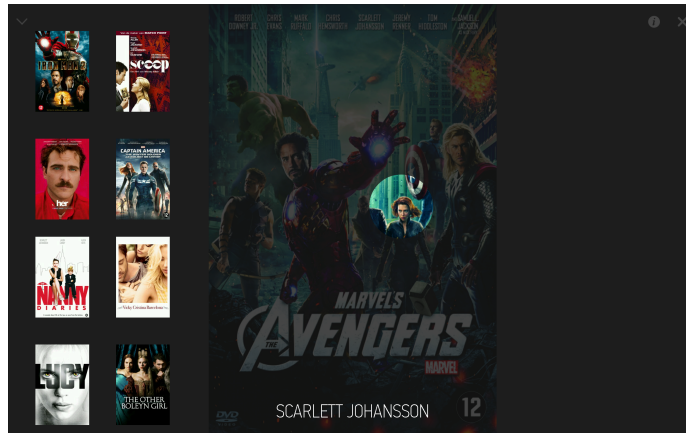

Figure 7: Design option: show related movies in the empty space

Information Space Design

The last design option is showing related movies in the information space, which is the area of the screen normally reserved for detail information. Opposed to the other versions, the poster is not centered anymore, to allow for a more consistent place to show the related movies, i.e.in the information space. The related movies are more clustered than was the case in the Empty Space design. More explicitly, the two grids from the Empty Space design are combined in to one grid, eliminating the need to shift the focus between two grids. Additionally, just as the Empty Space design option, the related movies refrain from cluttering the visited movie poster, inviting users to click other actors featured on the movie poster. However, since the grid replaces the text in the information space, the relation between the clicked actor and the related movies might become less obvious. That is, since the textual information in the information space is related to the movie, users might perceive the related movies to be related to the movie as well, rather than to the clicked actor.
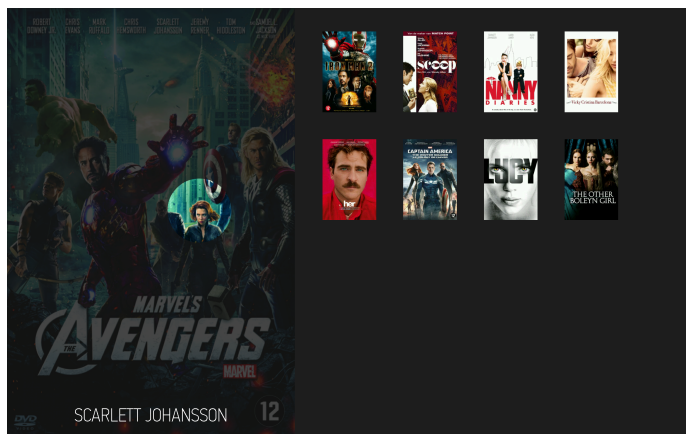
Figure 8: Design option: show related movies in the information space

Persistent Related Movies

The Persistent Related Movies design option, elaborates on the Information Space design. Specifically, after a related movie is clicked in any of the other designs, the other related movies disappear. However, after a movie is clicked in the Persistent Related Movies design, the related movies remain persistent when transiting from one movie to another. That is, if an actor is clicked while visiting a poster p_1 in any of the previously explained designs, a set S_1 of related movies is generated and, once one of these movies - suppose it is called p_2 - is clicked, S_1 disappears. Additionally, p_2 becomes the currently visited movie poster, and animates to the center while enlarging. However, in the Information Space design, the related movie posters do not block the poster, therefore, a related movie set can remain persistent between any two posters. That is, once poster $p_2 \in$ related movie set S_1 is clicked, it still becomes the currently visited movie poster. Related movie set S_1 now misses one movie, namely p_2, which can be replaced by p_1, forming the new related movie set S_2. This movie set can remain persistent and can be shown as long as the same poster p_2 is still the currently visited movie. Once the user clicks another actor, the related movies can be discarded and a new set of related movies can be formed. This design option is considered to speed up the navigation between posters. This can be achieved by users being able to click on related movies faster, and additionally go back and forth quicker between movies featuring the same actor. The possible navigational paths of the persistent related movies are also explained visually in Figure 5e.

3.4 Designs: Information Display

As was evident from the first user study (cf. Section 4.3), users missed the information corresponding to the clicked posters. Therefore, three variants were

devised to allow users to more easily find information about the currently visited poster. The reasoning behind each design is explained in the following sections.

Shrink/Enlarge Design

The main idea behind Visual Navigation, is the separation of the Detail space and the Poster space. However, when browsing the strict separation as used in the first experiment, users were unable to find the information of a visited movie. Users clearly missed the possibility to obtain information about the visited movie, which was possible by clicking the i-button. This showed that the visual cue needed to be more clear. Therefore, the Shrink/Enlarge design maintains a strict separation of the Detail and Poster space, however, to improve the visual cue showing users the ability to obtain information about the movie, the movie's title and rating are always shown, Figure 9 shows an example. Additionally, due to it being not strong enough as a visual cue, the i-button is removed from the design.

The removal of the i-button consequently means a change in the possible interaction paths in the Shrink/Enlarge design option. Therefore, the flow from the Detail space to the Poster space is slightly different. That is, once users click an actor, the movie information shrinks and part of it (i.e. the movie's title and rating) remains inside the Poster space. To return to the Detail space, users can click the x-button, anywhere to the right of the poster or (as intended) on the shrunken information, horizontal swiping is not possible anymore though. The separation is less obvious, since the information area enlarges back to normal size, however, the Detail space is still separated from the Poster space, since the application cannot be in both spaces at the same time.
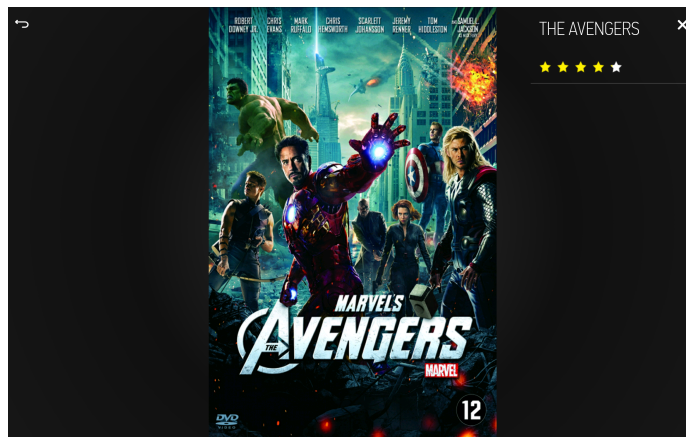

Figure 9: Design option: strict separation of Poster and Detail space, with some information already available.

24

Information Bar Design

A strict separation of the information and the poster might be too difficult to understand. Therefore, a bar (cf. Figure 10) is chosen to be the separation between the information and the movie poster. That is, the bar - when it is small - shows nearly the same information as the Shrink/Enlarge design from last section, with the addition of the *trailer* and *add to watch list* icons. Additionally, the bar allows for a play button to be displayed, which, until now, is shown on the poster. The play button is, however, outside the scope of this project. Furthermore, when the bar is extended, all corresponding information is displayed. It is, however, still possible to leave the Poster space and return to the Detail space.

The bar is swipeable and can be pulled up to show all information and down to hide the information. Additionally, the bar can also be clicked, which performs the same action as swiping it. When an actor is clicked, the user intends to find movies featuring the clicked actor, therefore, the bar animates out of the screen once the related movies are shown. This additionally lowers the visual load, and allows users to focus on the currently important information, specifically, the related movies.

The flow from the Detail space to the Poster space remains the same as explained in Section 3.1. Thus, once users click on an actor in the Detail space, the information animates out of the screen and only the poster with related movies remains. However, if the application resides in the Poster space and no actor is clicked, the information bar becomes visible again. Additionally, just as in the Shrink/Enlarge design, users now have to press the close button to return to the Detail space. In this design it is, however, possible to swipe horizontally to transfer from the Information to the Poster space and vice versa.
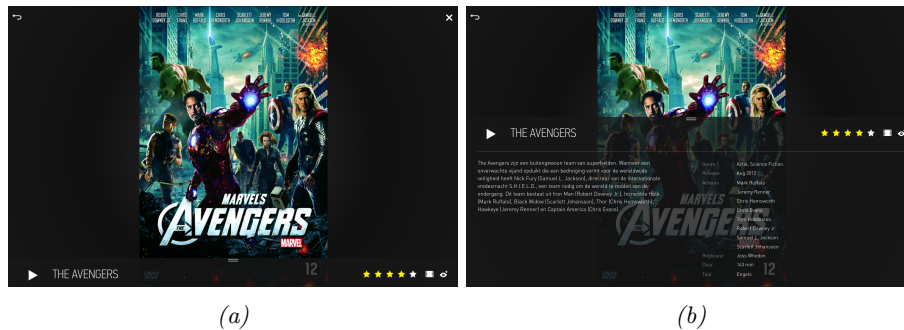

(a)   (b)

Figure 10: Design option: a swipeable information bar showing all information.

25

Persistent Information Design

The last design option eliminates the need for interaction to obtain information. That is, a persistent text box containing the information is visible at the left side of the poster (cf. Figure 11). The text box is draggable and can be dropped anywhere on the screen. This way users can decide what they find the most convenient place for the box. The start position of the box, however, ensures it does not occlude the poster. The text box is not removable. Nevertheless, just as with the Information Bar design, the text box disappears once an actor is clicked, either a face or a text item (see Section Detail Space). This way the visual load remains low, since users only have to focus on the related movies of the clicked actor.

The flow from the Detail space to the Poster space remains the same as explained in the previous section, that is, users can click on an actor to navigate to the Poster space and click the x-button or swipe to return to the Detail space.
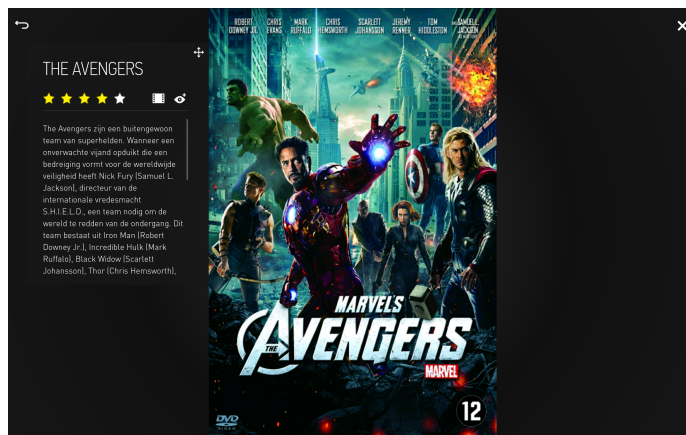

Figure 11: Design option: always show all information in the Poster space, to remove the extra interaction needed for information gathering

4 Experiments

In this section the executed experiments are elucidated. Furthermore, the database used for both tests is addressed and compared to a snapshot of the Videoland database, in order to ensure both datasets have a similar distribution. The explanation of both experiments begins with an elaboration of the purpose and task, followed by the proposal and description of the hypotheses. Then, the procedure of the experiment is elucidated. Whereafter, the subjects, the testing location and materials are treated. The results of both tests are elaborated in Sections 4.3.6 and 4.4.6 followed by a discussion in Sections 4.3.7 and 4.4.7 respectively.

4.1 Database

The database, as used in both experiments consists of 220 movies. Table 1 shows the amount of movies available for each genre contained within the database. However, movies might be classified to be part of more than one genre, leading to a greater total amount of movies than the amount of movies present in the database.

The distribution of movies among the different genres of both the Videoland database and the demo database appears to be highly similar, as evident from the histograms of *Figure 12*. Note that, due to the changing nature of the Videoland database this snapshot, made on 17-12-2015, might not be representing the distribution of the database at another time.

Genre	Amount
Action	90
Adventure	16
Art house	2
Comedy	53
Crime	29
Drama	95
Family	5
Fantasy	11
Horror	10
Musical	3
Mystery	4
Romance	22
Science Fiction	19
Thriller	64
War	6
Western	4
Total	433

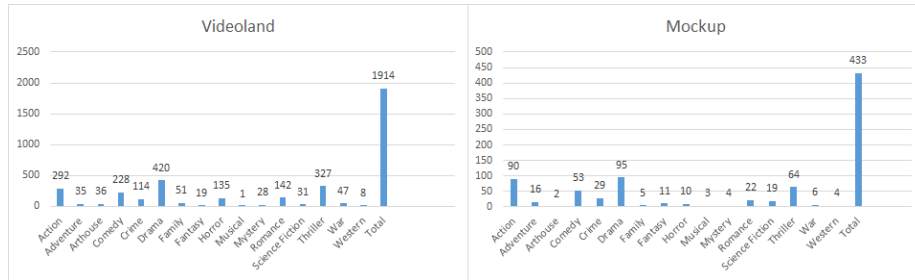*Table 1: Number of movies per genre for the demo application*

Figure 12: Distribution of the Videoland database as of 17-12-2015 is displayed on the left, whereas the distribution of the database as used in the demo application is shown on the right.

As visible in fig. 12, the two populations appear to be distributed similarly. However, the similar distribution of the datasets needs to be formally established. Firstly, normality had to be determined, therefore a Shapiro-Wilk test was executed on both datasets. The results showed both datasets were not normally distributed, with p-values of 0.001132 for the demo database and 0.005193 for the Videoland database. Therefore, a non parametric test was needed to establish a similar distribution of the datasets. A Kolmogorov-Smirnov test was executed on the percentages of the contribution of each genre to the databases to assess if the datasets had the same distribution. The test showed both datasets came from the same distribution ($p = 0.941$). Therefore, we can conclude that the dataset used in the demo application is a valid projection of a realistic database, eliminating any variation due to differences in the database distributions.

4.2 Browsing Task

In the Videoland application, but also other video streaming applications like Youtube or Netflix, users can execute two possible actions:

- Query; where the users enter a search term to find a particular (kind of) movie(s).

- Browse; where users browse the application in order to find a beforehand unknown movie. Both actions can be executed in any order.

Since this work is trying to improve upon the experience users have while browsing a video database, a browsing task is to be executed in the experiments. Therefore, users are asked to start a "search" without a particular goal movie in mind, but according to their own interests, i.e. to browse for movies they find interesting to watch. Therefore, the subjects are executing an undirected search task, meaning the goal is not to find a particular movie, but rather to find any movie which they would like to watch. The task simulates the generally executed task when a movie database is browsed, that is finding any movie

to watch. Additionally, a goal of visiting a movie database can be to find a particular movie to watch, however, this task is executed fastest when executing a query. Therefore, a search function is purposely left out of the experiment (and the application). The chosen task, i.e. browsing of the database, is the main use-case for Visual Navigation. That is, if users already have a particular movie in mind, Visual Navigation is less quick than a search function or scrolling trough the database. The browsing task is cut short after the time ends (*see Section 4.3.3 and Section 4.4.3*) to prevent subjects from going on indefinitely.

During the task, users might be prompted to execute certain subtasks. An example can be *"can you click on a part of the design?"*, to show them parts of the design they did not yet visit or *"can you find a way to view movies from actor x who is not on the poster?"* to provoke the execution of tasks not yet accomplished. Users are only given subtasks if they are uncertain of what to do, or when interesting parts of the application are un-used.

4.3 Experiment 1

The experiment, as elaborated in this section, is a user study performed by 8 users. Four subjects are member of the Videoland test panel, consisting of 483 users, the other four subjects are students. Firstly, the purpose and task is explained in the following section.

4.3.1 Purpose & Task

Three designs were evaluated in this experiment, with a fourth option being based on the Information Space design, additionally featuring the persistent movies functionality (cf. Section 3.3). The purpose of this test is to unravel which design is perceived to be most useful. This allows for an improved version of the design to be assessed in the next experiment (see Section 4.4). To this end, subjects are queried about which design they like best, and are encouraged to vent their opinion as much as possible during the test. In addition, the determination of whether users are able to understand the functionality of Visual Navigation is of great interest. More specifically, during this experiment, it will be determined if the subjects understand the concept of related movies once they click an actor. In order to give the subjects the opportunity to unravel the concept of Visual Navigation on their own, only a minimal instruction with no information about the concept was given. The introduction is done verbally and closely resembles the introductory text as can be found in *Appendix C*. While the understanding of Visual Navigation is important, it is also interesting to evaluate if users can cope with and more importantly if they actually use Visual Navigation to discover movies. Since, if users have a complete understanding of the concept it does not automatically mean they are going to use it during browsing of movies in the application. Furthermore, the ability to cope with the concept, i.e. being able to manage the visual load of the concept, greatly amounts to the usability of it.

To this end, users are inquired to browse the demo application with no particular goal in mind, i.e. executing an undirected search. By performing this task (cf. Section 4.2), the main use case is being simulated, that is, the search for an as of yet undetermined movie to watch. Known item search, i.e. the search for a specific item in a database, is excluded, since this task can be solved much easier by either using Visual Browsing or querying the database directly.

4.3.2 Hypotheses

The Information Space design was hypothesized to be most useful, i.e. it is expected to have the highest perceived performance. The Information Space design is most informative compared to the other designs, having the largest amount of related movies on screen at once, which may account for the expected high perceived performance. Even though the amount of shown movies in the Information Space design is tied with the shown amount in the Empty Space design, the latter splits the grid into two grids both competing for attention. This might lower the perceived performance due to a necessary focus shift between the two grids. This competition of attention is overcome by structuring all related movies into one grid in the Information Space design, which might allow users to more easily find all movies, i.e. all movies can be checked without changing focus.
Additionally, since the movie information on a detail page is always shown in the right portion of the screen, showing the related movies in the same screen estate might be perceived as more logical. This improves the consistency of information flow, because the same area is used to provide it. Therefore, users will probably understand that the related movies are related to the currently visited movie. However, a possible pitfall of this design could be that users are not able to understand the relation between these movies and the clicked actor. The relation between clicked actor and related movies is more clear in the Circular design, which spaces the related movies around the face of the clicked actor. The Circular design was additionally hypothesized as most influential on the emotions, due to new and innovative way of spacing the related movies.

Furthermore, the Persistent Related Movies Design was expected to further improve the usability of the Information Space design. As explained in Section 3.3, the related movies persist over multiple visited movies. Retaining the related movies enables subjects to more quickly browse between different movies of the same actor, which might enhance the usability of the navigation.

4.3.3 Procedure

During the experiment, the following described procedure was maintained. Firstly, the subjects (see Section 4.3.4) are minimally instructed about the experiment (*cf. Appendix C*). This introduction is intentionally kept vague, since we want to discover if users can unravel the functionality of Visual Navigation and the

possible interactions within it, on their own. Demographics are established, whereafter the users are asked to fill out a *PANAS questionnaire* with the instruction to assess their emotions in general. This initial PANAS questionnaire is executed to establish a base value, with which the other scores can be compared, allowing assessment of the emotions regarding the different designs. Once these steps are taken, the users are asked to browse the database (Section 4.1). The users are exposed to three different designs, balanced using a Latin-square design. After each design, users are inquired to fill out a *PANAS questionnaire* with the instruction to assess their feelings at the current moment. The last design, i.e. the Persistent Related Movies design is not rated on the PANAS scale, due to being only a small extension of the Information Space design. Additionally, there is no time limit for users to explore this design, which might influence their feelings regarding the design. Therefore, a PANAS questionnaire is not administered for the last design. Users are, however, inquired about the perceived usefulness of the Persistent Related Movies design. Furthermore, the expectations regarding this design are examined. That is, users are asked whether they perceive this kind of functionality as an improvement, or rather have a different use for the screen estate at that point of time. This way, the design can be assessed with respect to the Information Space design, allowing an examination of the functionality added in the design.

During the first run, users are asked to browse the movie database for 4 minutes, allowing for a full examination of the functionalities of Visual Navigation. During the first run, subjects are prompted to execute certain actions, that have not been accomplished before. An example is *"can you find the related movies from actor x not on the movie poster"*, which should encourage to click on the actor names. However, if all actions are executed within the first three minutes, no incentives are given. An action which can be executed by either swiping or clicking, e.g. closing the Detail space, which can be done by pressing the x-button or swiping downwards, only has to be completed once.

During the second and third run, the same browsing task has to be executed, albeit for a shorter time, being two minutes. Since all navigational actions are executed in the first run, subjects are likely to more quickly browse the database using actions discovered in the first run. In addition, the browsing time is shortened to prevent boredom.

After these three runs, another interview is conducted to determine the user's preference of the three designs. Lastly, the persistent related movies variation of the Information Space design is shown. Subjects are then once more asked to browse the database, albeit without a time limit. However, after two minutes a prompt is shown signaling the test is over, nonetheless subjects are allowed and encouraged to continue if they want to. A time limit is omitted due to the similarity with the Information Space design, i.e. only the visibility of the related movies differ. Therefore, users are likely to become bored more quickly. After the last run, subjects are inquired about the persistent related movies and are allowed to, one more time, vent anything about the designs.

4.3.4 Demographics

For this experiment, the Videoland test panel, consisting of 483 people, was invited via mail. Out of the 483 members, 14 replied and were considered for participating in the experiment. From these 14 respondents, eight were recruited to come over to Videoland Headquarters in Hilversum. However, not all people showed up, leading to the experiment only being executed four times. Therefore, additional tests were done with four students. Due to the Latin-Square balancing of the test, a multiple of the number of designs was ideal, that is a multiple of three, since all users are exposed to the Persistent Related Movie design last, as an extension to Visual Navigation. However, since the experiment was more exploratory, cf. one of the goals was to reveal if users were able to understand Visual Navigation, six to nine different subjects were sufficient. Since the Latin-Square contained only three different options, three replicates are available for two of the three options and two for the other option. Each subject assessed each design, leading to sufficient testing of each design by eight users.

The Videoland user group is composed of three males aged 27, 39 and 57, and one female aged 56. All subjects were users of Videoland, from who three out of four use it on daily basis. The fourth user watches Netflix more often than Videoland. Additionally, all, except for one - who had never used a tablet before - were experienced users of a tablet device.

Three females aged 24, 24 and 27, and one male aged 28 were part of the students subject group. All females were frequent users of Netflix, i.e. at least on weekly basis. The male was a user of Videoland, albeit not very often, i.e. generally only once a month. All were experienced tablet users.

4.3.5 Material & Location

The experiment was executed at different locations. First the Videoland test panel members were invited to the Videoland Headquarters, where they were interviewed in the board room due to unavailability of the user testing room. The students were interviewed at the Utrecht University or at home. The experiment was executed on a Samsung Galaxy TabPRO 8.4. It has a Qualcomm Snapdragon 800 processor running at 2,3 Ghz, 2 GB of memory and resolution of $2560x1600$. Additionally, at Videoland Headquarters, a Mr Tappy filming kit was attached to the tablet to record the screen. The screen has not been recorded while the students executed the experiment.

4.3.6 Results

The results obtained from the experiment, described in the previous sections, are elaborated here. In order to determine if the data obtained from the experiments was normally distributed an exploratory analysis was executed. This showed a non-normal distribution in the data. The Positive Affect (PA) scale, was however, distributed normally ($W = 0.967, p = 0.420$). Even though the

PA scale was normally distributed, the analysis has been executed using non-parametric tests, i.e. the Friedman's ANOVA and Kruskall-Wallis tests.
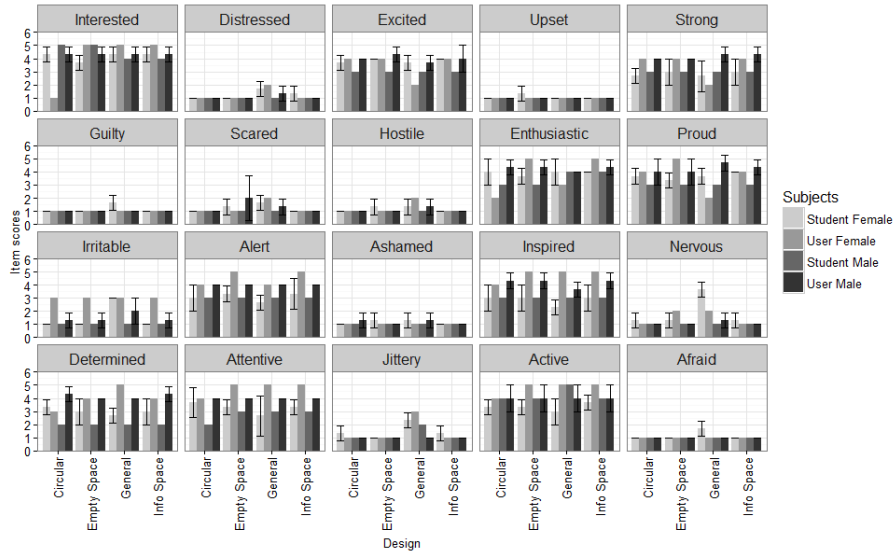

Figure 13: Means and standard deviations of the PANAS items. Scores are shown for each design, additionally a base line is shown, which is the general measurement. Four groups are female students (3x), female users (1x), male students (1x) and male users (3x)

Experiment 1, was administered to eight people as discussed before. The groups were split in several different ways to detect any significant changes in the emotional scales. Firstly, the groups were split, based on subjects being student or not. A difference between students and non-students was also shown by Engelen et al. [18], therefore, the choice was made to split the groups based on being student or not. Engelen et al. showed that students scored significantly lower on the PA scales and higher on the NA scales.

A *Kruskal-Wallis test* showed a significant difference between student and non-student PA scale for the base measurement (cf. Figures 13 and 14), with a p-value of 0.02. Furthermore, the PA scales of the Empty Space and Information Space design showed a significant difference between student and non-student users, with p-values of 0.02 and 0.029, respectively. After the Kruskal-Wallis test, *Dunn's post hoc rank sum* was executed, showing agreement with Engelen et al., namely, all student PA scores were lower than non-student PA scores. No statistical significant difference between the PA scales of students and non-students was observed for the Circular design. Furthermore, no significant difference was observed between users and students for any of the scores on the NA scales.

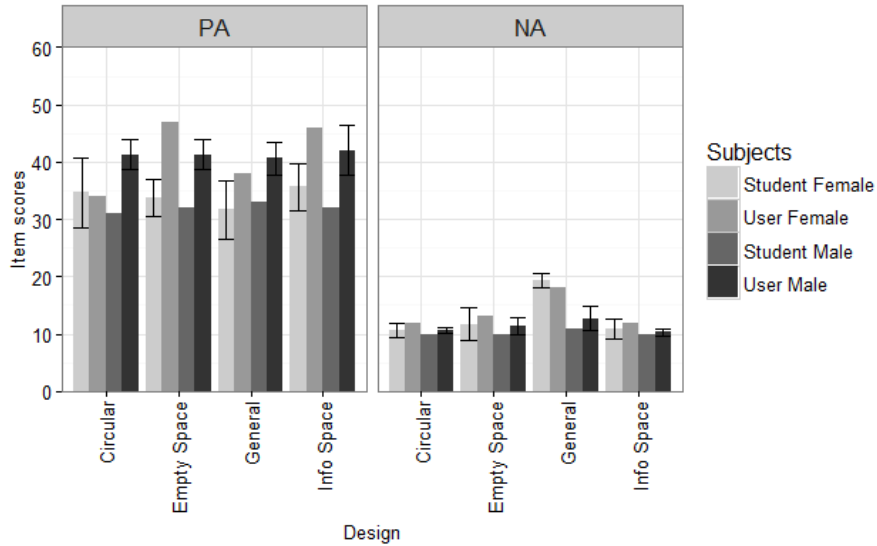Additionally, Engelen et al. showed males scoring significantly lower on

Figure 14: Means and standard deviations per PANAS scale per design, calculated from the values seen in Figure 13.

the NA scale and significantly higher on the PA scale. Visual Navigation did not have the same effect on users, showing no significant difference between males and females. The base measurement, however, reflected this significant difference which between males and females ($p-value = 0.01868$). Furthermore, Dunn's post hoc rank sum comparison showed this to be in agreement with Engelen et al., thus male NA scores being significantly lower than female NA scores. Further inspection of the scales on item level, showed no significant difference between males and females with respect to the Negative Affect scale for any of the designs. However, in the general measurement, males scored lower on the *jittery* ($p = 0.03247$), *nervous* ($p = 0.02465$) and *irritable* ($p = 0.0455$) NA-items. Following from the Dunn's post hoc rank sum comparison, only the gender differences on the jittery and nervous items were significant. The difference between males and females on the irritable scale were insignificant. Furthermore, males did not score significantly different, on any of the positive items, from females.

Results showed all - but one - users scored a higher, or equal, PA score on the Information space design than in general. This difference was, however, insignificant. Additionally, all, except two users, scored higher on the PA scale after the Empty Space design was assessed, than on general. Again, this difference was not significant at the 0.05 confidence level. Three users had a lower score on the PA scale, after they browsed the Circular design, than in general. Five users noted an higher PA score when assessing their emotions regarding the Circular design. Similarly to the other two designs, the Circular design did

not have a statistically significant influence on the users, neither positive nor negative. No significant difference between the designs with respect to the PA scale was observed. However, on average the Information Space design scored highest on the PA scale which had a score of 38.875. In compliance with the PANAS scale, it was also the best liked design, seven out of eight subjects chose the Information Space design over the other two.

On average, each design resulted in lower NA scores, indicating that users became more calm and serene after using Visual Navigation. One user, however, scored higher on the NA scale measurement for the Empty Space design. This value is considered to be an outlier since the user filled out the questionnaire too fast, and likely made a mistake. Furthermore, this user scored all items equally across all designs, and even scored all items equally to the general measurement, except for *ashamed*. Therefore, the user's score was left out, which led to all users scoring lower on the NA scales for each design. These differences were not significant though. Additionally, as with the PA scale, discussed above, no significant difference was found between designs.

The individual items of the PANAS questionnaire, showed results similar to the PA and NA scores. None of the PA-items scored significantly better than the base measurement. This is in compliance with the total score, i.e. the PA value. Thus, no individual item of the PANAS questionnaire scored significantly different from the general measurement. As expected from the NA scale not being significantly different, none of the individual items showed a significant difference compared to the general measurement.

In addition to the Positive and Negative Affect scales, comments and footage have been analyzed. The most important aspect was the fact that users missed the *blink* (tutorial) that explained the clickability of actors. Eventually, users always noticed the blink, albeit after two to three blinks. That is, before users noticed the tutorial, which fires when the Detail space is entered, or when the movie poster is clicked on a non-clickable area, it had to be shown two to three times. Furthermore, after users clicked a related movie, the related Poster space was visited, therefore, no information about the movie was shown. However, user unanimously expressed preference of visiting the Detail space rather than the Poster space after a related movie click. In addition, the i-button was used only half as much as the number of visited movies, suggesting it was not visible enough. Moreover, the previous movie button was overlooked as well, as suggested by the rare usage. It was only used three times on average, where 16 related movies were visited on average. Furthermore, text clickability, although clearly desired, as was evident from the results of the user test done by a fellow student, was not used that often. On average, the faces were clicked $3, 5$ times more often than the text.

4.3.7 Discussion

As proposed earlier in Section 1.1, the research questions are shown below.

RQ 1 How does the related items arrangement influence the perceived perfor-

mance?

RQ 2 How does the related items arrangement influence the emotional state of
users?

Results from the experiment showed that the influence of the ordering of
related movies on the emotional state of the users (and students) was limited.
Even though the subjects all had equal or slightly higher scores on the PA scale,
and equal or lower scores on the NA scale, the results were not significant, indi-
cating that the related movie placement only slightly influenced the emotional
state. Additionally, although the influence of Visual Navigation on the emo-
tional state is not significant, users became positively affected. This lead to the
conclusion that users were, in general, slightly, albeit not significantly, influ-
enced by Visual Navigation. However, this promising influence might be shown
to be significant with increased sample size.

The perceived performance, was more positively influenced for the Empty
and Information Space designs as opposed to the Circular design. Users ex-
pressed the feeling that they had more data at their disposal when browsing the
database using the Empty and Information Space designs. The biggest influence
here is the difference in the amount of visible related movies at a time. In the
Circular design, at most eight related movies are visible, whereas for the other
two designs 16 movies can be shown at any given time. Users, however, never
expressed the feeling of missing information, other than information about the
actor - which is outside the scope of this work - or the movie itself, which will
be addressed later. Thus, users always had the idea they could reach all movies
available in the database from a given actor.

The perceived performance of the Circular design was lowered because of
the extra operation necessary to inspect all related movies. This extra interac-
tion lowered the sense of control, leading to conclude that the Information and
Empty Space designs had the best perceived performance. In addition, subjects
complained about the Empty Space design separating the related movies in two
different grids. As been hypothesized in Section 4.3.2, users felt the competition
for attention between the two grids of related movies. Therefore, the Informa-
tion Space design, which showed the related movies in one grid, was perceived
to be easiest to perform with. In addition, it was also chosen by seven out of
the eight users to be most appealing. Therefore, the Information Space design
most positively influenced the perceived performance.

Additionally, in Section 1.1, more informal questions were asked, which will be
answered here.

1. Do users understand Visual Navigation?

2. Do users like Visual Navigation?

3. Can users handle Visual Navigation?

4. Do users use Visual Navigation?

These questions are more general, and allow to get more insight in the users' behavior using Visual Navigation. Due to the vague explanation of the new navigation method (cf. Appendix C), it could be determined if users understood Visual Navigation. The first run of the experiment was therefore doubled in time, allowing users to discover all possible actions of Visual Navigation. Furthermore, if not all operations were discovered, subjects could be encouraged to execute the missed actions. Some subjects were encouraged to execute certain actions to discover all functionalities of Visual Navigation. However, only one subject needed intervention to explain the basic functionalities of Visual Navigation. This user however, never used a tablet before and was therefore instructed on the basic functionalities of a tablet as well. Thus, seven out of eight users understood the clickability of the posters of Visual Navigation. Therefore, it can be concluded that the concept of Visual Navigation was understood by users.

In addition, assessed was if users were able to handle Visual Navigation, namely, if they understood the concept of related movies, and were able to cope with the visual load of the application. Therefore, if users did not express it themselves, they were asked what they observed when related movies were shown on screen. All users expressed the other movie posters to be movies featuring the clicked actor. The related movies, as explained in Section 3.3, indeed show other movies featuring the clicked actor, leading to the believe that they understood the concept of related movies. Note, the movies were not actually called *related movies* in any of the screens of the application or questions asked by the interviewer. Additionally, as hypothesized in Section 4.3.2, the visual load of Visual Navigation was perceived as pleasant by users. That is, users expressed being pleased when the screen estate was filled with related movies. Furthermore, subjects suggested to increase the visual load at some points. For example, when the database was browsed using the Information Space design, and the clicked actor featured in four or five movies, users were expecting more related movies to be shown at once. However, this was not expressed with respect to filling the screen estate, but rather because subjects were aware of the actor playing in more movies than available in the demo application. Expecting more related movies, however, indicated a possible increase of the number of shown related movies at once. Therefore, the visual load of Visual Navigation was sufficiently low, and could even be increased at some points, leading to the conclusion that the subjects were able to handle Visual Navigation. Furthermore, if the poster was clicked anywhere but on a face, the information was dismissed and no related movies were shown. Subjects expressed that the unused screen estate needed to be filled with either movie information, thus staying in the Detail space, or related movies, which is not possible because no actor was clicked. This was solved in the second design iteration of Visual Navigation, since it remained in the Detail space when no actor was clicked.

Moreover, subjects unanimously expressed they would use Visual Navigation when fully implemented in a large movie database. Partially due to the

fact that the idea of Visual Navigation is new and intriguing to users and, partly, because it could be a usable addition to the normal search behavior of the users, i.e. looking at suggested movies or browsing through a database to find a movie to watch. Therefore, it can be concluded that users like using Visual Navigation as well. In addition, the last question, *"Do users use Visual Navigation?"*, was answered positively by all users except one. The negative responder, doubted between Visual Navigation being a gimmick that would be used often in the beginning, or the need of adjusting to the idea with increasing use during the process. Therefore, it can be concluded that all subjects would use Visual Navigation when implemented, at least in the beginning, as a gimmick. However, long term usage of Visual Navigation cannot be assumed, since users might just like it and use it at first, but later stop using it because it is more time consuming than Visual Browsing, albeit with a different goal.

Results from the first experiment allow to conclude that the related movie placement does not significantly influence the users' emotional state. The related movie placement, however, does influence the perceived performance, that is users perceived more related movies to be available in the Empty and Information Space designs, while the amount of available related movies was equal for all designs. In addition, users expressed their preference of the Information Space design, which was also visible in the PANAS scores given to the designs. However, this design is preferred over the Circular design, partly, due to users habituation to grid based designs, and partly because the Information Space design closely resembles the design from other parts of the Videoland application. However, since the concept of Visual Navigation is a new method of browsing a movie database, the design should convey this. In addition, the Circular design adapted the idea of a separate Poster space better than the other two designs did, which was the main idea of Visual Navigation. Therefore, the Circular design was chosen to be altered according to the comments made by users, and to feature in the next experiment (cf. Section 4.4).

4.4   Experiment 2

This experiment, where different design options for the information display were incorporated, builds on the results of the first experiment. Results from the first experiment showed that subjects unanimously wanted to see information about a movie as soon as they visited it, which was not the case in the first iteration of the design (cf. Sections 4.3.6 and 4.3.7). Therefore, three different design options (see Section 3.4) of showing the movie information are assessed in this experiment. As opposed to the first experiment, this experiment was first administered among students. The students came from different study programs. Additionally, members from the Videoland user panel were contacted with an inquiry to participate in the user study.

4.4.1 Purpose & Task

Where the first experiment featured three different designs for the placement of the related movies, this experiment solely features the Circular design option (reasoning can be found in Section 4.3.7). Additionally, the three different placements of information were assessed on their usefulness. The purpose of this experiment is to determine if Visual Navigation is of additional value to the currently used Visual Browsing navigation in the Videoland application for finding beforehand unknown movies. It is assessed if users are satisfied using Visual Navigation and are able to discover new movies with it. Furthermore, users were directly asked if and why they would use Visual Navigation. The usefulness for finding beforehand unknown movies of Visual Navigation can be established in this way. Additionally, the usefulness is assessed using an administration of the System Usability Scale (Section 2.4) and subjects' subjective expressions during the experiment. Furthermore, the PANAS questionnaire (Section 2.3) is administered to assess the emotions of users regarding Visual Navigation. Both measurements are used to quantify if Visual Navigation is usable as a method of discovering new content to watch.

Since the main use case of Visual Navigation is the discovery of beforehand unknown content to watch, users are once again asked to browse the demo application with no particular goal in mind. This task, a replication of an undirected search, simulates the action users execute if they are uncertain of what to watch. Leaving out an option to search, further encourages users to use Visual Navigation as intended, allowing for an assessment of the intended use. Furthermore, it can be evaluated if users actually use Visual Navigation, when given the option.

4.4.2 Hypotheses

From the three designs the Shrink/Enlarge design showed, together with the Information Bar design, the smallest amount of information at the start. However, the Information bar, which is more stretched out and partly covering the movie poster, can be perceived as occluding. Since the Shrink/Enlarge design does not cover the poster, it is hypothesized to be preferred over the Information Bar design. However, as was evident from the first experiment, users needed instructions to call back the movie information. In both designs, this still requires an action, which might not be clear enough. The Persistent Information design might therefore, be preferred over the other two, since it always shows all information of a movie, eliminating the need for interaction to read the information about the currently visited movie. However, since the Persistent Information Design always shows information about the currently visited movie, it can be perceived as invasive. Partly, because users are browsing the Poster space rather than the Detail space, leading to the believe that they are not interested in the synopsis at that point. Persistently showing the information might create a competition for attention, which might increase the visual load.

Additionally, it is hypothesized that users are likely to use Visual Navigation, once it is available, to browse for an unknown movie. That is, users that are uncertain of what to watch might be likely to use Visual Navigation from any starting point. A starting point can be either a queried movie, the home screen or a detail page. From there, users can find movies related to actors they like easier than having to query actors they find each time. Therefore, it is hypothesized that Visual Navigation is of additional value when users are uncertain of what to watch. Furthermore, answers on the questionnaires from the first experiment suggest users are likely to use Visual Navigation. Additionally, the influence of Visual Navigation on the users' emotional state is expected to be positive.

4.4.3 Procedure

The experiment was executed according to the following procedure, where users were encouraged to vent their opinion as much as possible. First, the subjects (see Section 4.3.4) were instructed about the experiment (*cf. Appendix C*). As opposed to the first experiment, users were explained what kind of interactions are possible when using Visual Navigation, i.e. clicking on actors' faces, text elements etc. Due to the fact that the results from the first experiment already showed users understood the concept of Visual Navigation. Demographics were established, whereafter the users were asked to fill out a *PANAS questionnaire* with the "in general" time instruction. This was used as a base measurement to compare the emotions regarding Visual Navigation with. Once these steps were taken, the users were asked to browse the database (Section 4.1). The users were exposed to three different designs as shown in Section 3.4, balanced using a Latin-square design, to expose each user to each design. After each design, users were asked to fill out another *PANAS questionnaire* with the instruction to assess their feelings at the current moment, these were compared to the earlier obtained base measurement. In this way, the emotions regarding Visual Navigation could be assessed.

Similar to the first experiment, users were asked to browse the database for four minutes the first time, in order to explore the functionalities of Visual Navigation. Additionally, if users still needed guidance, they were given prompts to provoke actions. Again, the second and third run consisted of a browsing task for two minutes to prevent boredom.

After the three runs, users were asked to fill out the SUS questionnaire to assess the performance of the application in general. That is, they take the three designs and rate the application based on the usability of Visual Navigation rather than on the design of it. Additionally, a final interview was conducted to determine the preference regarding the designs.

4.4.4 Demographics

As opposed to the first experiment, this experiment was first administered to students. Nine students participated, six of them male and three females. The

average age was 22,78 with a standard deviation of 2,1. All except two were Master Students, divided over *Game and Media Technology* (3x), *Master Business Informatics* (3x) and *Game Studies* (1x), the other two subjects were *Communication and Multimedia Design* and *Computing Science* Bachelor students.

Additionally, once again the Videoland test panel was consulted, it consisted of 483 members of which 10 agreed to participate in the experiment. Out of these 10 people one person already participated in the first experiment and was excluded for this experiment. Additionally, one person replied after the deadline, and was therefore not taken into account. So, in total eight people were invited to participate in the experiment. However, from these eight people only two showed up, they were both male, aged 51 and 62, respectively. All participants were experienced tablet users.

In total 11 people participated in the test, allowing for 4 replicates for the first two options of the experiment, and 3 replicates for the last option. Since an equal number of replicates would be ideal, at least 15 or 18 participants would be better. This was the intended amount of participants, cf. 8 members from the Videoland test panel got invited, but only 2 showed up. In addition, increasing the amount of users to more than five per option of the Latin-Square, would not significantly improve the findings ([25]).

4.4.5 Material & Location

This experiment was executed at different locations. That is, seven out of nine students participated in the experiment at the Utrecht University. The other two tests were administered at Triple headquarters. Furthermore, the Videoland test panel members were invited to Videoland headquarters and interviewed in the user testing room. The experiment was executed on the same hardware as the first experiment, namely a Samsung Galaxy TabPRO 8.4. The tablet was equipped with a Qualcomm Snapdragon 800 processor running at 2,3 Ghz, 2 GB of memory and resolution of $2560x1600$.

4.4.6 Results

The results obtained from the experiment, described in the previous sections, are elaborated here. To determine normality of the data, an exploratory analysis was executed. The analysis, again, showed the data, except for the PA scale, to be not normally distributed. Therefore, non-parametric tests were used, i.e. the Friedman's ANOVA and the Kruskal-Wallis test.

As with the first experiment, the subjects - 11 in total - were grouped based on several different characteristics. First, the difference between students and users was analyzed (cf. Figures 15 and 16). Recall that Engelen et al. showed students to score significantly lower on PA and higher on the NA scale than people who were not students. Therefore, Kruskal-Wallis tests were executed to detect any significant differences within the emotional state of students and
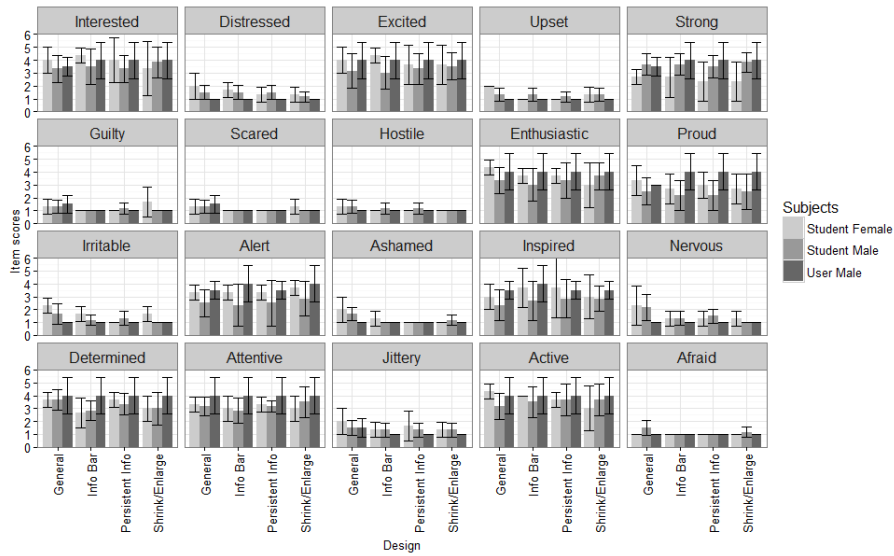
Figure 15: Means and standard deviations of the PANAS items. Scores are shown for each design, additionally a base line is shown, which is the general measurement. Three groups are female students (3x), male students (6x) and male users (2x)

non student users. However, there were no significant differences with respect to the emotional state of student and non student users at the 0.05 confidence level.

Additionally, the group was split based on gender, that is, three females and eight males. Kruskal-Wallis tests were executed to find a significant difference between male and female users with respect to the emotion scales. The analysis showed two differences to be significant, i.e. the difference between *irritable* within the Shrink/Enlarge design and *upset* in the general measurement. Dunn's post hoc test showed, however, the effect size to be too small for these to be accepted as significant. Therefore, no significant differences were found between male and female users.

Furthermore, unlike the first experiment, users did not became more positive affected by Visual Navigation. On average the Shrink/Enlarge design and the general measurement scored highest on the PA scale (33.6). For the Persistent Information and Information Bar design the PA values were lower on average being 33.5 and 32.7, respectively. Not surprisingly these differences were not significant. Whereas the PA scale scores basically did not change at all, the NA scale showed a more prominent difference. That is, for each design the NA scale lowered nearly four points on average. More precisely, the general NA was 15.72 on average whereas on average the NA scores for the designs were 11.45 (Shrink/Enlarge design), 11.63 (Information Bar design) and 11.54 (Persistent
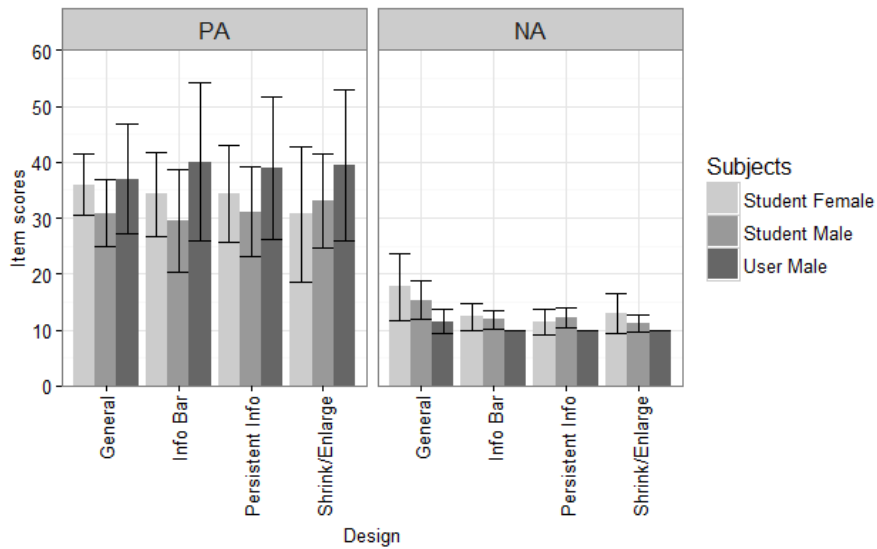
Figure 16: Means and standard deviations per PANAS scale per design, calculated from the values seen in Figure 15.

Information design). However, a post-hoc test (Friedman ANOVA), showed all these differences to be not significant either. Thus, no significant difference was observed between the PA and NA scales of the designs compared to the general measurement. Additionally, no differences were observed within the designs either.

Lastly, all individual questionnaire items were examined, by applying the Friedman's ANOVA. After the Friedman's ANOVA, the data was corrected for multiple comparisons using Friedman's multiple comparisons test. In this way, all PA and NA items for each design were examined. However, after a closer examination, no meaningful pairs - i.e. pairs that belong to each other - were found to differ significant. Thus, no significance was found for the PANAS scales in the second experiment.

In addition to the PANAS questionnaire, the System Usability Scale questionnaire was conducted. Exploratory analysis again showed the data to be not normally distributed. The data, however, showed an average total score of 77.3 (cf. Figures 17 and 18) on a scale from 0 to 100. According to Bangor et al. [24] Visual Navigation scored within the acceptable area of the acceptability range. Furthermore, with an average score of 77.3 it scored within the area of good to excellent. In addition to the usability score being high, 10 out of the 11 participants would use the functionality without a doubt. Furthermore, the last participant would probably use Visual Navigation.

The users had some negative comments, but these were related to the amount of information given, i.e. users wanted more information about actors. In ad-
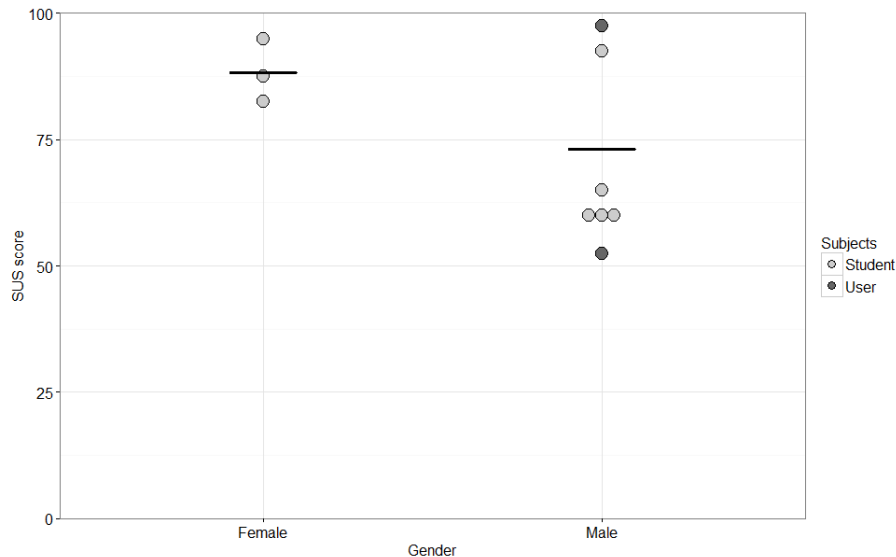
Figure 17: Total System Usability Scale scores per user group and gender, calculated from the individual item scores of the SUS questionnaire, see Figure 18.

dition, some users found the Persistent Information and Information Bar too much, meaning they saw the movie information at two different places, which confused them. Furthermore, the Shrink/Enlarge design was most often chosen to be the most appealing design. However, the other two designs were chosen only two times less to be most appealing. Additionally, the Persistent Information and Information Bar designs were chosen only one time more often as being the least pleasant designs (both were chosen 4 times). As a preliminary result, the choice of a separation of the Detail and Poster space (i.e. the Shrink/Enlarge design), as was part of the original idea of Visual Navigation, is preferred by the subjects. However, the number of times this design was chosen over the other designs is too small to conclude this design to be most useful. Future work should therefore, involve assessing the designs using a larger sample. Users only traversed the database very shallowly on average, that is on average users navigated 3.3 layers deep. The average number of visited movies during the test was 12.18 and the average number of related movies clicked was 15.63. Thus, on average users clicked a related movie more often than they clicked a movie from the Overview space. However, according to Kolmogorov-Smirnov test, this difference was not significant ($p = 0.461$).

4.4.7 Discussion

The second experiment was executed to answer the other research questions as proposed in Section 1.1.

RQ 3 Is Visual Navigation a usable navigation technique to find beforehand unknown movies?

RQ 4 How does Visual Navigation influence the emotional state of users?

RQ 5 Is Visual Navigation a good addition to Visual Browsing when users are uncertain what to watch?

RQ 4 is an expansion of **RQ 2** from experiment 1. That is, in experiment 1 the focus lies on the separate designs that might influence the users' emotional state. In experiment 2, however, the focus lies on the influence of Visual Navigation on the users' emotional state. Nonetheless, to fully answer the question, first, each design has to be compared to the general measurement. As shown in Sections 4.3.6 and 4.4.6 none of the PA and NA scores differed significantly from the general measurement for any of the designs. This leads to the believe that Visual Navigation does not significantly influence the emotional state of users. However, for all but the Information Bar design the PA values were higher than the general measurement. Furthermore, for all designs the NA scores were lower than the base measurement. This showed that the users were positively influenced by the designs. However, due to the fact that it is not statistically significant this result is not conclusive. The influence of Visual Navigation on the emotional state can be considered a preliminary, but promising, result. Therefore, executing the experiment with an increased amount of participants might prove a statistically significant influence of Visual Navigation on the users' emotional state.

Visual Navigation was rated on the System Usability Scale (see Section 4.4.6), results ranged from a good to excellent (cf. [24]) score. The average score of 77.3 does not guarantee that Visual Navigation is usable for all users. However, as has been observed from the results of the first experiment, and additionally from the results of this experiment, all users would use Visual Navigation to discover a movie to watch. Together with the SUS score, this indicates that the usability of Visual Navigation is good. Moreover, six people explicitly mentioned they would use it for the specified use case, i.e. using Visual Navigation to find a beforehand unknown movie to watch. These reasons lead to the conclusion that Visual Navigation is a useful navigation technique to find beforehand unknown movies.

The last research question (**RQ 5** *Is Visual Navigation a good addition to Visual Browsing when users are uncertain what to watch?*), can be answered with the help of the previously answered questions. That is, users were able to understand and use Visual Navigation, which was evident from both experiments (cf. Sections 4.3.6 and 4.4.6). Furthermore, the results showed that users gave Visual Navigation a high SUS score, showing that Visual Navigation is a useful browsing method. Therefore, results showed Visual Navigation to be a favorable technique for discovering new content. The usefulness of Visual Navigation as a navigation technique for finding predefined content is limited though.

Beforehand known content is often found more easily using a search function, by browsing the database or by selecting a movie from the recommended movies. These functionalities allow users to start watching the intended, and beforehand known, content much faster. However, when users are uncertain of what to watch, both functionalities restrict the user in navigating the database. That is, searching for a specific movie result in the specific movie and possibly related movies. For example, if users search for an action movie, the resulting movies are most likely to be the searched title, maybe completed with other action movies. This limits the amount of currently available titles. Furthermore, navigating from action movies to a different genre is impossible without querying the database with another search term. Additionally, users can search by actor, allowing them to view all movies featuring a given actor. Again, this limits the view a user has of the database by only showing movies of the queried actor. If another actor is desired, a new query has to be executed, a different way of acquiring all movies of another actor is not possible. Visual Navigation does not restrict users to a certain actor or genre and allows them to traverse the entire database. Therefore, it can be concluded that Visual Navigation is a more useful technique for discovering new content than searching a database.

Recently watched content is limited per default. However, by watching something previously watched (a movie) or following a series, the choice is made to limit the view of the database. In addition to a recently watched list, movie databases often feature a suggested content section for recurrent users. Similar to querying the database using a search function, suggested content is limiting when users are looking for new content. For example, if users tend to watch action movies, the suggested content often includes a higher percentage of action movies, limiting the user in discovering new content. Furthermore, an preferred actor from a certain drama movie, might not be featured in other drama movies, and is thus not suggested to the user. In addition, the newly suggested content is always similar to previously watched content because of the way these suggestions are being calculated. Therefore, to discover new content Visual Navigation is a more useful technique than the suggested content list.

Visual Browsing, additionally, revolves around discovering content of a database by browsing through it. This way of browsing gives the user a sense of their 'position' in the database, by arranging the movies based on genre. However, the chosen categories limit the overview of the database. Furthermore, these categories do not necessarily cover all available genres, leaving out some genres users might want to watch. In addition, users can only browse the database following the 'direction' the application gives, i.e. users are able to browse the data given by the application but are not able to follow their own path inside the data, lowering the control users have over the application. Visual Navigation gives users total control of the path they choose to follow through the database. That is, users can click any actor on any movie to see other movies they feature in. These movies can be visited if desired. Therefore, it can be concluded that, for the use case for which Visual Navigation is devised, i.e. *finding a beforehand unknown movie to watch*, the navigation technique is a more useful method than Visual Browsing. However, using Visual Navigation as a standalone navigation

technique limits the user in finding predefined movies. Therefore, to fully discover a movie database, adding Visual Navigation to a currently implemented version of Visual Browsing is ideal.

5 Conclusion and Future work

In this work Visual Navigation is proposed. Unexpectedly, results showed Visual Navigation to have a small positive influence on the users' emotional state. Furthermore, the two executed experiments showed Visual Navigation to be of additional value for users that are uncertain what to watch. On average, Visual Navigation scored 77.3 out of 100 on the System Usability Scale [2]. Moreover, a preliminary design option is devised in the form of the Shrink/Enlarge design option as discussed in Section 3.4. However, to decide on the optimal design for Visual Navigation, the last experiment has to be administered again to more people. Future work would therefore include further assessment of the design of Visual Navigation.

To further increase the usability of Visual Navigation, the amount of clickable objects has to increase. Whereas only actors can be clicked right now, it would be interesting to see the effect of other items on the posters being clickable. An example could be clicking the Empire state building, which shows other movies situated in New York. Furthermore, including Optical Character Recognition to find interesting text on the movies posters, e.g. the title, featuring actors or the working director, could be a good addition as well. This addition increases the amount of outgoing navigational paths from each movie poster, allowing users to browse the database while interacting with even more data on the movie posters. Furthermore, this enables selection of related movies based on, for example, producing studio or director. However, increasing the amount of clickable items, might lead to choice overload, which should be assessed with an experiment. Assessed should be if users are able to browse a database when exposed to many outgoing navigational paths. A possible implementation of such an experiment could be a directed browsing task. That is, subjects are asked to execute certain task while browsing the database.

Furthermore, it would be interesting to expose a larger audience to the navigation technique. Visual Navigation has been assessed by a diverse set of users from the target audience group already, however, it would be interesting to increase the amount of test subjects. Increasing the amount of subjects, increases the amount of data, which in turn could lead to a more convincing result of the influence of Visual Navigation on users' emotional state. In addition to magnifying the tests, it would be interesting to include a different user group, i.e. children. Some work has been done in creating navigational methods just for children, e.g. [6], which involves a simple visually oriented interface. Visual Navigation is a visually oriented navigation method as well, which might allow children to more quickly find what they want to watch. This can be assessed by exposing children to Visual Navigation. The experiment that should be conducted to do so, should encourage children to browse the movie database to their interest, showing their understanding of and attitude towards Visual Navigation.

In addition, the current database has been checked by hand, which is a te-

dious task, especially for (large) databases which often change or replace their content. Therefore, face detection and recognition should be automatized up to an allowable error margin, which does not have to be 0%, but should be sufficiently low for it to be useful. In addition, a user base might be utilized to complete the missing data, i.e. annotating the posters with the relevant data. This might eliminate the need for automatic face detection and recognition and optical character recognition. An example of using the public to annotate data is the Google image labeler game, which turned labeling the images found on Google into a game. However, since the user group using video browsing applications are often interested in improving it, hence the 483 users that are a member of the Videoland test panel, the gamification might not be necessary. Users might be asked to label the faces on poster, and when the majority agrees on a name, it can be chosen. This way the data can be checked easily and the need for automatized face detection and recognition might be eliminated.

Acknowledgments

A Positive and Negative Affect Schedule

The Positive and Negative Affect Schedule, proposed by David Watson, Lee Anna Clark and Auke Tellegen [1], Dutch translation is done by Engelen et al. [26] among others.

Deze vragenlijst bestaat uit een aantal woorden die verschillende gevoelens en emoties beschrijven. Duid bij elk woord aan in welke mate u zich **{op dit moment/vandaag/gedurende de voorbije dagen/gedurende de voorbije week/gedurende de voorbije weken/gedurende het voorbije jaar/over het algemeen}** zo voelt. Lees elk woord en omcirkel daarnaast uw antwoord. Maak hierbij gebruik van de volgende schaal:

		1 Heel weinig	2 Een beetje	3 Matig	4 Veel	5 Heel veel
1.	Geïnteresseerd	1	2	3	4	5
2.	Bedroefd	1	2	3	4	5
3.	Opgewekt	1	2	3	4	5
4.	Terneergeslagen	1	2	3	4	5
5.	Sterk	1	2	3	4	5
6.	Schuldig	1	2	3	4	5
7.	Angstig	1	2	3	4	5
8.	Vijandig	1	2	3	4	5
9.	Enthousiast	1	2	3	4	5
10.	Zelfverzekerd	1	2	3	4	5
11.	Vlug geïrriteerd	1	2	3	4	5
12.	Alert	1	2	3	4	5
13.	Beschaamd	1	2	3	4	5
14.	Vol inspiratie	1	2	3	4	5
15.	Gespannen	1	2	3	4	5
16.	Vastberaden	1	2	3	4	5
17.	Aandachtig	1	2	3	4	5
18.	Zenuwachtig	1	2	3	4	5
19.	Energiek	1	2	3	4	5
20.	Bang	1	2	3	4	5

Table 2: Positive and Negative Affect Schedule, dutch translation by Engelen et al. [26]

B   System Usability Scale

System Usability Scales (SUS) are shown below (Tables 3 and 4) [2]. Since test subjects from Videoland are all Dutch native speakers they are asked to fill out the Dutch version of the questionnaire as seen in *Table 3*. Students, that participated in the experiment followed education in English, additionally some were not Dutch native speakers. Therefore, they were asked to fill out the original English version of the SUS questionnaire *Table 4*.

	Sterk mee oneens 1	2	3	4	Sterk mee eens 5
1. Ik denk dat ik dit systeem graag regelmatig wil gebruiken					
2. Ik vond het systeem onnodig complex					
3. Ik vond het systeem makkelijk te gebruiken					
4. Ik denk dat ik ondersteuning nodig heb van een technisch persoon om dit systeem te kunnen gebruiken					
5. Ik vond dat de verschillende functies in dit systeem erg goed geïntegreerd zijn					
6. Ik vond dat er teveel tegenstrijdigheden in het systeem zaten					
7. Ik kan me voorstellen dat de meeste mensen zeer snel leren om dit systeem te gebruiken					
8. Ik vond het systeem erg omslachtig in gebruik					
9. Ik voelde me erg vertrouwd met het systeem					
10. Ik moest erg veel leren voordat ik aan de gang kon gaan met dit systeem					

Table 3: *System Usability Scale Dutch translation, source: [27]*

|	Strongly disagree 1	2	3	4	Strongly agree 5
1. I think that I would like to use this system frequently					
2. I found the system unnecessarily complex					
3. I thought the system was easy to use					
4. I think that I would need the support of a technical person to be able to use this system					
5. I found the various functions in this system were well integrated					
6. I thought there was too much inconsistency in this system					
7. I would imagine that most people would learn to use this system very quickly					
8. I found the system very cumbersome to use					
9. I felt very confident using the system					
10. I needed to learn a lot of things before I could get going with this system					

Table 4: System Usability Scale, source: [2]
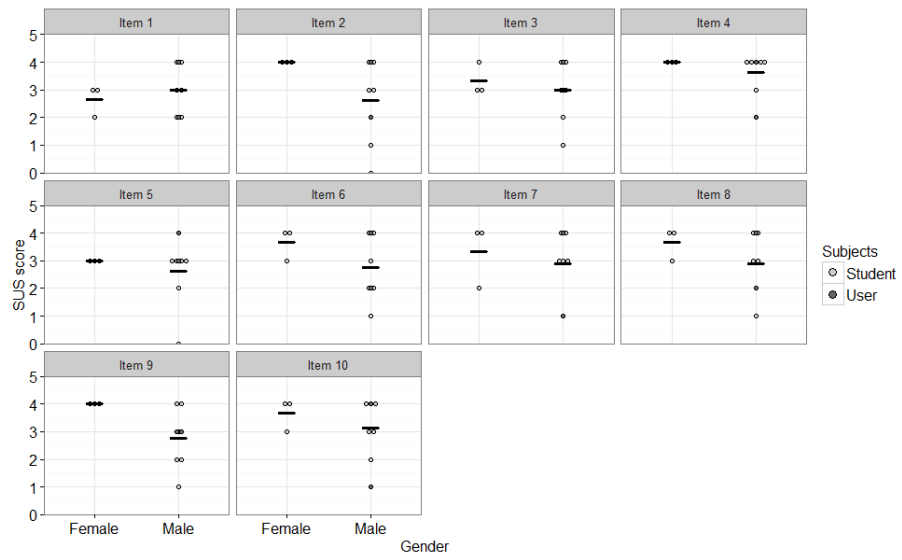
Figure 18: Scores of individual SUS items per group, results of experiment 2.

C   Experiment accompanying texts

Users are instructed the following before the first experiment. Instructions are Dutch, since users are native speakers.

> *We hebben een nieuwe manier om films te vinden gemaakt, er zijn er op het moment drie verschillende versies van. En deze willen we graag met u doorlopen. We gaan dan kijken welk versie u het fijnst en makkelijkst kunt gebruiken. U kunt altijd vragen stellen, en het zou fijn zijn als u zoveel mogelijk hardop denkt. Uiteraard is uw privacy gewaarborgd en zullen alle antwoorden anoniem worden behandeld. We gaan de toepassing testen en niet u, dus voelt u niet bezwaard. Voelt u ook niet bezwaard uw oprechte mening te geven, hier hebben we namelijk het meest aan.*

For the second experiment, users are instructed basically the same, however, they are explicitly instructed to click actors on the poster. Instructions are again in Dutch, and are given in English to users who are not fluent.

> *We hebben een nieuwe manier om films te vinden gemaakt. Dit houdt in dat u de op acteurs op de posters kunt klikken om door de films te bladeren. We hebben hier een demo van met drie designs en die willen we graag met u doorlopen. We gaan kijken of u het leuk vindt en of het werkbaar is. U kunt altijd vragen stellen, en het zou fijn zijn als u zoveel mogelijk hardop denkt. Uiteraard is uw privacy gewaarborgd en zullen alle antwoorden anoniem worden behandeld. We gaan de toepassing testen en niet u, dus voelt u niet bezwaard. Voelt u ook niet bezwaard uw oprechte mening te geven, hier hebben we namelijk het meest aan.*

References

[1] D. Watson, L. A. Clark, and A. Tellegen, "Development and validation of brief measures of positive and negative affect: the panas scales.," *Journal of personality and social psychology*, vol. 54, no. 6, p. 1063, 1988. (cited on pages 3 and 51.)

[2] J. Brooke *et al.*, "Sus-a quick and dirty usability scale," *Usability evaluation in industry*, vol. 189, no. 194, pp. 4–7, 1996. (cited on pages 3, 13, 48, 52 and 53.)

[3] K. Schoeffmann, M. A. Hudelist, and J. Huber, "Video interaction tools: A survey of recent work," *ACM Comput. Surv.*, vol. 48, pp. 14:1–14:34, Sept. 2015. (cited on page 9.)

[4] W. Hürst and P. Jarvers, "Interactive, dynamic video browsing with the zoomslider interface," in *Multimedia and Expo, 2005. ICME 2005. IEEE International Conference on*, pp. 4–pp, IEEE, 2005. (cited on page 9.)

[5] K. Wittenburg, C. Forlines, T. Lanning, A. Esenther, S. Harada, and T. Miyachi, "Rapid serial visual presentation techniques for consumer digital video devices," in *Proceedings of the 16th annual ACM symposium on User interface software and technology*, pp. 115–124, ACM, 2003. (cited on page 9.)

[6] L. Azzopardi, D. Dowie, and K. A. Marshall, "Yoosee: A video browsing application for young children," in *Proceedings of the 35th International ACM SIGIR Conference on Research and Development in Information Retrieval*, SIGIR '12, (New York, NY, USA), pp. 1017–1017, ACM, 2012. (cited on pages 10 and 48.)

[7] K. U. Barthel, N. Hezel, and R. Mackowiak, *Graph-Based Browsing for Large Video Collections*, pp. 237–242. Cham: Springer International Publishing, 2015. (cited on page 10.)

[8] W. Hürst, R. van de Werken, and M. Hoet, *A Storyboard-Based Interface for Mobile Video Browsing*, pp. 261–265. Cham: Springer International Publishing, 2015. (cited on page 10.)

[9] J. Lokoč, A. Blažek, and T. Skopal, *Signature-Based Video Browser*, pp. 415–418. Cham: Springer International Publishing, 2014. (cited on page 10.)

[10] A. Mehrabian and J. A. Russell, *An approach to environmental psychology.* the MIT Press, 1974. (cited on page 11.)

[11] M. Hassenzahl, A. Beu, and M. Burmester, "Engineering joy," *IEEE Softw.*, vol. 18, pp. 70–76, Jan. 2001. (cited on page 11.)

[12] G. A. Kelly, *The psychology of personal constructs. Volume 1: A theory of personality.* WW Norton and Company, 1955. (cited on page 11.)

[13] P. J. Lang, "Behavioral treatment and bio-behavioral assessment: Computer applications," *Technology in Mental Health Care Delivery Systems*, pp. 119–137, 1980. (cited on page 11.)

[14] R. L. Hodes, E. W. Cook, and P. J. Lang, "Individual differences in autonomic response: Conditioned association or conditioned fear?," *Psychophysiology*, vol. 22, no. 5, pp. 545–560, 1985. (cited on page 11.)

[15] M. M. Bradley and P. J. Lang, "Measuring emotion: The self-assessment manikin and the semantic differential," *Journal of Behavior Therapy and Experimental Psychiatry*, vol. 25, no. 1, pp. 49 – 59, 1994. (cited on page 11.)

[16] D. Watson, L. A. Clark, and A. Tellegen, "Development and validation of brief measures of positive and negative affect: the panas scales," *Journal of Personality and Social Psychology*, vol. 54, pp. 1063–1070, 1988. (cited on page 12.)

[17] D. Watson and A. Tellegen, "Toward a consensual structure of mood.," *Psychological bulletin*, vol. 98, no. 2, p. 219, 1985. (cited on page 12.)

[18] U. Engelen, S. D. Peuter, A. Victoir, I. V. Diest, and O. Van den Bergh, "Verdere validering van de positive and negative affect schedule (panas) en vergelijking van twee nederlandstalige versies," *gedrag en gezondheid*, vol. 34, no. 2, pp. 61–70, 2006. (cited on pages 12 and 33.)

[19] J. Kirakowski and M. Corbett, "Sumi: The software usability measurement inventory," *British journal of educational technology*, vol. 24, no. 3, pp. 210–212, 1993. (cited on page 13.)

[20] B. Laugwitz, T. Held, and M. Schrepp, *Construction and evaluation of a user experience questionnaire.* Springer, 2008. (cited on page 13.)

[21] J. P. Chin, V. A. Diehl, and K. L. Norman, "Development of an instrument measuring user satisfaction of the human-computer interface," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '88, (New York, NY, USA), pp. 213–218, ACM, 1988. (cited on page 13.)

[22] B. D. Harper and K. L. Norman, "Improving user satisfaction: The questionnaire for user interaction satisfaction version 5.5," in *Proceedings of the 1st Annual Mid-Atlantic Human Factors Conference*, pp. 224–228, 1993. (cited on page 13.)

[23] J. Kirakowski, "The software usability measurement inventory: background and usage," *Usability evaluation in industry*, pp. 169–178, 1996. (cited on page 13.)

[24] A. Bangor, P. T. Kortum, and J. T. Miller, "An empirical evaluation of the system usability scale," *Intl. Journal of Human–Computer Interaction*, vol. 24, no. 6, pp. 574–594, 2008. (cited on pages 13, 43 and 45.)

[25] J. Nielsen and T. K. Landauer, "A mathematical model of the finding of usability problems," in *Proceedings of the INTERACT'93 and CHI'93 conference on Human factors in computing systems*, pp. 206–213, ACM, 1993. (cited on page 41.)

[26] U. Engelen, S. De Peuter, A. Victoir, I. Van Diest, and O. Van den Bergh, "Verdere validering van de positive and negative affect schedule (panas) en vergelijking van twee nederlandstalige versies," *gedrag en gezondheid*, vol. 34, no. 2, pp. 61–70, 2006. (cited on page 51.)

[27] J. Sauro, "Measuring usability with the system usability scale (sus)," May 2016. http://www.measuringu.com/System (cited on page 52.)