The Interaction of Animated Transition and Cognitive Load on User Experience

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Declaration

I declare that this submission is my own work. Where I have read, consulted, and used the work of others I have acknowledged this in the text

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Abstract

User Experience (UX), a field which promotes enjoyable experiences as well as ease-of-use, has risen in popularity (Hassenzahl, 2006; Hassenzahl & Tractinsky, 2006). Cognitive load theory is also concerned with ease of use. There is overlap between these two fields that could allow greater understanding of how a user interface (UI) affect users on both a hedonic level and a cognitive one. Animation use in UI has become more common in the last few years as web technologies make animated transitions easier to implement. Research would suggest that animation can be beneficial to UX if used correctly, but its overuse may cause excessive cognitive load, negatively impacting the UX. This study examined the effects of animated transition and cognitive load on perceived quality of user experience. 75 undergraduate students completed a simple task on a website interface with different styles of animated transition. No difference in the perceived quality of UX was found based on the type of animated transition experienced, neither was there was an effect based on amount of cognitive load experienced. Further research into the relationship between cognitive load and user experience is needed and recommendations are made.

Introduction

As the development of digital products has focused on providing a better user experience (UX) in the last ten years, testing individual components of website interfaces with a participant (or user) has become increasingly common (Hassenzahl & Tractinsky, 2006). Both broad aspects such as the layout of imagery, to extremely specific components such as minor changes in colour are tested. These tests (user tests) are often done quite informally, without much scientific rigor (Cooper, Reimann, Cronin, & Noessel, 2014, p. 140). By using slightly more scientific rigor in the data collection in these tests, results could be more generalisable and further the collective understanding of UX.

The primary way that users interact with a digital product is through its user interface (UI). The improvement of web technologies such as Cascading Style Sheets (CSS), has allowed for increased ability in what a website UI can do. The more recent movement of UX values emotionally engaging and hedonic qualities as highly as pragmatic qualities (Hassenzahl & Tractinsky, 2006). Animation use in UI can add to hedonic quality and improve UX (Finney, 2017; Merz, Opwis, & Tuch, 2016) and, if used appropriately, provide beneficial effects on learnability and reduce cognitive load (Chen, Woolcott, & Sweller, 2017; Cheung, Hong, & Thong, 2017). When animation is misused in a website UI, it can have a negative effect on UX, potentially focusing users' attention in the wrong area (Hong, Thong, & Yan Tam, 2004). Animation in website UI can be a powerful tool for UI designers if used correctly. Incorporating cognitive load into this discussion allows for a richer view of how animation affects UX, one that encompasses psychological processes.

Cognitive Load

Traditionally, the field of Human Computer Interaction (HCI) would see ease of use and an ability to quickly understand layout as end-goals for any interface (Hassenzahl, 2006). Ease of use and learnability are also the focus of Cognitive Load

Theory (Sweller, Ayres, & Kalyuga, 2011). Cognitive Load Theory looks at the total amount of mental effort being used in the working memory (Jong, 2010; Sweller, 1988; Sweller, Ayres, & Kalyuga, 2011). Theories of human memory suggest a distinction between long-term memory and working memory. Working memory was formerly conceptualised as "short-term memory", but changed to emphasise the role of information processing (Baddeley, 2003; Baddeley & Hitch, 1974). Long term memory is for semi-permanent storage of large amounts of information, whereas working memory is a short-term storage where information is processed (Baddeley, 2003; Baddeley & Hitch, 1974). The concept of working memory has driven design of products that require processing of large amounts information simultaneously such as cars, computer programs, and instructional systems (Baddeley, 2003; Chen, Woolcott, & Sweller, 2017). Cognitive load theory suggests that if the total amount of cognitive resources is exceeded by using an interface, learning, efficiency and understanding will be negatively affected (Sweller, 1988).

Cognitive load theory distinguishes two subdivisions of cognitive load, both contributing to cognitive load as a whole: intrinsic cognitive load and extraneous cognitive load (Jong, 2010; Sweller, Ayres, & Kalyuga, 2011). Intrinsic cognitive load is generated by the inherent difficulty of solving a problem – a quadratic equation would generate a higher level of intrinsic cognitive load than a simple subtraction problem, producing a higher amount of total cognitive load. Extraneous cognitive load is produced by the difficulty in the problem caused by its presentation. The action of recognising a word is simple, until it is surrounded by other letters in a word search puzzle. This difficulty produced by the layout of the problem generates extraneous cognitive load, increasing total cognitive load. On an instrumental level, people use digital interfaces to reach goals or solve problems (Hassenzahl & Tractinsky, 2006), so it is imperative to UX that the UI does not make the achieving of these goals difficult though generating additional extraneous cognitive load.

Literature has pointed to issues with the conceptual complexity of cognitive load theory. Jong (2010) questions whether the different types of cognitive load can be distinguished from one another and notes that the theory is constructed in such a way that it can account for almost any outcome post-hoc. Jong also suggests that the use of a physiological test may be the only way to get a concurrent measure of cognitive load, as opposed to completion of the commonly used one-item questionnaire proposed by Paas (1992). However, Szulewski, Gegenfurtner, Howes, Sivilott and Merrienboer (2017) found that participant cognitive load reported on the Paas scale correlated strongly with the physiological measurements on the same activities. Testing on 32 physicians, they found a correlation of 0.675 ($p < 0.001$) between the cognitive load reported by pupillary response and the Paas scale (administered after the task was completed).

User Experience

User Experience (UX) is a term which refers to the experience an individual has while using a digital or analogue product (Albert & Thullis, 2013, p. 4). The term is associated with different aspects of a digital product, from how enjoyable it is to use to how easy it is to use (Hassenzahl, Diefenbach, & Göritz, 2010; Nielsen, 2012). UX originates in Human Computer Interaction (HCI), a discipline concerned with how users accomplish tasks on an interface (Hassenzahl & Tractinsky, 2006), but the connotations of UX go beyond this instrumental perspective.

Hassenzahl (2010; 2004) defines user experience as a “momentary, primarily evaluative feeling while using a product or service”. Hassenzahl argues that people evaluate product interaction from two perspectives – pragmatic quality and hedonic quality. Pragmatic quality refers to the how well a product accomplishes the user’s goals. Hedonic quality refers to how pleasing the product is to use. The goals of pragmatic quality and hedonic quality are referred to as “do-goals” and “be-goals”, respectively. Hassenzahl (2008) has argued that fulfilment of be-goals (a higher hedonic quality) holds more weight in the evaluation of an experience than the fulfilment of do-goals. This suggests that an individual will judge an experience more heavily by how it makes them feel rather than how well it accomplishes the goals they started with.

Users of a digital product must process a lot of information such as the behaviour, layout and organisation of an interface (Cooper, Reimann, Cronin, & Noessel, 2014, p. 271). The processing and organising of this information can generate a high level of extraneous cognitive load (Sweller, 2010). In the context of cognitive load theory, interactive elements are logically connected, so that interacting with one element affects another (Chen, Woolcott, & Sweller, 2017; Sweller, 2010). In website UI, these interactive elements take the form of links and other clickable items. Material that contains a high quantity of interactive elements is more inherently difficult to comprehend than material with less interactive elements due to higher intrinsic cognitive load (Jong, 2010), so effort should be taken to ensure that the UI is not causing additional extraneous cognitive load.

Animation in User Interface

Animation use in UI was seen as secondary to the functionality of the product until Apple released the first iPhone in 2007, which made animation in the UI an integral part of the digital product (Cooper, Reimann, Cronin, & Noessel, 2014, p. 266). From this point in 2007, the use of animation in UI to explain how a system works or behaves has become quite common, both on the web and in native applications (Merz, Opwis, & Tuch, 2016).

Much of the existing literature in this area has used Disney's 12 Basic Principles of Animation (Thomas & Johnston, 1995) as a framework for discussion of different types of animation and animated transition. These animation principles are still used today in the design of UI to focus attention and provide a more enjoyable experience (Merz, Opwis, & Tuch, 2016). The 12 Basic Principles of Animation are guidelines for giving animated elements the illusion that they are following the laws of physics. Merz, Opwis, and Tuch's (2016) pilot study of the effect of animation use in UI on quality of UX tested a subset of the 12 Basic Principles: Slow-in and slow out, anticipation, and follow through. The researchers had 44 participants use their personal phones to interact with an interface featuring one of the animations mentioned above (or a control which featured no animation). There were no significant results, however it was found that the slow-in and slow-out condition had the highest mean quality of perceived UX. It should be noted that the 44 participants were sent a link to use the interface on their personal mobile phone, which raises issues in consistency to do with screen size, browser and the processing power of different phones.

The use of animation on the web has become more widespread with the improvement of web technologies that allow for animation use in a web browser. Simultaneously, there has been a push toward providing better user experience on websites (Hassenzahl, 2008). One of the 12 Basic Principles of Animation which is meant to be applied to all animation is "appeal", which refers to captivation and stimulation with the object in motion (Thomas & Johnston, 1995). In the context of Hassenzahl's (2008) model of UX, animation use often serves to add to the hedonic quality or "be-goals" of a product, which has seen to affect a user's evaluation of their experience (Hassenzahl, Diefenbach, & Göritz, 2010; Tractinsky, Katz, & Ikar, 2000).

When used correctly, animation use in UI can help to reduce the amount of effort in comprehending UI's. Cheung, Hong and Thong (2017) examined the role of animation in UI plays with users' attention and focus. Using eye tracking to measure number of fixations and fixation duration of 63 undergraduate participants, the study found that significantly more attention was directed to animated elements on the UI. The study also found that participants spent significantly longer on webpages that featured UI animation on any element than those which did not feature any UI animation at all. This study has implications in the context of both cognitive load and UX. The focus of attention on one interactive element of the UI reduces split-attention and therefore has the potential to lower cognitive load (Blayney, Kalyuga, & Sweller, 2010). The longer amount of time on pages with UI animation present also suggests a better UX due to a perceived increase in hedonic quality.

Animation in UI can also be used to show progress and provide feedback on the state of the product being used. Finney (2017) examined the effects of animation on perceived loading time and quality of UX. Based on Merz, Opwis, and Tuch's (2016) pilot study of the effects of animation on quality of UX, the research implemented three of the 12 Basic Principles of Animation into a web UI to examine how they affected 80 participants' perception of how long the next state of the interface took to load. The study did not find significant results.

Present Study

The present study aims to provide further insight into the interaction between animation use in UI, cognitive load and user experience. Using Merz, Opwis and Tuch's (2016) subset of the 12 Basic Principles of Animation (slow-in and slow-out, anticipation and follow through), this study will look at how amount of cognitive load generated affects perceived quality of UX, how animating transitions in the UI affects perceived quality of UX and whether this relationship is moderated by the amount of cognitive load generated. The study expects to find that the use of animated transitions in website UI improves perceived UX, while the amount of cognitive load generated diminishes perceived quality of UX. The present study also expects to find that there is an interaction between cognitive load generated and the type of animated transition being used on the perceived quality of UX, i.e. animated transitions will be beneficial to UX permitted that they do not cause increased cognitive load.

The following research questions are proposed:

1. Do animated transitions on a website UI affect the users' perceived quality of UX?

2. Does the amount of cognitive load experienced by users while using a UI affect their perceived quality of UX?
3. Is the impact of animated transition in the UI on the users' perceived quality of UX moderated by the amount of cognitive load they experience while using the website?

Hypotheses

Based on the above research questions, the following hypotheses are proposed:

H1: There will be a significant difference for the participants in their perceived quality of UX based on the type of animated transition they see in the website UI (no animation, slow in slow out, anticipation, follow-through).

H2: There will be a significant difference for the participants in their perceived quality of UX based on the amount of cognitive load they experience while using the website (low, medium, high).

H3: There will be a significant interaction between the participants' cognitive load experienced (low, medium, high) and the type of animated transition they see in the website UI (no animation, slow in slow out, anticipation, follow-through) on their perceived quality of UX.

Method

Design

This study used a 3x4 between-groups experimental design. The independent variables were the type of animation used in the user interface (slow-in and slow-out, anticipation, follow-through and no animation) and the amount of cognitive load experienced while using the UI (low, medium and high). The dependant variable was perceived quality of user experience measured by the AttrakDiff questionnaire.

Participants

The number of participants in this study was 85. 8 participants did not correctly complete one of the questionnaires, reducing the total number of participants to 77. Participants were undergraduate students in IADT Dun Laoghaire. It was explained to the participants that their participation was completely optional and would not affect any aspect of their future grades. The mean age of the participants was 23 with a standard deviation of 5.04. There were 29 men and 48 women. Convenience sampling was used and participants were randomly assigned to groups of the independent variable. Participants were retroactively assigned to levels of the cognitive load variable (low, medium and high).

Materials

Information sheet, consent form and debrief.

An information sheet (see appendix A) and consent form (appendix B) were given to the participants before they completed the experiment, after which they received a debrief form (appendix C).

Attrakdiff questionnaire.

The Attrakdiff questionnaire is used to measure perceived user experience (See appendix D). The questionnaire consists of 28 pairs of polar adjectives about the UI being tested. The participants marks on a scale from one to seven which adjective best describes the UI (one and seven being the polar adjectives). The questionnaire outputs scale data on the perceived pragmatic quality, hedonic quality (both stimulation and identity) and overall attractiveness (a combined score of pragmatic and hedonic quality). For this study, only overall attractiveness were used. This part of the questionnaire consisted of 7 items. A sufficient internal reliability for this questionnaire was found with this sample ($\alpha = 0.85$).

Paas scale.

The Paas scale is used to measure cognitive load (see appendix E). The questionnaire has one item, a 9-point Likert scale that asks the participant to rate how much mental effort they exerted on the previous task. Though simple, research suggests that the Paas scale provides a valid measure of cognitive load that correlates with more sophisticated methods such as eye-tracking (Szulewski, Gegenfurtner, Howes, Sivilott, & Merrienboer, 2017). The Paas scale was given to the participant after they complete the task given.

Sample interface

A sample user interface was developed for the research (Appendix F). The user interface consisted of a grid of nine images and a navigation bar (reminiscent of a stock-photo website). The interface was developed using HTML, CSS and JavaScript and hosted through Github Pages. Using Google Chrome's developer tools to test the site at different internet speeds, it was found that even with very weak connection speed (2MB/s) that the interface loaded within a second. The website was "static", meaning that once it loaded, it did not require any additional loading. This meant that network speed would not impact the quality of UX or smoothness of animation. The UI was used in the Google Chrome browser in all of the tests to ensure consistency.

Pilot Testing

The experiment was pilot tested multiple times to ensure that there would be no practical issues that could affect results. The pilot tests highlighted the importance of consistent and clear instructions on the task. Unclear instructions made the task difficult, increasing extraneous cognitive load. Clear written instructions were developed to ensure that they would not act as affect results.

Procedure

Participants were given an information sheet and two copies of a consent form. The second copy contained their unique ID number in case they wanted to withdraw data from the study. The participants were then told what they would have to do – click and expand images containing buildings. Before participants could access the site, they were asked to input their unique ID code. Based on the code entered, the website would change to fit the type of animated transition group the participant was in. When participants had clicked all of the images with buildings, they were asked to complete the Paas scale, measuring the cognitive load exerted in the preceding task. When they had completed the Paas scale, they were asked to complete the Attrakdiff Questionnaire. Participants were given a debrief and thanked for their time. The process of data collection took an average of five or six minutes per participant.

Results

Overview

The dependent variable was perceived quality of user experience (UX; as measured with the Attrakdiff questionnaire). The independent variables were the type of animated transition experienced on the website (no animation, slow-in and slow out, anticipation, follow-through) and cognitive load (low, medium and high).

Analysis

Table 1. Descriptive statistics for perceived quality of UX

Animation Type	**Cognitive Load Group**	***N***	***M***	***SD***
No Animation	Low	4	1.00	0.76
	Medium	11	1.68	0.67
	High	6	1.52	1.04
	Total	21	1.50	0.81
Slow In, Slow Out	Low	7	1.57	0.81
	Medium	11	1.52	1.07
	High	4	1.54	0.91
	Total	22	1.54	0.91
Anticipation	Low	3	2.10	0.70
	Medium	8	2.36	0.58
	High	9	1.17	0.98
	Total	20	1.79	0.96
Follow-Through	Low	4	1.89	0.82
	Medium	7	1.94	0.61
	High	8	1.55	1.15
	Total	19	1.77	0.88

A two-way between groups analysis of variance was conducted to determine the effects of the type of animated transition and amount of cognitive load on perceived quality of UX. Preliminary analysis showed no violations of the assumptions of this test. Descriptive statistics for the groups are presented in Table 1. There was no significant interaction effect between cognitive load (low, medium, high) and type of animated transition (none, slow in slow out, anticipation, follow through) on perceived quality of UX, $F(6, 70) = 1.03$, $p = 0.41$, power = 0.38. There was no significant main effect of the type of animated transition experienced on perceived quality of UX, $F(3, 70) = 0.82$, $p = 0.36$, power = 0.28. There was also no significant main effect of cognitive load on perceived quality of UX, $F(2, 70) = 1.75$, $p = 0.18$, power = 0.35.

Discussion

Findings of the Present Study

The research questions that this study aimed to answer were whether the type of animated transition affected the perceived quality of UX, whether the amount of cognitive load experienced affected the perceived UX and whether there was a significant interaction between type of animated transition and amount of cognitive load experienced on the perceived quality of UX. The present study found that there was no difference on participants' perceived quality of UX based on the type of animated transition they experienced or how much cognitive load they experienced during the task. There was also no difference in perceived quality of UX based on an interaction of cognitive load and type of animated transition.

These findings are consistent with Merz, Opwis and Tuch's (2016) pilot study on the relationship between perceived quality of UX and the type of animation used in a smartphone interface in that there were no significant results found. Merz and colleagues found that the "slow-in, slow-out" animation had the highest mean UX score in their sample. The present study found that the "anticipation" animated transition produced the highest mean quality of perceived UX for the sample. The results of the present study are consistent with Finney's (2017) study on the effects of different types of animated transition on perceived loading times and total satisfaction. Neither study found significant difference in total satisfaction with the UX based on the type of animated transition.

Strengths and Limitations With Regard to Existing Literature

Merz, Opwis and Tuch's (2016) pilot study on the effects of animated transition on perceived quality of UX had 44 participants. This study had almost double that ($N = 77$), but still fell well short of their ideal sample size for future research of between 250 and 430 participants. The participants of this study were also exclusively IADT Dun Laoghaire undergraduate students of various courses, which could limit the extent to which the results can be inferred to a wider population.

The relatively small sample size undoubtedly affected the statistical power of the analyses. The observed power of the tests were low: the interaction effect had an observed power of 0.38, the main effect of cognitive load had an observed power of 0.35 and the main effect of type of animated transition had an observed power of 0.28. This means that the likelihood of the tests accurately rejecting the null was less than 40% for all effects, about half of the ideal level of 80%. Power could be increased through increasing the sample size or increasing the significance level from 0.05 to 0.1, though this would raise the possibility of a type 1 error.

It is possible to build an entirely online experiment while still controlling for screen size and input through CSS and JavaScript, something which would allow participants to take part in the experiment remotely. This was how Finney (2017) collected data. Collecting data remotely avoids many of the practical limitations that in-person experiments encounter. This would be a way to possibly achieve a larger sample size without compromising on consistency of screen size. It would be important to note that the interface built for the experiment would have to load quickly enough that differences in network speed would be negligible, something which could have a confounding effect on perceived quality of UX.

It may be possible to improve on the complexity of the task that participants were asked to complete in the present study. Merz, Opwis and Tuch (2016) asked participants to simply press a button to initiate a representation of one of the four animation styles in a very basic manner. Though Merz and colleagues' research did not measure cognitive load, this task is not representative of one that a user would often experience when using a website. The task should be sufficiently realistic as to represent an everyday goal of users on a website. The present research involved participants clicking on any of the nine images on the interface that contained buildings. The task was based off a common CAPTCHA test where users confirm that they are not “bots” or computer scripts by clicking on images that contain a chosen element. This task was also used in Finney’s (2017) study on the effects of animation on perceived loading times. This task was picked on the basis of its relative ease to ensure that it was easy to interpret and not impact heavily quality of UX, while still being realistic to the goals of a potential user on an image-based website. In hindsight, this task was too simple. It proved to be too easy in terms of the cognitive load it generated: the mean cognitive load score for all participants was 2.34 out of 9. Though used as a grouping variable, it meant that there was not a wide spread of scores across the low, medium and high cognitive load groups. Ideally the task to be completed on the interface would be sufficiently difficult that there would be a higher mean cognitive load score and a normal distribution of scores. Future research could also include a range of tasks of different difficulty to provide an even more realistic portrayal of the challenges facing a user of a website UI.

Merz, Opwis and Tuch’s (2016) study had participants complete the experiment on their personal mobile phones. This creates issues with consistency, primarily to do with screen size, processing power and the browser that the interface was used in. Screen size and resolution may affect the perceived attractiveness (and therefore UX) of a product. The processing power and the browser that the UI runs in may affect the smoothness or loading times of animations, also affecting the UX. Participants in this study were tested on an ad-hoc basis due to constraints in resource availability. This meant that different groups of participants were tested in different manners, initially on a one-to-one basis, followed by in a group setting (the majority), then some were tested remotely as in Finney (2017). Steps were taken to ensure that screen size, browser and loading speed were consistent across all scenarios as outlined in the materials subsection. Consistency in the environment that tests take place in is imperative to the generalisability of results from experiments to do with UI.

Cheung, Hong and Thong (2017) looked at the effects of animation on attention but not in the context of cognitive load. Their findings give insight into how animation use in user interface interacts with cognitive processes and would suggest that animation can be beneficial in focusing attention. Their study also found that users stayed on pages with animation longer, the reason for which could be that the users had a better quality of UX. It is important to note that this study did not directly measure quality of UX. The results of the present study are not consistent with these findings: no significant improvement in user testing was found in any of the animated transition groups.

Neither Merz Opwis and Tuch (2016), nor Finney (2017) measured cognitive load or anything similar. A strength of this study was that it measured both the effects of animated transition on perceived UX and importantly, whether or not it was moderated by cognitive load. This is a consolidation of fields that has not been studied in much detail. Research would suggest that adding excessively to the presentation of an interface would increase users' cognitive load. This research design has the ability to see whether there is a significant interaction between cognitive load and animation on the perceived quality of UX, that is whether a high cognitive load would negate the positive effects of an animated transition on perceived UX.

The present study used an interface developed for the experiment built to mirror a typical stock image website. This was done to make the interface seem as real as possible, while also allowing for maximum control of the animated transitions. Previous research in this area have used very basic UIs that are not representative of the advanced standards of modern websites. Merz, Opwis and Tuch's (2016) research used an extremely basic UI that required a user to click a button to play an animated transition. Cheung, Hong and Thong's (2017) used a similarly basic interface that looked very outdated. It's imperative to the generalisability of results from future research that the UI being tested on are as modern and standard as possible, as in the present research and Finney (2017).

Theoretical and Practical Implications

The inclusion of cognitive load in this area allows for the study of how effective animation can be with UX, but also has the potential to explore where the limit for "too much" animation is, when it begins to produce cognitive overload. Research in this field should test with lifelike UIs that run in-browser as they would in everyday life. The relationship between cognitive load and UX also bears further exploration, as there paucity in this research despite their shared aspects.

Future Research

Future research in the area of animation in website UI should focus on its suitability as well as its effect on perceived quality of UX. An entirely online experiment using CSS and JavaScript to ensure consistency in screen size would have the potential to yield a larger sample size, increasing the power of the analyses. The UI being tested must load quickly to limit the possibility of a slow connection acting as a confounding variable on quality of UX. Further research into the relationship between cognitive load and quality of UX is also needed. Cognitive load can be measured using pupillometry – recording the change in dilation of pupils using eye tracking equipment (Szulewski, et al., 2017). This would allow for a concurrent measure of cognitive load as the participants used an interface, which would make it easier to give multiple tasks and measure cognitive load more objectively.

Conclusion

The current research found that the type of animated transition present on a web interface and how much cognitive load a participant experienced while using said interface did not affect the perceived quality of UX. Animation can be a powerful tool for directing focus (Chen, Woolcott, & Sweller, 2017) when used correctly. Overuse of animation may result in the production of extraneous cognitive load (Sweller, Ayres, & Kalyuga, 2011), which has the potential to negatively affect quality of UX. Further rigorous research in this field is needed to pin down the effects of animated transition and cognitive load on user experience. This research may be seen as a first step of studying a specific component of a UI and how it affects quality of UX in a scientific manner. There is more research needed in the field of animation use in UI and how it can be used effectively to provide a better UX. This field can benefit from the inclusion of cognitive load theory, to further examine how it interacts with UX and how to avoid cognitive overload

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Appendices

Appendix A – Information Sheet

Information Sheet

Title of Project: The interaction of animated transition and cognitive load on user experience

Purpose of the Research

The purpose of this research is to examine the effects of using animated transitions in website design, specifically how it affects user experience and mental effort.

Invitation

You are being invited to consider taking part in the research study "Can use of animation on web interfaces lower cognitive load and improve user experience?". This project is being undertaken by Robert McLoughlin.

Before you decide whether or not you wish to take part, it is important for you to understand why this research is being done and what it will involve. Please take time to read this information carefully and discuss it with friends and relatives if you wish. Please ask if there is anything that is unclear or if you would like more information.

Do I have to take part?

You are free to decide whether you wish to take part or not. If you do decide to take part you will be asked to sign two consent forms, one is for you to keep and the other is for our records. You are free to withdraw from this study at any time and without giving reasons. Taking part in this study will have no impact on your marks, assessments or future studies.

If I take part, what do I have to do?

You will be asked to use a sample website of stock photos and then complete two questionnaires. This should take no more than five minutes.

What are the benefits (if any) of taking part?

There are no expected benefits for the participants from taking part in this study.

What are the disadvantages and risks (if any) of taking part?

There are no expected disadvantages for the participants from taking part in this study.

How will information about me be used?

The data collected today will be used in an undergraduate thesis for the Applied Psychology program in IADT Dun Laoghaire. No personal or identifying information will be used and the data will be entirely anonymous.

Who will have access to information about me?

The data from this research is stored securely on a password-protected computer. The data is unlinked-anonymous, meaning no data can be identified as yours. The data will be kept for five years, after which it will be deleted. A copy of the data from the Attrakdiff questionnaire is kept on a server in Germany for two and a half years, where it is not used for any other purpose.

What will happen to the results of the study?

The results of this research will be used in a final year dissertation for the BSc in Applied Psychology program in the Dun Laoghaire Institute of Art, Design & Technology. A soft copy of this thesis will be available in the library in IADT once it is completed.

Who has reviewed the study?

This study has been approved by the Department of Technology and Psychology Ethics Committee (DTPEC).

What if there is a problem?

If you have a concern about any aspect of this study, you may wish to speak to the researcher(s) who will do their best to answer your questions. You should contact Robert McLoughlin or his supervisor, Dr Nicola Porter.

Contact for further information

Robert McLoughlin: N00147059@student.iadt.ie Or Dr Nicola Porter: nicola.porter@iadt.ie

Appendix B – Consent Form

CONSENT FORM

Title of Project: The interaction of animated transition and cognitive load on user experience **Name of Researcher:** Robert McLoughlin

Please tick boxes

1 I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. ☐

2 I understand that my participation is voluntary and that I am free to withdraw at any time. ☐

3 I agree to take part in this study. ☐

4 I understand that data collected about me during this study will be anonymised before it is submitted for publication. ☐

______________________	______________________	______________________
Name of participant	Date	Signature
______________________	______________________	______________________
Researcher	Date	Signature

Appendix C – Debrief

Debrief

Thank you very much for taking part in this research study.

The study in which you just participated was designed to investigate how implementing animated transitions into websites can be used to provide better user experience and lower cognitive load. Research would suggest that animating transitions between "states" of a websites would mean less cognitive effort being exerted in understanding the interface and a better overall experience. Research suggests that animated transitions add a nice aesthetic quality to websites.

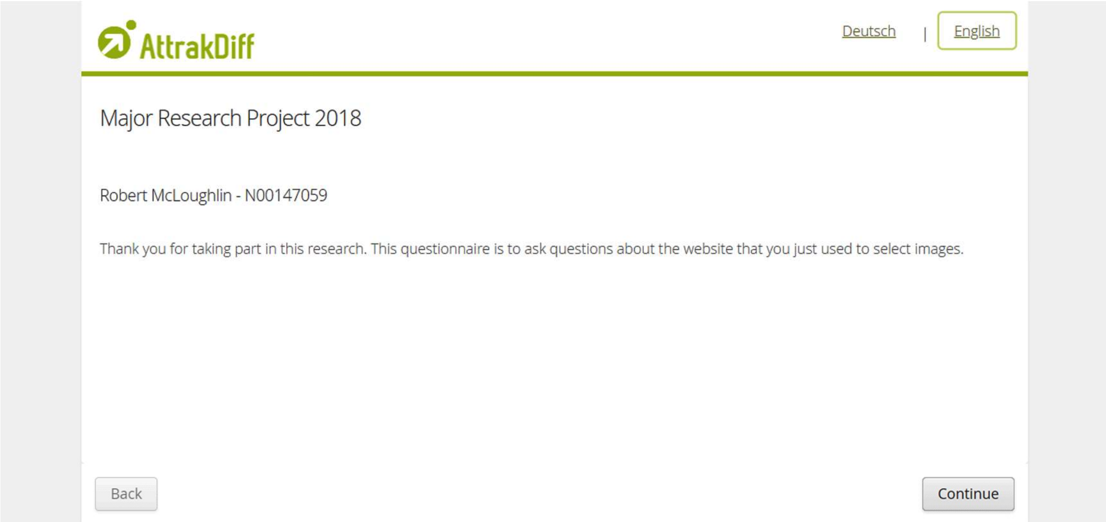
If you have questions about this study or you wish to have your data removed from the study before the 28th of February, please contact me at the following e-mail address: **N00147059@student.iadt.ie**. Alternatively, you may contact my supervisor, Dr. Nicola Porter at IADT, at **nicola.porter@iadt.ie**.

If you are interested in learning more about this area, I would recommend the following resources as starting points:

- Academic pilot study on the effects of animation on user experience by Merz, Opwis and Tuch: https://dl.acm.org/citation.cfm?id=2892489
- Article on functional animation in Smashing Magazine: https://www.smashingmagazine.com/2017/01/how-functional-animation-helps-improve-user-experience/
- Podcast hosted by famous website designer Jeffrey Zeldman about animation in website design: http://5by5.tv/bigwebshow/163

Robert McLoughlin

Appendix D – Attrakdiff Questionnaire



AttrakDiff

Deutsch | English

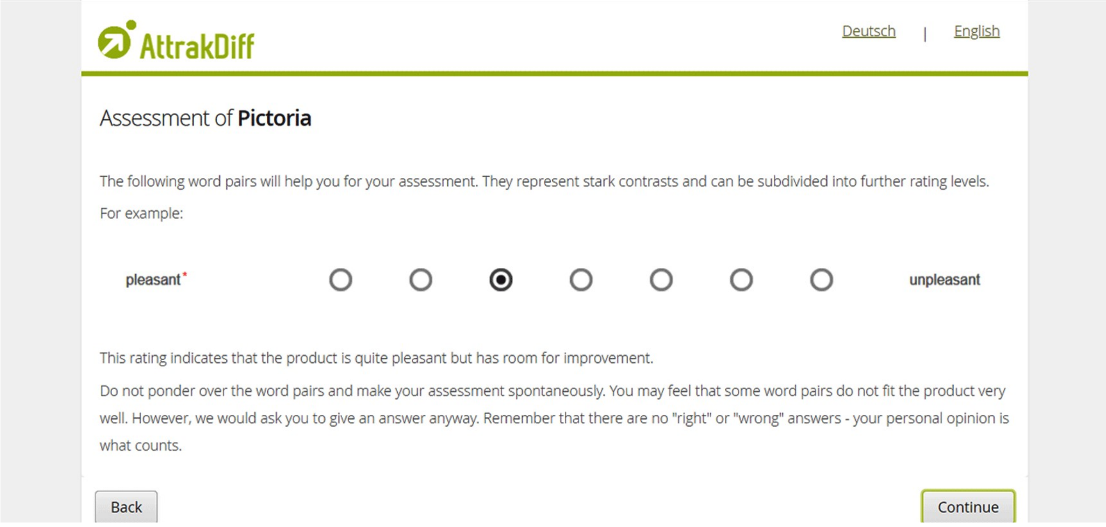
Major Research Project 2018

Robert McLoughlin - N00147059

Thank you for taking part in this research. This questionnaire is to ask questions about the website that you just used to select images.

Back

Continue



AttrakDiff

Deutsch | English

Assessment of **Pictoria**

The following word pairs will help you for your assessment. They represent stark contrasts and can be subdivided into further rating levels. For example:

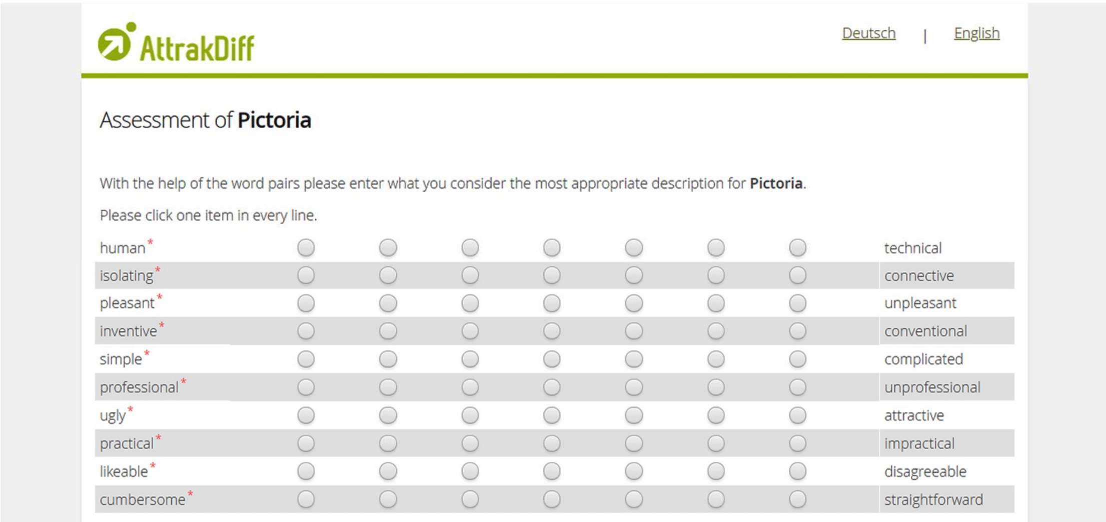
pleasant* ○ ○ ◉ ○ ○ ○ ○ **unpleasant**

This rating indicates that the product is quite pleasant but has room for improvement.

Do not ponder over the word pairs and make your assessment spontaneously. You may feel that some word pairs do not fit the product very well. However, we would ask you to give an answer anyway. Remember that there are no "right" or "wrong" answers - your personal opinion is what counts.

Back

Continue



AttrakDiff

Deutsch | English

Assessment of **Pictoria**

With the help of the word pairs please enter what you consider the most appropriate description for **Pictoria**.

Please click one item in every line.

human*	○	○	○	○	○	○	○	technical
isolating*	○	○	○	○	○	○	○	connective
pleasant*	○	○	○	○	○	○	○	unpleasant
inventive*	○	○	○	○	○	○	○	conventional
simple*	○	○	○	○	○	○	○	complicated
professional*	○	○	○	○	○	○	○	unprofessional
ugly*	○	○	○	○	○	○	○	attractive
practical*	○	○	○	○	○	○	○	impractical
likeable*	○	○	○	○	○	○	○	disagreeable
cumbersome*	○	○	○	○	○	○	○	straightforward

AttrakDiff

Deutsch | English

Assessment of **Pictoria**

With the help of the word pairs please enter what you consider the most appropriate description for **Pictoria**.

Please click one item in every line.

stylish *	○	○	○	○	○	○	○	tacky
predictable *	○	○	○	○	○	○	○	unpredictable
cheap *	○	○	○	○	○	○	○	premium
alienating *	○	○	○	○	○	○	○	integrating
brings me closer to people *	○	○	○	○	○	○	○	separates me from people
unpresentable *	○	○	○	○	○	○	○	presentable
rejecting *	○	○	○	○	○	○	○	inviting
unimaginative *	○	○	○	○	○	○	○	creative
good *	○	○	○	○	○	○	○	bad

AttrakDiff

Deutsch | English

Assessment of **Pictoria**

With the help of the word pairs please enter what you consider the most appropriate description for **Pictoria**.

Please click one item in every line.

confusing *	○	○	○	○	○	○	○	clearly structured
repelling *	○	○	○	○	○	○	○	appealing
bold *	○	○	○	○	○	○	○	cautious
innovative *	○	○	○	○	○	○	○	conservative
dull *	○	○	○	○	○	○	○	captivating
undemanding *	○	○	○	○	○	○	○	challenging
motivating *	○	○	○	○	○	○	○	discouraging
novel *	○	○	○	○	○	○	○	ordinary
unruly *	○	○	○	○	○	○	○	manageable

* required field

AttrakDiff

Deutsch | English

Assessment of **Pictoria**

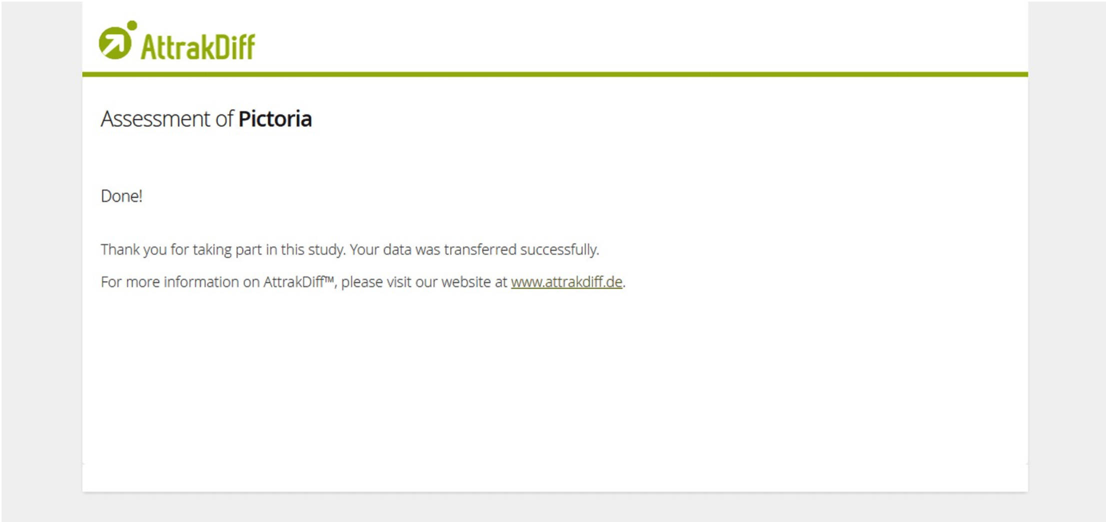
In the following section we would ask you to give information about yourself and your own experience with the product.

Age *

Gender *

Please enter your four character ID Number: *

* required field

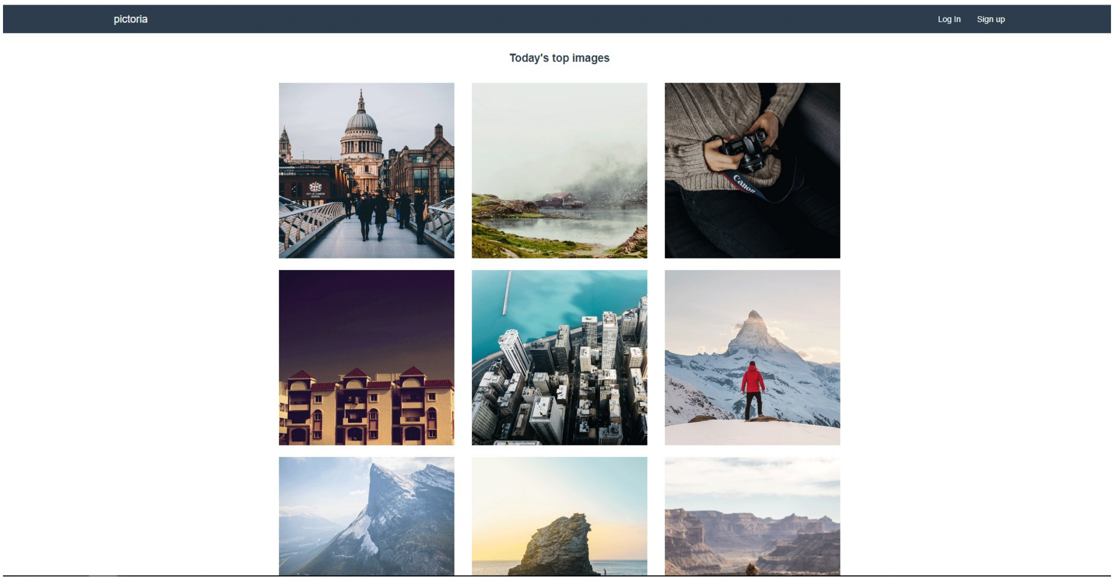

AttrakDiff
Assessment of Pictoria
Done!
Thank you for taking part in this study. Your data was transferred successfully.
For more information on AttrakDiff™, please visit our website at www.attrakdiff.de.

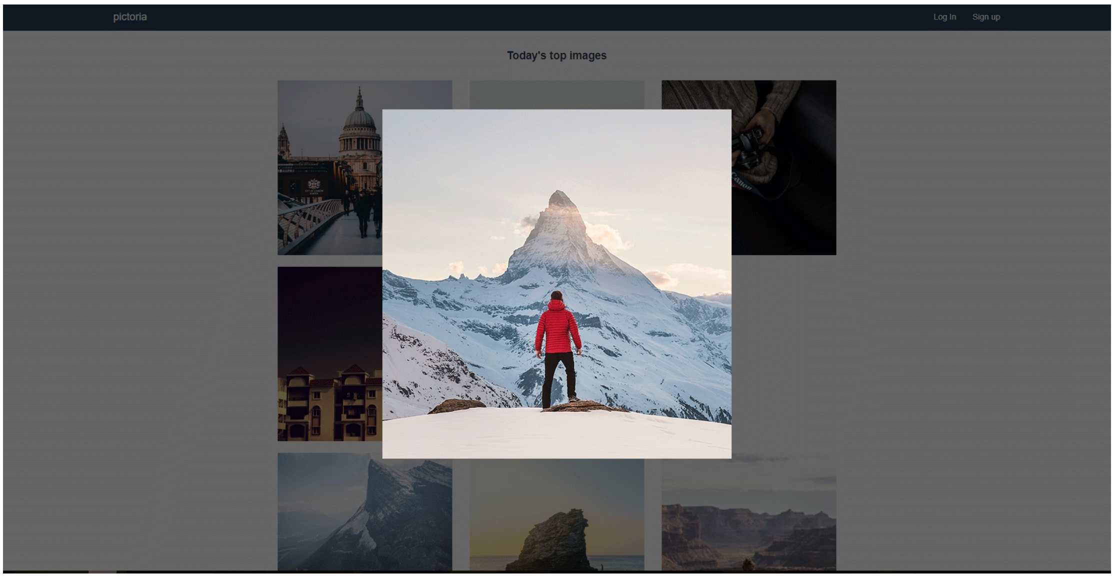
Appendix E – Paas Scale

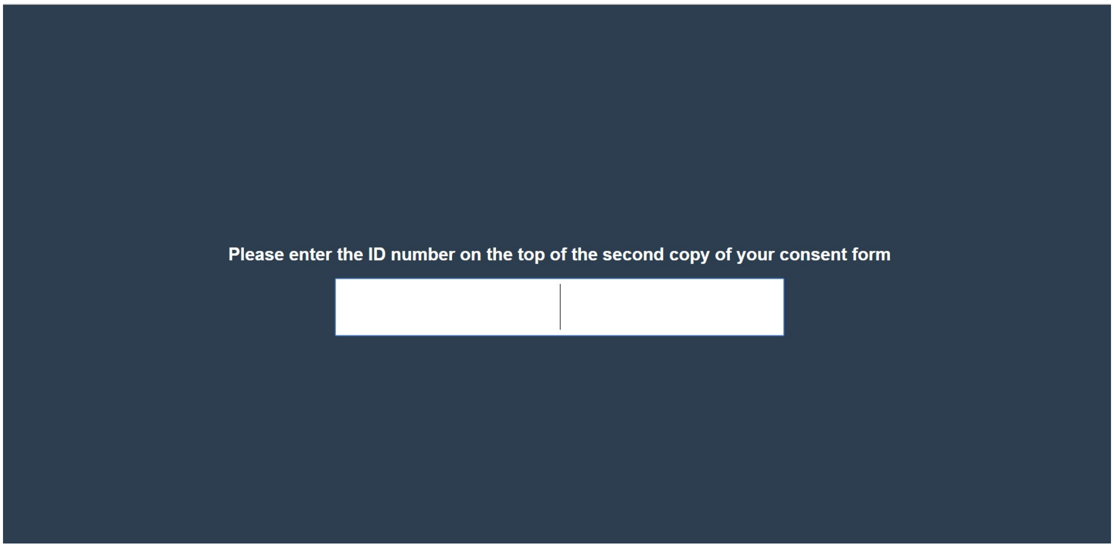
In completing the preceding task of selecting images with buildings in them, I invested

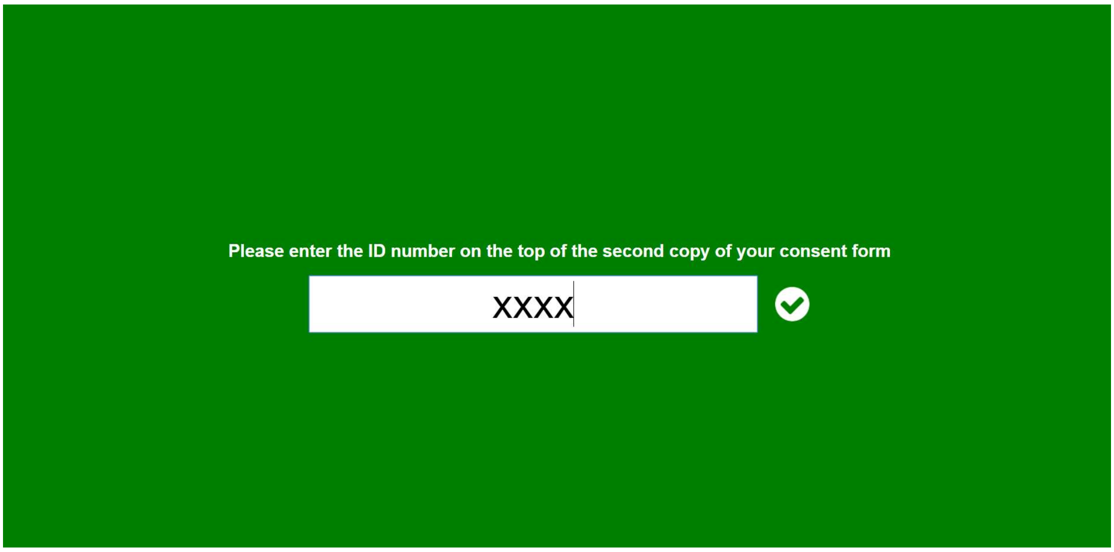
1. very, very low mental effort
2. very low mental effort
3. low mental effort
4. rather low mental effort
5. neither low nor high mental effort
6. rather high mental effort
7. high mental effort
8. very high mental effort
9. very, very high mental effort

Appendix F – Sample Interface for Testing






Please enter the ID number on the top of the second copy of your consent form


Please enter the ID number on the top of the second copy of your consent form
XXXX

Appendix G – SPSS Output

Reliability

Notes

Output Created		18-MAR-2018 20:59:50
Comments		
Input	Data	
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	85
	Matrix Input	
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data for all variables in the procedure.
Syntax		RELIABILITY /VARIABLES=att1 att2 att3 att4 att5 att6 att7 /SCALE('ALL VARIABLES') ALL /MODEL=ALPHA /STATISTICS=DESCRIPTIVE SCALE /SUMMARY=TOTAL.
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.01

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	85	100.0
	Excluded[a]	0	.0
	Total	85	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.874	7

Item Statistics

	Mean	Std. Deviation	N
pleasant - unpleasant	5.73	1.229	85
ugly - attractive	5.87	1.223	85
likeable - disagreeable	5.88	1.028	85
rejecting - inviting	5.72	1.109	85
good - bad	5.75	1.184	85
repelling - appealing	5.76	1.192	85
motivating - discouraging	4.94	1.189	85

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted

pleasant - unpleasant	33.93	28.947	.564	.868
ugly - attractive	33.79	27.383	.706	.848
likeable - disagreeable	33.78	28.699	.741	.846
rejecting - inviting	33.94	28.175	.723	.847
good - bad	33.91	27.682	.709	.848
repelling - appealing	33.89	26.953	.771	.839
motivating - discouraging	34.72	31.276	.393	.889

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
39.66	37.918	6.158	7

Univariate Analysis of Variance

Notes

Output Created		18-MAR-2018 20:36:37
Comments		
Input	Data	
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	85
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data for all variables in the model.

Syntax		UNIANOVA tattqual BY condition cogLoadGrp /METHOD=SSTYPE(3) /INTERCEPT=INCLUDE /POSTHOC=condition cogLoadGrp(TUKEY BONFERRONI) /PLOT=PROFILE(cogLoadGrp*condition) /PRINT=ETASQ DESCRIPTIVE HOMOGENEITY OPOWER /CRITERIA=ALPHA(.05) /DESIGN=condition cogLoadGrp condition*cogLoadGrp.
Resources	Processor Time	00:00:00.66
	Elapsed Time	00:00:00.18

Between-Subjects Factors

		Value Label	N
animation type	1	none	21
	2	slow in, slow out	22
	3	anticipation	20
	4	follow-through	19
Cognitive Load	1	low	18
	2	medium	37
	3	high	27

Descriptive Statistics

Dependent Variable: total attractiveness

animation type	Cognitive Load	Mean	Std. Deviation	N
none	low	1.0000	.76488	4
	medium	1.6753	.67034	11
	high	1.5238	1.04067	6
	Total	1.5034	.80638	21
slow in, slow out	low	1.5714	.81232	7
	medium	1.5195	1.06766	11
	high	1.5357	.83605	4
	Total	1.5390	.91200	22
anticipation	low	2.0952	.70470	3
	medium	2.3571	.58154	8
	high	1.1746	.98400	9
	Total	1.7857	.95607	20
follow-through	low	1.8929	.81961	4
	medium	1.9388	.60529	7
	high	1.5536	1.14906	8
	Total	1.7669	.88475	19
Total	low	1.6032	.81339	18
	medium	1.8263	.81798	37
	high	1.4180	.98651	27
	Total	1.6429	.88384	82

Levene's Test of Equality of Error Variances[a]

Dependent Variable: total attractiveness

F	df1	df2	Sig.
.752	11	70	.685

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + condition + cogLoadGrp + condition * cogLoadGrp

Tests of Between-Subjects Effects

Dependent Variable: total attractiveness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	9.594[a]	11	.872	1.137	.347	.152	12.511	.570
Intercept	189.327	1	189.327	246.882	.000	.779	246.882	1.000
condition	2.496	3	.832	1.085	.361	.044	3.254	.281
cogLoadGrp	2.676	2	1.338	1.745	.182	.047	3.489	.354
condition * cogLoadGrp	4.741	6	.790	1.030	.413	.081	6.182	.380
Error	53.681	70	.767					
Total	284.592	82						
Corrected Total	63.276	81						

a. R Squared = .152 (Adjusted R Squared = .018)

b. Computed using alpha = .05

Post Hoc Tests

animation type

Multiple Comparisons

Dependent Variable: total attractiveness

	(I) animation type	(J) animation type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Tukey HSD	none	slow in, slow out	-.0356	.26716	.999	-.7387	.6676
		anticipation	-.2823	.27361	.731	-1.0024	.4378
		follow-through	-.2635	.27727	.778	-.9932	.4662
	slow in, slow out	none	.0356	.26716	.999	-.6676	.7387
		anticipation	-.2468	.27056	.799	-.9588	.4653
		follow-through	-.2280	.27426	.839	-.9498	.4939
	anticipation	none	.2823	.27361	.731	-.4378	1.0024
		slow in, slow out	.2468	.27056	.799	-.4653	.9588
		follow-through	.0188	.28054	1.000	-.7196	.7571
	follow-through	none	.2635	.27727	.778	-.4662	.9932
		slow in, slow out	.2280	.27426	.839	-.4939	.9498
		anticipation	-.0188	.28054	1.000	-.7571	.7196
Bonferroni	none	slow in, slow out	-.0356	.26716	1.000	-.7610	.6899
		anticipation	-.2823	.27361	1.000	-1.0252	.4606
		follow-through	-.2635	.27727	1.000	-1.0164	.4894
	slow in, slow out	none	.0356	.26716	1.000	-.6899	.7610
		anticipation	-.2468	.27056	1.000	-.9814	.4879
		follow-through	-.2280	.27426	1.000	-.9727	.5167
	anticipation	none	.2823	.27361	1.000	-.4606	1.0252
		slow in, slow out	.2468	.27056	1.000	-.4879	.9814
		follow-through	.0188	.28054	1.000	-.7430	.7806

follow-through	none	.2635	.27727	1.000	-.4894	1.0164
	slow in, slow out	.2280	.27426	1.000	-.5167	.9727
	anticipation	-.0188	.28054	1.000	-.7806	.7430

Based on observed means.

The error term is Mean Square(Error) = .767.

Homogeneous Subsets

total attractiveness

	animation type	N	Subset
			1
Tukey HSD[a,b,c]	none	21	1.5034
	slow in, slow out	22	1.5390
	follow-through	19	1.7669
	anticipation	20	1.7857
	Sig.		.732

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .767.

a. Uses Harmonic Mean Sample Size = 20.439.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

c. Alpha = .05.

Cognitive Load

Multiple Comparisons

Dependent Variable: total attractiveness

			Sig.	95% Confidence Interval

	(I) Cognitive Load	(J) Cognitive Load	Mean Difference (I-J)	Std. Error		Lower Bound	Upper Bound
Tukey HSD	low	medium	-.2231	.25166	.651	-.8257	.3795
		high	.1852	.26647	.767	-.4529	.8233
	medium	low	.2231	.25166	.651	-.3795	.8257
		high	.4083	.22165	.164	-.1225	.9390
	high	low	-.1852	.26647	.767	-.8233	.4529
		medium	-.4083	.22165	.164	-.9390	.1225
Bonferroni	low	medium	-.2231	.25166	1.000	-.8404	.3942
		high	.1852	.26647	1.000	-.4684	.8388
	medium	low	.2231	.25166	1.000	-.3942	.8404
		high	.4083	.22165	.209	-.1354	.9519
	high	low	-.1852	.26647	1.000	-.8388	.4684
		medium	-.4083	.22165	.209	-.9519	.1354

Based on observed means.

The error term is Mean Square(Error) = .767.

Homogeneous Subsets

total attractiveness

	Cognitive Load	N	Subset 1
Tukey HSD[a,b,c]	high	27	1.4180
	low	18	1.6032
	medium	37	1.8263
	Sig.		.231

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .767.

a. Uses Harmonic Mean Sample Size = 25.079.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

c. Alpha = .05.

Profile Plots