The reduced satisfaction of gesture interaction on e-commerce websites for smartphones

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Abstract

This study aims to assess whether gesture interaction can increase users' satisfaction on e-commerce websites for smartphones. Touchscreen smartphones are being used more and more around the world and, among other possibilities; this type of device allows the gesture interaction which implies the adoption of new practices for the interface design. In addition, in October 2013, the W3C published recommendations for the development of tactile applications for websites, suggesting that this category of interaction can be widely used for site development in a near future. Gesture interaction can give users more satisfaction since it enables a reduction of the visual overhead of the interface and can also turn the interactions more natural. However, gesture interaction may present problems related to the discovery of interface possibilities and affordances. Among usability-related metrics, satisfaction is the one that is most related to trust in e-commerce, which is a very delicate element of this type of system, since the perceived risk in electronic transactions is generally high. Thus, satisfaction assessment was performed as a usability test with two prototypes of e-commerce sites, one of them using the traditional "touch" interaction and the other where it was applied to gesture interactions such as drag, drop and sliding. The test was applied to 20 undergraduate students in southern Brazil. The results suggest that on e-commerce sites for smartphones, users prefer the traditional touch interaction rather than gesture interaction. Thus, the present study provides an empirical contribution related to the perception of users regarding the interaction by gestures in e-commerce websites, which can serve as reference for the decision-making of managers, designers and developers of e-commerce systems. In addition, relevant aspects related to gesture interaction, commonly used in Human Computer Interaction (IHC), are clarified.

Keywords: smartphone, gesture interaction, e-commerce.

Resumo

Este estudo pretende avaliar se a interação gestual pode aumentar a satisfação dos usuários em sites de comércio eletrônico para smartphones. Os telefones inteligentes (smartphones) com telas de toque estão sendo cada vez mais usados em todo o mundo e, entre outras possibilidades, esse tipo de dispositivo permite a interação gestual, o que implica a adoção de novas práticas para o design da interface. Além disso, em outubro de 2013, o W3C publicou recomendações para o desenvolvimento de aplicativos táteis para sites, sugerindo que esta categoria de interação já pode ser amplamente utilizada para o desenvolvimento de sites. A interação por gestos pode dar mais satisfação aos usuários uma vez que ela possibilita uma redução da sobrecarga visual da interface e também pode tornar as interações mais naturais. Contudo, a interação por gestos pode apresentar problemas relacionados à descoberta das possibilidades da interface e aos affordances. Dentre as métricas relacionadas à usabilidade, a satisfação é aquela que tem maior relação com a confiança no comércio eletrônico, sendo esse um elemento muito delicado desse tipo de sistema, dado que o risco percebido em transações eletrônicas é geralmente alto. Assim, a avaliação da satisfação foi realizada como um teste de usabilidade com dois protótipos de websites de comércio eletrônico, um deles usando a tradicional interação por "toque" e outro onde foi aplicada a interação por gesto, como arrastar e soltar e deslizar. O teste foi aplicado a 20 estudantes de graduação no sul do Brasil. Os resultados sugerem que, em sites de comércio eletrônico para smartphones, os usuários preferem a interação tradicional de toque à interação gestual. Assim, o presente estudo fornece uma contribuição empírica relacionada à percepção dos usuários em relação à interação por gestos em websites de comércio eletrônico, que pode servir de referência para a tomada de decisão de gestores, designers e desenvolvedores de sistemas de comércio eletrônico. Além disso, são esclarecidos aspectos relevantes relacionados à interação por gestos, categoria comumente utilizada na Interação Humano Computador (IHC).

Palavras-chave**: **smartphone, interação por gestos, comércio eletrônico.

1. INTRODUCTION

The use of smatphones have grown consistently in recent years, including in emerging economies (POUSHTER, 2016), indicating that this type of technology will be widely used in the near future. However, e-commerce on websites through mobile devices (m-commerce) still has a significantly lower revenue when compared to this same type of electronic commerce made through desktop devices, mainly because of its low usability (NIELSEN, 2017).

Also, in electronic commerce one of the main concerns is to establish and maintain costumers' trust on. In a study of 5,000 adults, about US$ 1 billion was lost in electronic commerce due to perceived lack of security by users (GARTNER, 2006). It is important to point out that in this case the negotiations were not concluded due to a real failure in electronic commerce, but because of the lack of trust noticed by the users, and much of the perceived trust is related to the usability of the system (KAMOUN and HALAWEH, 2012) .

The touch screen is a very popular hardware feature on mobile devices today. It allows users to access system features through direct touch to the display screen, which improves usability for unexperienced people and streamlines access to information, since the interaction does not depend on other hardware such as mouse, trackballs or external buttons (SAFFER, 2008).

The main advantage of touch screens is that direct access to the objects offers a more intuitive interaction, there is no mechanical intermediate device and no displacement between the input and output control and feedback. No physical input device is needed before making a selection. In addition, fast access saves time compared to the operation of a mouse (ALBINSSON and ZHAI, 2003).

Another advantage is that only one surface between the information display and the menu options means that the control users' options are reduced. This eliminates learning curves and improves efficiency and accuracy. In the case of compact devices touch screens make the use of available space more efficient, combining exposure and input space, as well as being easier to learn and easier to use, especially suitable for unexperienced users (LIU, 2012).

The use of smartphones occurs by four product types: native applications (apps), web applications (web apps) hybrid applications and websites. Native applications are those that need to be installed on the device, usually through digital stores (NIELSEN and BUDIU, 2012).

Web applications run from a browser, and usually resemble a native application, but due to the current development technology they have more limited features than native applications. Hybrid applications are native applications that use alternate application features and features of a website. Finally, websites, on both the desktop and mobile platforms, are accessed through web browsers (NIELSEN and BUDIU, 2012).

Currently key features of touch screens are available for several technological contexts, as for websites and smartphone applications. In addition, the World Wide Web Consortium (W3C) has published in 2013 web standards (W3C, 2013) for this type of technology, which indicates that it can be used more frequently by website developers.

Touch screens can be manipulated by touching, emulating a click of the mouse, or by gestures. For Saffer (2008), a gesture is a physical movement that a digital system can search for and respond to, without the use of any pointing device such as the mouse or optical pen. This type of interaction can bring a reduction in the learning curve, be more intuitive and fun for users, which can result in greater use satisfaction.

For the author, we are entering a new era of interaction. The paradigms of the 1960s and 1970s, such as the "Desktop", "window", and "copy and paste" metaphors, already deeply rooted in the use of personal computers, will be supplemented by interaction methods that use the body as a whole.

Currently, interactions on websites developed for mobile devices are mostly based on simple touches that emulate a mouse click, in this study described as "tap interaction". However, this type of interaction requires larger graphical interaction elements (such as buttons and links), given the human finger dimensions (Hoober and Berkman, 2012). The large areas necessary for the dimensioning of the interaction graphic elements contribute to the experience of the users being impaired, since in the smartphones the screens have reduced dimensions (Nielsen and Budiu, 2012).

For Nielsen and Budiu (2012), the usability of applications for smartphones is superior to that of websites. For the authors, it happens because applications have access to more hardware resources, such as accelerometers, GPS devices and touch screens, which broadens the possibilities for interaction.

2. THEORY

Gesture interaction is a category of interaction which uses gesture recognition as an input method in digital systems. Saffer (2008) states that a gesture is a physical movement a digital system can capture and respond to, with no use of any peripheral pointing, such as the mouse or stylus. For the author, we have entered a new era of interaction, and paradigms established in the 60s and 70s such as the metaphors of the "Desktop", "windows", and "copy and paste", already deeply rooted in the use of personal computers will be supplemented by interaction methods that use the entire human body (Saffer, 2008).

The characteristics of gesture interaction can be described as: (a) it provides a more natural interaction, less heavy devices, since it is not necessary to add visible hardware such as a mouse or physical keyboards; (b) it provides a more flexible interaction, as opposed to physical elements which always have the same setting, gestural interaction systems can create different input conditions; (c) the gestural interaction also allows more nuances, gestures are related to subtle forms of communication, which can be exploited in human-computer systems interaction; (d) gesture interactions are more fun, because they allow users to explore different forms of interaction (Saffer, 2008).

For Wigdor and Wixon (2011), gesture interaction does not supplant existing interaction technologies, it only adds one more possibility of interaction. The evolution of the interfaces goes through three major phases: command line, graphical interfaces and gesture interaction, but command line interaction still exists in specialized programming sectors, and graphical interfaces continue to be the favorite for activities in daily life. Gesture interaction only replaces graphical interfaces in niches where it can deliver a better experience.

So, gestural interfaces cannot be considered natural in every niche, and they are more suitable in more strongly oriented systems for fun purposes, such as electronic games, and may not be the best for other daily tasks such as entering text or spreadsheet formatting, for example (WIGDOR and WIXON, 2011).

In agreement with Wigdor and Wizon (2001), Beurden, Jsselsteijn and Kort (2011) compared pointing devices for information input (mouse) with gestural input devices (Nintendo Wii). The results suggest that pragmatic attributes, such as speed and accuracy, are significantly higher in the case of the mouse, while the hedonic attributes, such as entertainment are significantly higher in the interaction with

gestures. However the authors state that the results should be cautiously evaluated, since the preference for gesture interaction can be related to the new system and not necessarily to the quality of the interaction itself.

Also, Rice at al (2011) evaluated gesture interaction for the elderly public through games on big screens and interaction by free and peripheral designed gestures. The results indicate that gesture interaction was considered stimulating, engaging, immersive and easy to use.

And finally, for Nielsen and Budiu (2012) the reduction of interface elements is important in some systems, especially those where there is a little space available on the screen as in smartphones. In such cases gesture interaction is a viable solution to avoid the overload of graphics on the system interface. But the authors suggest a learning phase with functionality indicators for novice users.

Related to the development of gesture interactions, the Android and IOS mobile operating systems have touch interaction patterns that can be used in the design of mobile systems. These patterns enable similar forms of interaction with touch screens, with slight variations.

IOS provides touch (in any amount), long touch, move (activating and moving interface objects), pinching with two fingers, two-finger expansion, swipe, two-finger rotation INC., 2013). The Android system supports the same actions above, but in the case of simple touch only two possibilities are supported, the simple touch and the double touch, unlike IOS, that allows the manipulation of touches in any quantity (GOOGLE INC., 2013).

In addition to the preset touches for operating systems, programmers can establish other forms of interaction by mapping the gestures in the interface. However, this type of project involves a greater technical effort, since the gesture processing algorithms need to be fully developed.

3. GESTURE INTERACTION ISSUES

Gesture interaction, like any design decision, depends on the assessment of user needs, and is not the best solution in all cases. It is not recommended for large volumes of data inputs, such as extensive typing tasks; for users with visual difficulties, since the feedback of many interfaces is strongly dependent on the visual feedback; when there is a great physical demand, actions that require large movements may not be performed by all users, and the same applies to tasks that require very delicate and precise gestures; in inappropriate contexts, some gestures can be embarrassing for users, depending on the point of use, such as in public spaces, for example (Saffer, 2008).

Nielsen and Budiu (2012) imply that gesture interactions can be problematic if the action performed by the system is different from the expected action by the user. Thus, the actions should be as natural as possible, have some correlation with everyday actions and not use arbitrary or unusual gestures. For the authors, the general guideline is that gestures are designed to have some connection with the use of physical objects, such as the flipping from one page to another in digital books with a horizontal gesture with the finger. In addition, observation of gesture patterns for each operating system contributes to quick use learning.

Other issues of gesture interaction are related to the implementation of a heavily based universe in pointing devices (such as a mouse and stylus) to another based on gestures (WU et al., 2006). In this scenario, some recommendations and standards can be simply transposed, while others must be developed and tested.

Norman and Nielsen (2010) state that gesture interaction can be a problem for the user's experience, since there are principles that are absolutely independent of technology and that are not met in most systems with interaction based on gestures. One problem is the system affordance, a concern that is corroborated by Nielsen and Budiu (2012) and Saffer (2008).

According to Gibson (2014) affordances are physical characteristics of objects and environments that enable the possible interactions of human beings (or any other agent, such as animals) with these environments. These possibilities of perception concern the evaluation of surfaces, environments, objects and even between two living beings, such as animals x humans or even among humans themselves. Being a perceptive characteristic, affordances can provide positive and negative insights in the sense that they may indicate an opportunity or a threat.

Norman (2013) has used the concept of affordance proposed by Gibson in the universe of human computer interaction to describe the visual characteristics of the interfaces that allow a user to identify the possible actions to be performed. Although more restricted than that proposed by Gibson, it became widely adopted by the design community, which until then (around the beginning of the year 2000) did not have a term to define and discuss the visual characteristics that made possible the interaction Human-computer.

When comparing the subjective preference and the objective use measurement values of the two drag gestures and three enlarging gestures among the different age groups, it was found that children and adults were consistent, whereas the elderly were inconsistent. Overall, in operating the original drag and pinch gestures, the elderly exhibited better objective use measurements, but they preferred the improved gestures, such as slide down.

However, real-world objects have more clearly defined affordances, for example a handle, the shape itself indicates that it should be grasped, and being connected to a door suggests that it should be used to open or close this door (COOPER, RAIMAN AND CRONIN , 2013).

Digital affordances on the opposite, only indicate a possibility of interaction, they have more difficulty in suggesting what can be done with them. A button on an interface may suggest that it can be clicked, but the result of that click is difficult to predict only by formatting its shape (COOPER, RAIMAN AND CRONIN, 2013).

In gesture interaction the affordances issues can be even more challenging because in some situations there can be no visual clues indicating the results of specific gestures (NORMAN and NIELSEN, 2010).

Also, as stated by Norman and Nielsen (2010), all human-computer systems must have a high capacity for discovery, that is, users should be able to unravel the functionalities through consistent operation of the menu system. However, the authors believe that some gesture-based systems have hidden features that can only be accessed by specific gestures.

Another issue, the visual feedback is a duty in any system however in the case of gesture interaction it is more urgent since these systems are often accidentally activated, according to Wu et al (2006); Nielsen and Norman (2010); Gatto and Pittarello (2012).

Also, Wu et al (2006) adds the problem of occlusion of interaction elements in touch-based systems where the finger or hand can hide elements of the interface during the interaction process.

For Norman and Nielsen (2010), the lack of consistency or standards is one of the great problems of this type of interaction. For the authors, the companies' insistence on establishing their own interaction agreements results in severe

difficulties for users, since it requires a new learning for each system. In addition, Gatto and Pitarello (2012) imply that the meanings of gestures vary from culture to culture, and therefore they cannot be considered universal, suggesting the need for a learning period.

3.1 The effect of satisfaction on e- commerce

Electronic commerce has taken several years to establish itself as an economically viable option, however currently it can be considered a common and even popular option. The same goes for trade transactions from mobile devices which is presented as a more convenient option for relationship with consumers, as it can reach them in situations where personal computers and tablets have big difficulty, such as in front of the television or on the street (Skeldon, 2012).

Schade and Nielsen (2012) argue that the three main reasons that lead consumers to buy online are the ability to access and select products that they could not access in other ways; the convenience of having the products delivered where the consumer wants; and the price, since the search for prices on the internet is much easier than other methods.

The device mobility allows searching for information in varied environments, and over 58% of US consumers have used a smartphone to find information and products of a particular brand or store, 55% of them have researched prices in a physical store (Martin, 2013).

However, users on the Internet can experience relative vulnerability, because they have no control over access to their personal information. Also, they are not able to feel, touch or physically try the products, which generates a sense of insecurity in the purchase. Thus, trust and risk are closely related: the higher the perceived risk, the higher the confidence to facilitate a transaction. Therefore, the quality of a website, including information, usability, security and privacy, was influential in gaining the consumers' trust.

The effective design of the site, including navigation capability or visual appeal, can potentially result in confidence or satisfaction, and these two factors contribute to improve customer loyalty, which can contribute decisively in profits, as a retention of 5% can increase profits by around 25% to 95%. At least three factors, information design, navigation design and visual design, have a direct effect on loyalty and account for approximately 41% of the variation of this factor (CYR, 2008). Other interface factors, including download speed, quality of information or service, and the aesthetics of the site do not show significant relationships to the trust (Chen, Dibb and Keynes, 2010).

The results of the research by Casaló *et al* (2008) also indicate a positive and significant influence of the reputation and the satisfaction in the loyalty of the visitor, also it is corroborated the influence of the usability in the satisfaction of the user and finally the familiarity is confirmed as moderating factor of the process. The authors (2008) also argue that usability does not only increase satisfaction, but has a direct effect on loyalty.

In Human Computer Interaction, the satisfaction also plays an important role, as it is one of concepts that defines usability. For the ISO 9241-11 the usability can be described as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.

These studies suggest that the satisfaction on the use of websites has an effect on trust and loyalty of website visitors, and elements that provide a more efficient use of e-commerce websites can enhance the satisfaction and consequently the loyalty of e-commerce users, especially for mobile devices which may have poorer usability than other forms of use.

Therefore, given the literature review presented here, it is possible to assume that the satisfaction of using a digital system has an important effect on the loyalty of users of electronic commerce, and that there are aspects of the gesture interaction that can improve the satisfaction of use in electronic commerce (SAFFER, 2008) as the decrease of the amount of graphic elements in the interface (NIELSEN and BIDIU, 2012), or more natural and flexible interactions (SAFFER, 2008). However, there are concerns related to this category of interaction that are not clearly stated in recent studies, such as the affordance and discoverability issues described by Nielsen and Norman (2010).

Thus, knowing the effects of gesture interaction in electronic commerce can be considered a relevant concern both for electronic commerce and for the Human Computer Interaction area and in order to address this research concern will be described below the methodological procedures of this study.

4. MATERIALS AND METHODS

This study is characterized as a usability comparison study and seeks to identify which of two possible options is the easiest to use, learn or understand from the users' perspective (Rubin and Chisnell, 2008).

4.1 The present study

Observing the positive characteristics of gesture interaction and the recent possibility of using this type of interaction on websites, this study aims to compare the satisfaction of users regarding gesture interaction and "tap only" interaction on e-commerce websites for smartphones. In this study the term "tap only interaction" refers to interaction based on a point and click behavior, like the most common use of mouse. On the other hand, the term "gesture interaction" refers to a broader use of the touch screen, including "drag and drop" and "swipe" gestures.

The study was conducted as a usability comparison test with two prototypes of websites, one of them using predominantly "tap only" interaction and another using predominantly gesture interaction. The test was conducted with 20 university students aging between 20-24 years-old considering that this group is the one that most owns cell phones in Brasil (IBGE, 2016).

Based on the previous review, we propose three study hypotheses: H1) gesture interaction gives greater satisfaction than the "tap only" interaction; H2) "tap only" interaction gives greater satisfaction than the gesture interaction; H0) the two interaction modes give the same satisfaction to users.

4.2 Study Individuals

In this study, 20 individuals were asked to use two versions of an e-commerce website prototype, one of the versions prioritizing gesture interaction and other the "tap only" interaction. User satisfaction was documented using an adapted version of the PSSUQ (Post Study System Usability Questionnaire) proposed by Lewis (1992).

The selected users are college students from 19 to 23 years old (21 ± 2) considering that this group is the one that most owns cell phones in Brazil (IBGE, 2016). The selected users should also already have had a smartphone with touch screen capability for the six months to ensure that lack of familiarity with the device had no effect on the results. Individuals with expertise in design, computer science and usability, such as students in design and computer science, were excluded from the sample.

Sampling took place in February and March 2014 in the conglomerates of two universities in the south of Santa Catarina, Brazil, due to that they presented a great concentration of the groups to be studied. The selection of the participants took place through invitations in classrooms and research laboratories of the institutions.

Tap	Strongly Agree	7	6	5	4	3	2	1	Strongly Disagree	N/A
Gesture	Strongly Agree	7	6	5	4	3	2	1	Strongly Disagree	N/A

Comments:

Figure 1: Lewis (1993) PSSUQ form adaptation example.

4.3 Satisfaction Assessment

User satisfaction was evaluated using an adapted version of the PSSUQ form (Post Study System Usability Questionnaire) proposed by Lewis (1992) and revised by Rosa (2015). In Lewis' version the form is formatted with a seven-point Likert scale and a field for comments.

Table 1: PSSUQ sub scores.

#	Question	Sub score
1	Overall, I am satisfied with how easy it is to use this system	System quality
2	It was simple to use this system	System quality
3	I could effectively complete the tasks and scenarios using this system	System quality
4	I was able to complete the tasks and scenarios quickly using this system	System quality
5	I was able to efficiently complete the tasks and scenarios using this system	System quality
6	I felt comfortable using this system	System quality
7	It was easy to learn to use this system	System quality
8	I believe I could become productive quickly using this system	System quality
9	The system gave error messages that clearly told me how to fix problems	Information quality
10	Whenever I made a mistake using the system, I could recover easily and quickly	Information quality
11	The information (such as on-line help, on-screen messages, and other documentation) provided with this system was clear	Information quality
12	It was easy to find the information I needed	Information quality
13	The information provided for the system was easy to understand	Information quality
14	The information was effective in helping me complete the tasks and scenarios	Information quality
15	The organization of information on the system screens was clear	Interface quality
16	The interface of this system was pleasant	Interface quality
17	I liked using the interface of this system	Interface quality
18	This system has all the functions and capabilities I expect it to have	Interface quality
19	Overall, I am satisfied with this system	Interface quality

To clarify the comparison between the two categories of interaction, in this study the Likert scale was split into two separate lines, related to the two interaction categories (Figure 1). The comments field was maintained to enable a qualitative assessment regarding user satisfaction.

The PSSUQ also has four sub scores related to different aspects of the satisfaction assessment described in table 1, the System Usefulness (items 1-6) related to the usefulness and efficiency of the system, the Information Quality (items 7-13) related to communication and information aspects, and Interface Quality (items 13-19) related to the interface itself.

As seen above the PSSUQ covers a breath of attributes related to the Human Computer Interaction assessment and is considered a very adaptable and reliable instrument (FRUHLING e LEE, 2005).

4.4 Prototypes

Satisfaction was compared using two e-commerce prototypes for smartphones, one with a possibility of gesture interactions, another using "tap only" interactions. To delimitate the two categories of interaction the two prototypes were developed with strict possibilities of interaction, in the prototype with "tap only" interaction the possibilities of gesture interaction have been reduced, for instance, the page scroll, very often used as an up gesture was removed. In the prototype with the possibility of gesture interaction the tap interactions, just like the action buttons, were also reduced. The main differences between the "tap only" prototype and "gesture" interactions are described below.

The two prototypes had the same information architecture and very similar graphical user interfaces. The "tap only" prototype interface is characterized by the more consistent presence of graphic elements of interaction, especially buttons. The prototype with the possibility of gesture interaction is characterized by the response to gestures like drag and drop and swipe.

The drag and drop and swipe actions were used because the Android and IOS mobile operating systems have touch interaction patterns that can be used in the design of mobile systems. These patterns enable similar forms of interaction with touch screens, with slight variations.



Figure 2: Examples of interaction modes for purchase actions, to the left purchase buttons, to the right addition to the cart through a drag and drop.

IOS provides for touch (in any amount), long touch, move (activating and moving interface objects), two-finger pinching, two-finger expansion, swipe, two-finger rotation INC., 2013). Android system supports the same actions above, but in the case of single touch only two possibilities are supported, the

single touch and the double touch, unlike IOS, that allows the manipulation of touches in any quantity (GOOGLE INC., 2013).

In addition to the preset touches for operating systems, programmers can establish other forms of interaction by mapping the gestures in the interface. However this type of project involves a greater technical effort, since the algorithms of the gestures processing need to be developed in a whole.

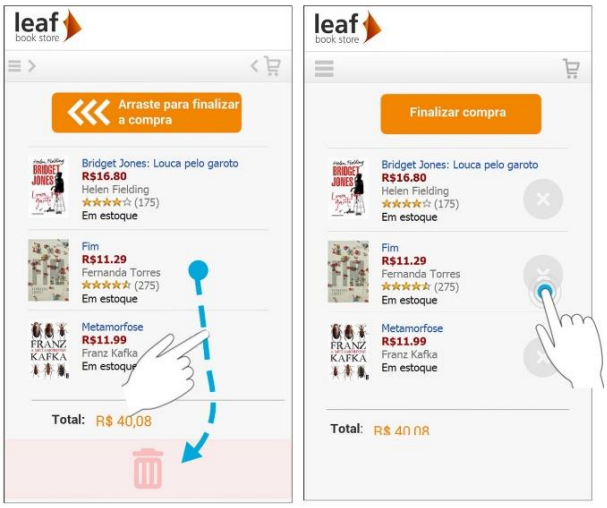


Figure 3: Examples of interaction modes performed to delete an item from the shopping cart, on the left drag and drop in the gesture prototype, on the right delete buttons.

Another concern is the interface overload. In smartphones, this kind of overload can be reduced using gestural interfaces (NIELSEN e BUDIU, 2012), so one of the objectives of the prototype was the reduction of interface elements such as buttons. In the gesture prototype the drag and drop gesture was used to add products to the shopping cart, and in the "tap only" prototype, buttons were used as a buying method (Figure 2).

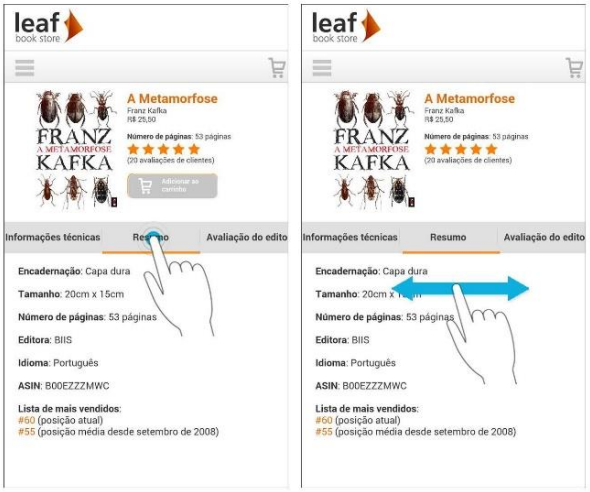


Figure 4: Examples of gestures used to navigate between blocks of information, on the left tap interaction, on the right use of a swap gesture.

Drag and drop gestures were also used to delete a book from the shopping cart while a delete button was used to perform the same task in the "tap only" prototype (Figure 3). Also, to improve discoverability in the gesture prototype the trash area was highlighted when the user tapped on one of the items of the list and a textual message at the top of the page indicated that the books should be dragged to it to be added to the shopping cart.

Navigation between contents was performed by a swap gesture at the gesture interface, since it is an example of good use of gestural interfaces (NIELSEN e BUDIU, 2012), and tag button navigation at the "tap only" interface, since it is a very common interface element (Figure 4).

The main menu was accessed by a swipe gesture starting from the left side of the screen, while the traditional menu button was used on the "tap only" interface (Figure 5). In the gesture prototype the menu icon was maintained with an small arrow to the right indicating the movement required to access the menu.

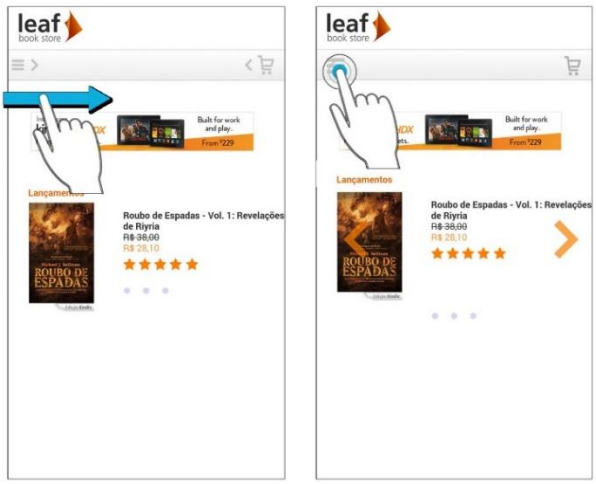


Figure 5: Examples of gestures used to access the main menu, on the left use of a swap gesture, on the right tap interaction.

The gesture prototype also had invitations screens (Figure 6) used as a learning phase element of interaction before actual use, as suggested by Nielsen and Budiu (2012). The screen indicates the movements required to use the menu, the shopping cart and the navigation between contents.



Figure 6: Example of interaction invitation used in the gesture prototype.

The prototypes are characterized as a virtual bookstore. This was chosen because of the possibility of selling the product in physical or digital format, that is considered a sales catalyst Skeldon (2012).

The prototypes were developed with the "Proto.io" platform and used by a Samsung Smartphone Galaxy SIII, a very popular device with high processing capabilities.

4.5 Research Procedures

All study subjects used the two prototypes alternately. The individuals were divided into two groups, the first group named "GT" first used the gesture based prototype and later the tap based prototype, the second group named "TG" first used the tap prototype and then the gesture prototype.

First the users consented to participate in the research and then completed a user profile form which describes the user's age, gender and experience with smartphones.

Then, the users were asked to perform a sequence of tasks (described below) modeled from the 'search for a specific product' behavior described by Schade and Nielsen (2012), which for the authors are responsible for 35% of the reasons to access e-commerce websites. The authors categorize navigation on e-commerce into five major groups of pages as shown below:

1. Home page product categories: which usually start the purchase process;
2. Product page: where information on individual products is listed;
3. Shopping cart: main sales management tool;
4. Search tools: used to facilitate the location of specific products;
5. Customer service: as chatting or purchase support systems aiming to help consumers in the purchase process.

In this study the first three categories of pages were covered, because they relate more directly to the buying process. Hence, these usability test tasks were modelled as shown below:

1. Find the book " Metamorphosis " by Franz Kafka in category " Books ";
2. Add the book " Metamorphosis " by Franz Kafka to Cart;
3. Sign in to book the link " Metamorphosis " by Franz Kafka and find its summary;
4. Access the shopping cart;
5. Delete the book "Fim" by Fernanda Torres Shopping cart ;
6. Simulate the purchase of the book using the payment option "Visa ".

The tasks were the same in both prototypes and were performed in the same sequence.

After performing these tasks on the two prototypes users were asked to complete the PSSUQ form. At the end of the usability test sessions the answers of the PSSUQ form were reviewed by the interviewer and if there was any doubt about the answers the users were invited to complement them.

The tests were applied individually in a meeting room with a strong wireless signal and large internet bandwidth so the internet connection had very short effect on the user's satisfaction. The tests took place in April 2014.

4.6 Data Analysis Method

The analysis started with a descriptive analysis of the individuals involved in the research to identify the sample profile. Later, the scores of the PSSUQ form were compared between genders of respondents (men x women), between the different study groups (GT x TG), and between the smartphone use profiles (frequent users x occasional users) to assess whether there were significant differences between these paired groups. The comparison was performed using the Mann-Whitney U-test (MACFARLAND AND YATES, 2016) with an alpha value of 5 % ($p < 0.05$).

After that preliminary analysis, the scores of the two modes of use (gesture x touch) were compared in each of the responses of the PSSUQ form, and their sub scores. The scores were analyzed by their frequency distribution to identify preference trends and those were validated using the Wilcoxon test (paired) with an alpha value of 5 % ($p < 0.05$).

Later the reviews were analyzed by frequency distribution of words used in the comments and assessing the context of the most frequent words. The comments analysis was performed by the QDA Miner 4.0 software.

5. RESULTS AND DISCUSSION

The sample consists of 20 undergraduate students, ten women and ten men, aged between 19 and 23 years (21 ± 2) and mean age of 19.75 years (SD = 1.552). Of these, six subjects reported using the smartphone at least once a week for internet access, another 14 subjects reported using the device more than once a week, with two groups characterized thus: "casual", using the smartphone at least once a week and "common", which uses the device more than once a week. As discussed in section 2.4 individuals were divided into two groups, one using first the tap prototype and named "TG" (N=10) and other first using the gesture prototype named "GT" (N=10).

No significant differences were identified in the scores of the three groups defined in the study (casual x common, men x women and between the two "TG" and "GT" groups) according to the Mann Whitney "U" test. Thus, the sample was homogenized.

5.1 Tap only x gesture comparison

The results of the satisfaction comparison between the two prototype categories will be discussed below.

The first analysis was the frequency distribution of the average scores for each question (Figure 7). As can be observed the "tap only" prototype had the best scores in all questions, so it can be assumed that in this study the "tap only" interaction is the preferred one.

However, the satisfaction assessment scores showed statistically significant differences in seven of the 19 questions, six of them related to the subs core " system quality" and one related to the "interface quality" sub score. The differences between the "information quality" sub scores did not present statistically significant differences (table 2)

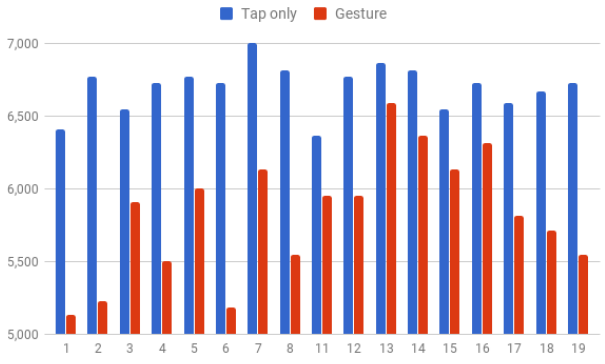


Figure 7: Frequency distribution of the average scores in each question of the PSSUQ.

Table 2: Mann Whitney "U" test results.

#	Question	Sub score	p
1	Overall, I am satisfied with how easy it is to use this system	System quality	**0,027***
2	It was simple to use this system	System quality	**0,002***
3	I could effectively complete the tasks and scenarios using this system	System quality	0,168
4	I was able to complete the tasks and scenarios quickly using this system	System quality	**0,003***
5	I was able to efficiently complete the tasks and scenarios using this system	System quality	0,072
6	I felt comfortable using this system	System quality	**0,002***
7	It was easy to learn to use this system	System quality	**0,01***
8	I believe I could become productive quickly using this system	System quality	**0,024***
9	The system gave error messages that clearly told me how to fix problems	Information quality	**
10	Whenever I made a mistake using the system, I could recover easily and quickly	Information quality	**
11	The information (such as on-line help, on-screen messages, and other documentation) provided with this system was clear	Information quality	0,581
12	It was easy to find the information I needed	Information quality	0,084
13	The information provided for the system was easy to understand	Information quality	0,414
14	The information was effective in helping me complete the tasks and scenarios	Information quality	0,059
15	The organization of information on the system screens was clear	Interface quality	0,222
16	The interface of this system was pleasant	Interface quality	0,197
17	I liked using the interface of this system	Interface quality	0,522
18	This system has all the functions and capabilities I expect it to have	Interface quality	0,058
19	Overall, I am satisfied with this system	Interface quality	**0,016***

* Statistically significant results p<0,05
** Question omitted since no errors were simulated in the prototype.

Observing the results of the sub-scores it is possible to suggest that the dissatisfaction is due to pragmatic aspects (sub-score "quality of the system"), since the questions with greater statistical difference are related to the proper use of the system. The question "it was easy to learn the system" (p=0,01), "It was simple to use this system" (p=0,002) and "Overall, I am satisfied with how easy it is to use this system" (p=0,027) indicates that the gesture interaction was not easy to use and may corroborate with Norman and Nielsen (2010) when they state that the discoverability of gestural interfaces can be reduced. In this study, even with visual clues, as the menu and shopping cart icons in the top of the screen, and the invitation screens used to communicate the movements required for the use of the system, the learning of the system seems to be difficult in the perspective of the users.

The efficiency of the system also seems to have been negatively affected by gesture interaction, since the questions "I was able to complete the tasks and scenarios quickly using this system" (0,03) and "I believe I could become productive quickly using this system" (p=0,024), present a statistically significant variation. In fact, some gestures take a little long to perform than a single "tap".

But two aspects of the quality of the system sub-scores received an insignificant difference between the two prototypes despite the predilection for the "tap only" interface. The questions "I could effectively complete the tasks and scenarios using this system" (p=0,168) and "I was able to efficiently complete the tasks and scenarios using this system" (p=0,072), both related to the completion of the tasks. So, it seems that the gesture interaction does not become a barrier to the accomplishment of the tasks.

It is possible to suppose that the questions related to aspects of information of the system did not have significant differences because in terms of presentation of information the two interfaces were very similar.

5.2 Comment evaluation

As mentioned before, the second stage of the analysis was the comment of the users regarding the use of the system. The PSSUQ suggests a text field for comments, used to clarify the reasons for each score. However, in the present study most of the users concentrated the comments on the initial questions of the form, which translated in a certain reduction of qualitative answers.

The first analysis was the frequency distribution of terms used in the comments, and the first four most frequent terms are presented below (Table 3), all other terms obtained drastically lower scores (10 repetitions or less within 20 responses).

Table 3: Four most frequent terms in the comments.

#	Term	Count	Relative Frequency*
1	Tap	20	28.612
2	Gesture(s)	19	27.182
3	Easy	15	21.469
4	System	11	15.739

* per million

Excluding the words "gesture" and "tap", which describe the two categories of interaction in the study and would naturally appear as an answer, one can notice the frequency

of the word "easy", which reinforces the expectation of ease of use by the users.

The next step in the analysis is the identification of contexts where the terms "tap", "gesture" and "easy" appear. The cross-referencing of the word "system" with others is not analyzed because it describes a technological aspect, and not an element directly related to the user satisfaction.

In the comments, six users said that tap interfaces are easier when compared to the gesture interfaces (Table 4). It was also observed that at some moments users still had a strong mental model based on pointing interfaces (such as mouse), corroborating the statement of Wu et al. (2006), who says that the biggest challenge of gesture interaction is the overcome of a heavily pointing based universe to another emphasizing gestures. One user (Table 4 – case 2) explicitly mentioned the notebook as interaction reference.

Table 4: User comments matching the words TAP and EASY.

#	Text	Profile	Genre
1	The TAP system is EASIER, because I'm more used to this when I surf the web.	Cm	F
2	The TAP system looks more like the accessed from a notebook, so it becomes EASIER.	Cm	M
3	I'm used to the "TAP" interaction, so it was EASIER to do the tasks using that alternative.	Cs	F
4	The TAP test was EASIER because it is more straightforward.	Cs	M
5	Both systems were easy to use, but the TAP is the EASIEST.	Cs	F
6	The TAP system is faster, EASIER to understand, and under my perspective, safer to use.	Cm	M

Cm = common, Cs = casual, M = male, F = female

In two cases, users say they are already used to tap interaction (cases 1 and 3), which suggests that the patterns established by this type of interaction are sufficiently consistent and effective, corroborating Nielsen and Norman's (2010) concern about exploiting existing patterns.

In only one comment the gesture interaction mentioned both EASY and GESTURE keywords (Table 4), in the comment the user states both interfaces are easy to learn.

Table 5: User comments matching the words GESTURE and EASY

#	Text	Profile	Genre
1	GESTURE system became more EASY to use, despite the two being didactic.	Cm	M

Cm = common, Cs = casual, M = male, F = female

As observed in tables 4 and 5, both the "casual" and "common" groups, and the male and female genders present similar responses, which corroborates the statistical analysis described in section 2.4, and reaffirms that the results are not the direct result of the users experience profile or of the gender of the participants.

Therefore, based on the results presented here, it is possible to consider that the interaction by gestures does not contribute to the satisfaction of users of websites, thus, the H2 hypothesis is retained.

The results seems to corroborate the assertion of Wigdor and Wixon (2011) and Beurden, Jsselsteijn and Kort (2011), who claim that the gestural interfaces are recommended for niches with emphasis on hedonic factors, such as electronic games. Apparently, on websites in general and more specifically in mobile e-commerce websites users seem to value efficiency and productivity.

The gestural interface proposed in this study was not easy to learn, even using gestures well known to users, such as drag and drop and swipe, and invitation system proposed by Nielsen and Bidiu (2012).

However, despite the significant differences in the evaluation of the two modes of interaction, it cannot be affirmed that the interaction by gestures had a rejection by the users. As it can be seen on Table 2, most evaluations do not presented a statistical difference between the two modes of interaction, and this suggests that there is a tenuous difference between the users' satisfaction.

In addition, many comments indicate the preference for touching from the perspective of a personal "habit" often related to the use of personal computers. Thus, it is possible to suppose that in the long term with the consolidation of other gesture interaction devices, the "habit" with the tap interaction would be compared in terms of experience to gesture interaction.

6. CONCLUSIONS

The use of smartphones for internet access is a seemingly unquestionable trend, and growing technologies to enhance the use of websites are increasing. In this sense since 2013, standards have been established for the development of websites with possibilities for interaction by gestures.

As in any decision related to Human Computer Interaction, the use of this category of interaction requires knowledge of its potentialities and weaknesses.

Gesture interaction can be described as an interaction category that is based on the recognition of users' gestures and on smartphones is widely used through the touch screen of the device and this category of interaction can turn the interfaces more fun and enjoyable depending on the niche where they are used. However, significant problems such as the difficulty of communicating affordances and elements of system discovery can have the opposite effect and make interaction unsatisfactory.

In the present study, we evaluated the satisfaction of two e-commerce prototypes developed to isolate gesture interaction from the currently established interaction for websites, namely the tap interaction, described here as a simple touch on the screen.

The choice of satisfaction as a metric of the study is based on evidence that satisfaction has an effect on the trust and loyalty of visitors, key elements for internet-based business.

The results of the study suggest that gesture interaction when used exclusively in an e-commerce interface reduces user satisfaction, because they seem to prefer the currently established standards. In addition, users apparently perceive tap interaction as a category of interaction easier than gesture interaction, even in situations where the gestures used were already known such as swipe and drag and drop, both widely used in the IOS and Android systems, the most used operational systems nowadays.

Based on the findings of this study, gesture interaction is not recommended for e-commerce websites today, or at least major interaction categories such as drag and drop and sweep have not been effective enough from the users' point of view.

However, this study was based on a single round of use, which means that the results represent only a first impression of the use and it is possible to suppose that in the long term use this reduced satisfaction would not be as high.

Also, nowadays most websites are developed only with a tap based interaction, which creates a mental model based on this type of interaction, and that appears as one result of this study. So, it is possible to suppose that a hybrid interface can be successful to increase the user satisfaction.

In addition, the research format, an adapted usability lab, may not be able to identify the key elements that make up the smartphone users' experience of gesture interaction, which will most often be in two distinct environments. A crowded, interfering public environment that reduces the ability to experiment with the system, and a domestic environment where experience is less strict than a laboratory.

For future work it is suggested the exploration of other interaction categories for websites, as well as the enlargement of the sample size and the type of prototype used in this study. In this case, it is suggested a hybrid interface with both gesture and tap interactions.

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