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Exploration of the Impact of 3D Gestural Interaction on the Customer Experience

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Abstract

Nowadays, creating a positive customer experience is a key source of competitive advantage (Lemon & Verhoef, 2016). A good experience makes a person five times more likely to recommend a company and more likely to purchase in the future (Yohn, 2019). Besides, gestural interaction (Daugherty et al., 2015) technology appears as a promising way to provide individuals a more immersive and richer experience than with classical user interfaces (Vanderdonckt & Vatavu, 2018). However, we currently ignore the concrete impact of this type of interaction on the customer experience, whereas it is necessary for an efficient adoption of such interfaces. The aim of this work is therefore to overcome this gap in order to provide a sufficient understanding allowing to efficiently design such interfaces, with the objective of providing a more complete and rich customer experience. In order to do so, we selected the most representative variables to assess regarding the experience and the gestural interaction. We then build a digital catalog controllable by our mid-air hand gestures. After a data collection phase in a controlled laboratory environment, we analyzed the quantitative and qualitative data. Doing so allowed us to answer to our research questions: "what are the key aspects to consider when designing gestural interaction interfaces?" and "how does the gestural interaction impact the customer experience?". This work contributes to the current literature by providing understanding of the impact of new technologies in retailing, and particularly in the case of 3D gestural interaction. From a managerial point of view, we provide guidelines for the use of this type of new technology and its impact on the customer experience.

Keywords: Gestural Interaction; Mid-Air Hand Gestures; Structural Equation Modeling; Digital Catalogs; Online Customer Experience

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1. Introduction

For several years now, the customer experience has become of capital importance in marketing (Holbrook & Hirschman, 1982; Pine & Gilmore, 1998; Verhoef et al., 2009), and perhaps even more in the field of retailing (Jin and Sternquist, 2004). Indeed, providing optimal customer experiences is now key for companies in order to ensure their competitiveness (Lemon & Verhoef, 2016). In addition, technologies are constantly evolving to provide more and more immersive, rich and complete experiences.
One of the latest trending technologies is the 3D gestural interaction (Daugherty et al., 2015), mainly studied in the discipline of human-computer interaction. This consists of the interaction between an individual, producing movements with any part of his body, and a computer system, capable of interpreting those movements. This topic is particularly interesting as gestural interaction is considered intuitive and natural because it is based on the gestural communication that humans acquire naturally (Baudel & Beaudouin-Lafon, 1993).
Yet, while we know that this mode of interaction tends to offer individuals a richer user experience than a traditional user interface (Vanderdonckt & Vatavu, 2018), we still ignore its impact on the customer experience. It is particularly important as the customer experience is broader than the user experience and considers subjective and emotional aspects of individuals (Sellier et al., 2021). Understanding these would enable practitioners to pay particular attention to the important aspects to consider when designing such interfaces, with the objective of providing a more complete and rich customer experience. Therefore, we formulate the following research questions: “what are the key aspects to consider when designing gestural interaction interfaces?” and “how does the gestural interaction impact the customer experience?”.
In order to answer there, we gathered different variables from marketing and human-computer interaction literatures. We then built a digital catalog controllable by gestures and carried out an exploratory data collection in which the participants, after having carried out an experience of interaction with the catalogue, fill in a questionnaire containing the variables of our model. The first results, obtained using SmartPLS, are then presented in this paper with some recommendations.

2. Methodology

In this chapter we detail how we selected the variables to take into account in order to build a conceptual model. We then develop the digital catalog created for the data collection and the protocol that was followed.

2.1. Construction of a conceptual model

To collect a corpus of representative literature, we were able to benefit from a systematic literature review on the design of gesture vocabularies (Xia et al., to appear). This article analyzes a final corpus of 237 articles and identifies 13 key factors to take into account when designing gestures, from a physical, cognitive, situational and system point of view. In parallel with this work, we carried out a targeted literature review to cover other aspects of the experience that results from a gestural interaction, adding 270 articles. After the identification and screening, we analyzed the content of the articles in our corpus. For each, we noted all the elements mentioned which could be related to important factors of the gestures and the experience resulting from a gestural interaction. We also noted the definitions given as well as the modes of evaluation of these dimensions. After merging our data, taking synonyms into account, we ended up with a table summarizing the most used factors to consider in our model and their relations. We then built a conceptual model which, for reasons of the length of this extended abstract, will not be presented here.

2.2. Creation of a digital catalog

We constructed an IKEA digital catalog fully controllable by our mid-air hand gestures, based on the Large User Interface project (Parthiban & Lee, 2019). The interface is controlled using the Leap Motion Controller, a small (80×30×13mm) device that connects to a computer via its USB port. The interface that enables to use this sensor is the Large User Interface (LUI), managed by The MIT Media Lab. It is aimed at allowing people to naturally interact by gesture to manipulate multimedia contents on a large display, such as a wall display or a tabletop. Initially, this interface works with a set of pre-recorded gestures. However, the system we used in this work replaced the commands by a gesture recognition algorithm selected following a benchmarking. Thereafter, a gesture elicitation study was then carried out (Wobbrock et al., 2009). The aim of this type of study is to provide a gesture recognition algorithm with enough data to function properly and to implement gestures chosen by end users rather than arbitrarily selected by the researchers. The catalog is controllable by only one hand at a time, and

it is possible to change the hand controlling the system in order to adapt to the dominant hand of the user. Note that the initial version of LUI integrates a series of voice commands, which is an aspect abandoned in this version. In addition to changes in how it works, the interface has also been redesigned to look like an IKEA digital catalog.

2.3. Experimental protocol

As it is a first exploratory data collection, the sample of participants is composed of 35 students, aged between 19 and 23, and in which 4 were left-handed. First, a setup phase is carried out by the experimenters. They install a large 80inch 8k television as well as the Leap Motion device. The latter is placed 1.80 meters from the television, around 30 centimeters below the user's chest height. Therefore, this height is adapted during the passage of each participant. During this time, the participant completes the consent form and answers a few questions.
As suggested in the first evaluation of LUI (Parthiban, 2019), participants first have the opportunity to freely discover the interface for 3 minutes. This step makes it possible in particular to test the discoverability of gestures, which is the ability of users who are new to the system to find out by themselves how it works and what gestures to perform to control it (Wobbrock et al., 2005). For this phase, the participants are correctly placed at 1.80 meters from the screen, standing up in front of the Leap Motion device, and the only instruction given to them is that this system is controlled by the gestures they perform using their hand above the device.
Once this first phase is completed, the participants are given a video tutorial showing all the existing commands and the corresponding gestures. They are then offered to play again this video as many times as they want since they will then have two tasks to perform.
The first task is the video viewing scenario: the user must use the "videos" application, choose a video to watch and have the opportunity to fast forward. In the second task, participants are instructed to freely browse the interface and add the products they like to their basket. In order to motivate the participants to really get involved in this shopping situation, they are notified that they have a chance to be drawn and win one of the items they have liked. The duration of this second task is free, i.e., it is up to the participant to indicate when they estimate they have finished shopping. During this task and the previous one the participants receive an A4 sheet summarizing all the possible actions of the interface and the corresponding gestures. We also allow ourselves to repeat the instructions of the task if necessary. Other than these cases, no other help is provided. At the end of the session, the participants are asked to answer to a questionnaire. It is then followed by a quick interview, where participants have the possibility to formulate a free comment regarding their experience and the interface.

3. Exploration of the data

As the sample is composed of only 35 participants, we opted to use SmartPLS in order to analyze our results, based on our conceptual model. The structural equation modeling model retained after several analyzes is available in Figure 1.

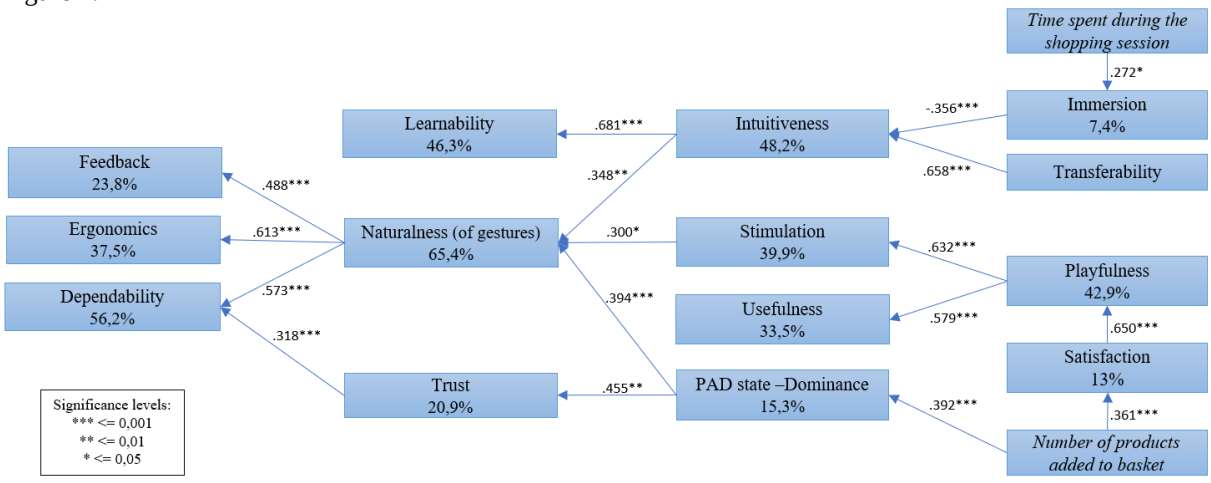

Figure 1: Model obtained after analysis via SmartPLS.

A first use of this model is that it highlights the important variables to consider when designing a gestural interaction interface. These variables are each defined in Table 1. In addition to highlighting these variables, this model enables us to detail some important relationships.

Table 1: Definition of the variables retained in our model.

Variable	**Definition**
Feedback	The signals that the interface returns in order to communicate with the user, on the basis of his actions. For example, the interface can send a visual signal in order to make it understood that a gesture has been recognized.
Ergonomics	According to the norm ISO 9241-400:2007, the ergonomics are the human anatomical, anthropometric, physiological and biomechanical characteristics related to physical activity. In our case, the produced gestures must be comfortable and allow a long-term use without causing too much muscular or cognitive fatigue.
Dependability	User's sense of control over the interface. Is the interaction secure and predictable?
Learnability	This factor, also called memorability (Nacenta et al., 2013), refers to the ease with which a new user can learn to use the interface and achieve maximal performance gestures (Dix, 2004). This factor is also linked to the intuitiveness as it is easier to learn how to use an interface based on intuitive gesture.
Naturalness	Considered as an objective of the gestural interaction experience, this factor refers to the subjective feeling of whether the interaction seems "natural" to the participant (Wigdor & Wixon, 2011). The advantage of including such a variable comes from the fact that gestural interaction can be considered natural because it is based on the gestural communication that humans acquire naturally (Baudel & Beaudouin-Lafon, 1993).
Trust	This is a user's subjective impression of how much confidence he can place in the system. This aspect enables to address issues of perceived security and anxiety, i.e. emotional factors more present in the customer and consumer experience (Rose et al., 2012; Sauro, 2015).
Intuitiveness	The degree to which a gesture refers to existing knowledge (Raskin, 1994), often because it is based on an existing movement or a metaphor. This factor is sometimes linked to the discoverability but remains different. For example, an experiment in 2007 showed that users new to touch screens almost never discovered the "pinch to zoom" movement, whereas once this movement was shown to them, they used it intuitively (Wigdor & Wixon, 2011).
Stimulation	This dimension corresponds to the difficulty of the task and of the interaction compared to the personal capacities. The reason why this factor must be taken into account is that some users do not necessarily seek to be as much as possible in their comfort zone but like to be challenged.
Usefulness	As the objective of a computer system is often to perform one or more tasks, this indicator aims to measure whether the performance of the system corresponds to the expectations of the user and whether this has been useful to him. This is a classic element already taken into account in most User Experience measurements (Turunen et al., 2009).
Emotional state	This factor enables to assess the global emotional state of individuals after interacting with the system. A quick measure of this state can be done through the Pleasure-Arousal-Dominance (PAD) model (Mehrabian, 1995). This model dichotomizes each of its three dimensions: pleasure versus displeasure, arousal versus non-arousal, and dominance versus submissiveness. Using it in our model makes it possible in particular to address the dimension of perceived control.
Immersion	This factor, often called “flow” in the customer experience literature (Novak et al., 2000), describes the state of mind of individuals psychologically absorbed in the activity they perform (Nakamura & Csikszentmihalyi, 2014). This state is often characterized by inattention to time and circumstances surrounding the individual.
Transferability	This factor measures to what extend learning a gesture modifies its performance when we change context (Perkins & Salomon, 1992). For example, a gesture may become easier to perform because it is used in different applications to perform similar tasks.
Playfulness	The state triggered by elements that “engage people’s attention or involve them into activity for play, amusement or creative enjoyment” (Kuts, 2009, p.9). This factor can also be called "fun" in the consumer experience literature, of which it is one of the founding pillars (Holbrook & Hirschman, 1982).
Satisfaction	The global subjective judgment on the quality of the interaction that has taken place (Khalifa & Liu, 2007). This term is also an important metric of the usability (ISO 9241; ISO 25010).

One of the main paths put forward in this model includes naturalness as a central factor. Despite its more subjective nature, it can be explained by several variables specific to gesture design, namely the presence of feedback, the overall ergonomic of the interaction and the dependability of the interface. This thus corresponds to the human-computer interaction literature where the presence of feedback is perceived as fundamental for most user interface (Ben & Catherine, 1998) as it enables individuals to match their mental model to the functionalities of the interface (Norman, 2013). As for the other two variables, the difficulty is to succeed in defining gestures that are both easy to remember and execute, and which make it possible to provide an interaction that is secure and predictable. A particularly relevant method to address this challenge is to carry out gesture elicitation studies (Wobbrock et al., 2009), in which users are directly questioned on which gestures would be the most appropriate according to them to carry out a given action. However, the limitations of this type of user-led methodologies are that everyone is unique and therefore it is almost impossible to obtain a result that is universally recognized (Xia et al., to appear).

It is therefore not a solution that is perfect, but which nevertheless improves the situation.
On the other side of this model, the naturalness of the interaction has a positive effect on the perceived intuitiveness, the stimulation felt by the user and the impression of feeling in control of the situation. First, the impact on intuitiveness appears to be central in this mode of interaction, in particular because it ensures that the gestures implemented correspond to the expectations of the users (Lao et al., 2009). According to Hassenzahl (2003), stimulation plays an important role in the experience of individuals, and particularly in the case of interactive technologies (Hassenzahl, 2010). Providing an interaction perceived as natural is therefore particularly important in order to guarantee sufficient stimulation. Regarding the PAD state, the 3rd dimension opposes feeling in control of the situation to feeling controlled (Coutrix & Mandran, 2012), in this case by the system. The naturalness therefore appears as essential in its role of allowing users to feel in control of the situation. It is particularly relevant as customers desire to exercise control at all stages of the service process (Bateson, 1985; Van Raaij & Pruyn, 1998).
When we are interested in what makes an interaction intuitive, we observe that it is strongly explained by the ease of learning and not by the discoverability of gestures (which has even been removed from the model). This result corresponds to an important observation that was made during the sessions and confirmed using the feedback made during the interviews. When performing the free discovery phase, 49% of the participants did not discover any gestures and therefore remained stuck for 3 min in the main menu. Yet these people were ultimately happy with the overall interaction they had with the interface. Most described that after seeing the tutorial, the gestures were easy and intuitive, even if they hadn't discovered them on their own. In the literature in human computer interaction, discoverability is highlighted as being an important factor in the context of an interaction with an interface (Xia et al., to appear). However, it emerges here that a weak discoverability can be compensated by a high learnability, at least for the case of 3D gestural interaction. We could explain this by the new and therefore destabilizing nature of this mode of interaction. Users have few references in their lives to discover by themselves how to use the interface (Wigdor & Wixon, 2011). However, given this novelty character, the customer experience can still be high if it is easy to learn how to use the interface. We therefore recommend being extra careful when explaining how to operate this type of interface, whether through video tutorials or even personalized support.
Finally, we can observe the impact of this gestural interaction on various factors specific to retailing. Indeed, the time devoted to the shopping session is impacted by the immersion of the consumer, the shopping time not having been defined in advance and left to the choice of the participant. Therefore, the stronger the customer's immersion, the more time he will devote to his shopping session. This is already explained in the literature by the nature of immersion, which is characterized in particular by an intention to time (Nakamura & Csikszentmihalyi, 2014) when the individual is psychologically absorbed. Another interesting factor is the number of liked products, which tends to increase with the overall satisfaction and the feeling of control. Satisfaction is itself dependent on the playfulness, directly impacted by the gestural modality of the interaction. There is therefore a real financial interest in making efforts to provide an interaction that is both fun and in which the customer feels in control.

4. Conclusions and discussion

To understand the impact of gestural interaction technologies on the customer experience, we first answered our research question “what are the key aspects to consider when designing gestural interaction interfaces?”. To do so, we highlighted the important variables to take into account when building an interface based on gestural interaction, and then built a conceptual model. In order to test it, we set up an exploratory data collection in which participants interact with an IKEA digital catalog fully controllable with gestures. The first analyzes were then carried out using SmartPLS, allowing us to answer our second question “how does the gestural interaction impact the customer experience?”.
We observed the importance of the naturalness of the interaction which, despite being subjective, is explained by several factors more objective and specific to the gestures. This naturalness itself has an impact on the perceived intuitiveness of the interaction, the stimulation of the customer and his feeling of being in control of the situation. Moreover, we can directly observe the impact of this interaction on retailing, with a positive impact on the time spent shopping and the number of products added to the basket.
For the designers of such interfaces, we therefore recommend paying particular attention to the naturalness of the gestures implemented. For this, it seems relevant to go through a gesture elicitation study. Another important element is the need to set up easy and complete learning of the interface, for example via a tutorial as in this data collection or via personalized support. Regarding the impact of gestural interaction on the customer experience, we have seen that practitioners can use gestural interaction to provide a more immersive experience, increasing the time spent shopping, and more fun and satisfying, impacting the number of products added to cart. We must also not neglect the user's feeling of control, which will directly influence his consumption.

It should be kept in mind that this is only a first exploratory data collection carried out with students, with a relative overall high ease with technologies. Also, even if it was enough to run SmartPLS, the sample is relatively small. It would be appropriate in a future study to directly compare the gestural interaction with a "classical" interaction using a mouse.

This work contributes to the current literature by providing understanding of the impact of new technologies in retailing, and particularly in the case of 3D gestural interaction. From a managerial point of view, we provide guidelines for the use of this type of new technology and its impact on the customer experience. More specifically, we study how this type of technology can improve the experience, in an environment where it is crucial to stay one click ahead of the competition.

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