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**Article — Published Version**

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Journal of Consumer Behaviour

**Provided in Cooperation with:**

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*Suggested Citation:* Märting, Christian; Bissinger, Bärbel Christine; Asta, Pietro (2021) : Optimizing the digital customer journey—Improving user experience by exploiting emotions, personas and situations for individualized user interface adaptations, Journal of Consumer Behaviour, ISSN 1479-1838, Wiley, Hoboken, NJ, Vol. 22, Iss. 5, pp. 1050-1061, <https://doi.org/10.1002/cb.1964>

This Version is available at:

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**SPECIAL ISSUE ARTICLE**

# Optimizing the digital customer journey—Improving user experience by exploiting emotions, personas and situations for individualized user interface adaptations

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## Abstract

This paper discusses a novel approach for exploiting emotions and situation-aware software adaptation methods for individualizing some of the touch points of the digital customer journey and thereby optimizing customer experience and effectiveness of e-commerce applications. Our approach uses emotion recognition, eye-tracking, and other individual tracking methods as well as customer personas for adapting interactive web applications by accessing a flexible adaptation framework at runtime. The framework allows for individualization at runtime by applying situation-aware adaptations. Two experimental customer studies were carried out in the e-commerce domain in order to provide a basis for exploitable emotion- and persona-related situational changes. The results of the studies were used to demonstrate the potential of our situation analytic adaptation approach with examples from a commercial beauty-products e-business portal.

## 1 | INTRODUCTION

One aspect of digitalization in marketing is the design of IT-based solutions for the steps or cycles of the customer journey (Følstad & Kvale, 2018). The customer journey is the customer's interaction at several touch points with a service or several services of one or more service providers in order to achieve a specific goal (Halvorsrud et al., 2016).

A generic customer journey is divided into the following five phases: *awareness*, where the customer is made aware of the product or service, *favorability*, where the interest of the customer is increased, so that the customer begins to take a closer look at the product and to inform herself about it, *consideration*, which increasingly triggers the customer's desire to own the product, *intent to purchase*, where the customer's intention to buy the product is being initiated, and, finally *conversion*, where the product will ultimately be bought by the customer. It also makes sense to add a *post purchase phase* to the customer journey. A distinction is made between direct and indirect touch points. The website, advertising spots and

advertisement in general are understood as direct touch points. Indirect touch points for example include rating portals, user forums and blogs and can only be influenced to a limited extent by the provider.

Optimizing the customer journey is very important and necessary for the success of e-commerce providers. By using suitable tracking technologies, the behavior of consumers can be analyzed in real-time. Analysis can also reveal all contact points created through advertising. Thanks to this knowledge, it is possible to identify optimization potential. It must be the provider's goal at every touch point, to create a situation that leads to optimum user experience (UX) for the potential customer (Stein & Ramaseshan, 2016). UX in the customer journey is often described as customer experience (CX). CX aims at “a customer's cognitive, emotional, behavioral, sensorial, and social” reactions to the offerings of a provider or a business “during the customer's entire purchase journey” (Lemon & Verhoef, 2016).

This paper is a revised and extended version of (Märtin et al., 2020). In our previous research we have designed and engineered the *SitAdapt* system that is able to observe activities and recognize emotions of users

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during their work in any interactive application environment. By applying situation rules the system exploits the gathered data in order to individually adapt the user interface and the behavior of the observed interactive application (Märting et al., 2019).

In this paper we lay the foundation for using SitAdapt for accompanying individual users during the different phases of the customer journey in the e-business domain. We create a suitable *experimental* setting for analyzing the following research questions:

- Q1: When are emotions triggered in e-business environments and how can they be exploited for optimizing the digital customer journey?
- Q2: Can predefined personas lead to better customer experience in e-business environments?
- Q3: Can direct observation of users lead to more individualized adaptations of the interactive e-business applications?
- Q4: Can situation-aware adaptations help to achieve better task accomplishment of the users?
- Q5: Can situation-aware adaptations help to achieve the providers' business goals more effectively?

The data we collected during our experimental studies give preliminary answers to these research questions and provide valuable input for triggering and targeting larger and more specific subsequent studies.

The remainder of this paper is organized as follows:

- Section 2 gives an overview of related and previous work relevant to the scope of this paper.
- Section 3 presents two experimental studies that evaluate the role of emotions and customer personas in order to raise customer experience for the b2c part of an existing e-commerce portal for beauty products.
- Section 4 discusses, how SitAdapt can exploit the findings and results of the studies by specifying and triggering appropriate situation rules.
- Section 5 concludes the paper and gives an outlook on our planned future work.

## 2 | MATERIALS AND METHODS

This section discusses some of the methods from the disciplines that have influenced and inspired our work. We also discuss the functionality of the SitAdapt system.

### 2.1 | Emotions, decision-making and user experience

#### 2.1.1 | Emotions and decision-making

In our society, emotions and emotional reactions are often perceived with a negative connotation even though emotions play an important role in all human actions. Emotions directly influence interaction

between humans as well as human-computer-interaction (HCI). This means that emotions are not only linked to social environments or to the entertainment industry, but that they are also essential for human communication, human perception and decision-making (Picard, 2000).

In the past, scientists were assuming that human beings primarily behave in a rational way. Today's expertise and research prove the opposite. It is now known that emotions trigger actions and are involved in human processes like

- Evaluation of situations
- Motivation
- Preparation
- Actions
- Regulations
- Social Tasks (Broschart & Monschein, 2017)

These processes cover a broad field of behavior and activities. It can be seen that the power of emotions influences the decision making processes in many situations and areas of life.

In 1994, a study by the neuroscientist António Damásio showed, how emotions affect decision making. Using a strategic card game, Damásio could prove that emotions are essential for long-term planning. Some of the participants of the study had a disorder of the cerebral cortex and were not able to evaluate actions emotionally. These players were at a disadvantage compared to the other participants, because the average persons could use their emotions to help them make long-term decisions which was necessary in this strategic card game (Damásio, 2006; Müsseler & Rieger, 2017).

We human beings are often not aware of how much influence emotions have on our choices. Even if we assume that we make a decision based on rational reasons, this is usually not the case - especially for long-term considerations. In some situations, it is also possible that emotions are the only reason for our judgment. In these cases, no logical element is necessary to pass a resolution. However, since we often consider a logical component to be important in our judgment, the logical element is added afterwards in order to reinforce and rationalize the emotionally made decision (Broschart & Monschein, 2017). This is how people avoid negative emotions, which would arise when opinions, attitudes, perceptions or thoughts do not match. This phenomenon is called cognitive dissonance, which is perceived as an uncomfortable tension for people and which needs to be reduced in order to build a coherent overall picture and a harmonious balance (Moser, 2015). The opinion that decisions need to be made rational leads to the phenomenon that humans subconsciously add a logical component after the decision has already been made. This shows that supposedly rational decisions can often be traced back to emotions without people being aware of it.

Even though emotions have such a high significance, there is no explicit definition for it and many different statements can be found. Kleinginna and Kleinginna have collected the similarities of around 100 assertions and definitions and have created a working definition that combines cognitive, mental, physiological and physical aspects (Kleinginna Jr. & Kleinginna, 1981). One possibility for categorization

are fundamental emotion models which are based on Darwin's findings of basic emotions. A famous example are the six basic emotions discussed by Ekman, which refer to facial expressions and should be valid regardless of a person's language and culture (Ekman, 1992a; Ekman, 1992b; Stürmer & Schmidt, 2014). Another option to categorize emotions are dimensional models. Two prominent dimensions are valence and arousal which are for example used in the model of Russel. The dimension of valence indicates the extent to which the emotion is felt positively or negatively. The arousal dimension shows how strong the emotion is and how relevant the environment is (Valenza et al., 2014).

### 2.1.2 | Emotions and user experience

Since emotions play a central role in human behavior and decision-making, they are meaningful for marketing and advertising measures, in classical and digital marketing. The choices of the customers determine whether a product or a company will be accepted or declined in the market. Consumer excitement, great anticipation and loyalty to a brand or products are achievements which can only be reached by creating and maintaining emotional value.

This is not only valid for an individual product, but for the whole experience users gather with the products, brands or companies. While usability describes *the extent to which an interactive system is effective, efficient and satisfying to use in a specified context of use*, user experience (UX) *considers satisfaction before, during and after use* (UXQB, 2020).

For online presence or digital touch points a smooth interaction due to compliance with usability rules, that is, an expected and faultless operation, is nowadays a prerequisite. A friendly user interface still leads to a competitive advantage, but does not mean that users are addressed emotionally or that they have a great experience by using the interface. This is only achieved when users feel excitement and a joy of use (Dorau, 2011).

When emotions are taken into account while creating and adapting user interfaces, more intelligent and human like interfaces can be designed. The attention of the user can thus be controlled more easily, which results in a more natural perception for the user. Computer systems and user interfaces can be adapted to people and not the other way around (Picard, 2000).

## 2.2 | Business intelligence in e-commerce

Whenever consumers enter the individual phases of the customer journey and get into contact with a provider through direct and indirect touch points, huge amounts of data are produced and transmitted to the respective provider. In order to generate valuable knowledge from such data, business intelligence (BI) can be applied. BI combines the use of various methods and technologies that serve the collection, administration, evaluation and presentation of mainly external but also internal data in digital form (Gluchowski & Chamoni, 2016). By using

adequate tools data patterns, cross-connections and correlations can be discovered and trends can be predicted. In the focus of the applied analytical methods are data mining that uses statistical algorithms as well as the hypothesis-based online analytics processing (OLAP), which allows a multi-dimensional analysis of data. In (Chen et al., 2012) the authors predicted for the now current generation of BI and analysis tools to focus on mobile and sensor-based content, location-awareness, person-centered and context-relevant analysis as well as mobile visualization techniques and HCI aspects.

Results from BI analysis can have an impact on the design of e-commerce sites and provide insights on how to organize content parts, advertising, navigation and presentational aspects. In our approach the large quantities of user and situational data recorded by the SitAdapt 2.1 recording component (see Section 2.4) can be accessed by BI tools. Analysis results can therefore evolutionarily influence customer experience in all phases and for all direct touch points in future sessions.

## 2.3 | Persona-based design

Another technique with positive impact on the customer journey and e-commerce in general can be the use of personas. In the context of this paper a "persona is an *archetype of a class of users* synthesizing goals and behavior patterns as well as skills, attitudes and environment. The user's characteristics [...] must be effective for the design problem at hand." (De Marsico & Levialdi, 2004). For each persona, an avatar is defined, that is equipped with authentic features such as name, photo, curriculum vitae, age, income, marital status, hobbies, education, etc. (Klünen, 2019). In our approach to optimizing the customer journey, a persona represents a certain customer group of a provider. Most information required to design personas, as well as all knowledge about their preferences, results from expert analysis of existing customer data. The use of personas helps us to create a customized approach for specific customer groups, that is, to work with specific visual, verbal and audio attributes. Also, persona-specific product preferences are taken into account. This allows the persona-specific tailoring of the marketing measures, in particular the choice of advertising material to be used, as well as of the web design of the e-commerce site.

Personas are also often used in HCI and software engineering (Jahavery et al., 2009). In (McGinn & Kotamraju, 2008) an alternative approach to finding personas is discussed: In order to reach specific HCI design goals, a survey was conducted with members of the different target groups, resulting in useful personas with attributes specific to tasks of each user group, but without organizational overhead.

## 2.4 | Context- and situation-awareness

The concept of context-aware computing was first proposed for distributed mobile computing by (Schilit & Theimer, 1994). In addition to technical aspects the definition of context also included

environmental and social attributes. Later the term situation-awareness appeared in psychology and the cognitive sciences with the aim to support correct task accomplishment of human operators in complex situations by defining situation-dependent guidance (Flach et al., 2004). In recent years interactive software has made huge steps towards understanding of and reacting to varying situations. To capture the individual requirements of a situation, (Chang, 2016) proposes that a situation consists of an environmental context  $E$  that covers the user's operational environment, a behavioral context  $B$  that covers the user's social behavior by interpreting his or her actions, and a hidden context  $M$  that includes the users' mental states and emotions.

### 2.4.1 | SitAdapt

Our own work, the SitAdapt system (Märting et al., 2019), (Herding & Märting, 2020) was inspired by Chang. The system (Figure 1) uses a broad set of visual and other observation and monitoring tools and has been tested and evaluated for a number of applications from different e-business domains. All data recorded in a user session are stored in very fine-grained situation profiles (minimum time resolution: 1/60 s). Possible adaptations of the target web application are planned and premodeled at development time. At runtime they are triggered by situation rules and generated by activating and exploiting domain-dependent and independent actions and/or HCI-patterns. For applying SitAdapt in the e-commerce domain we have exploited the results of two experimental user studies in order to optimize our approach (see Section 3). The current software version, the SitAdapt 2.1 system, is now able to cover broad parts of the customer journey. Section 4 demonstrates the capabilities of the SitAdapt system with application examples from e-commerce.

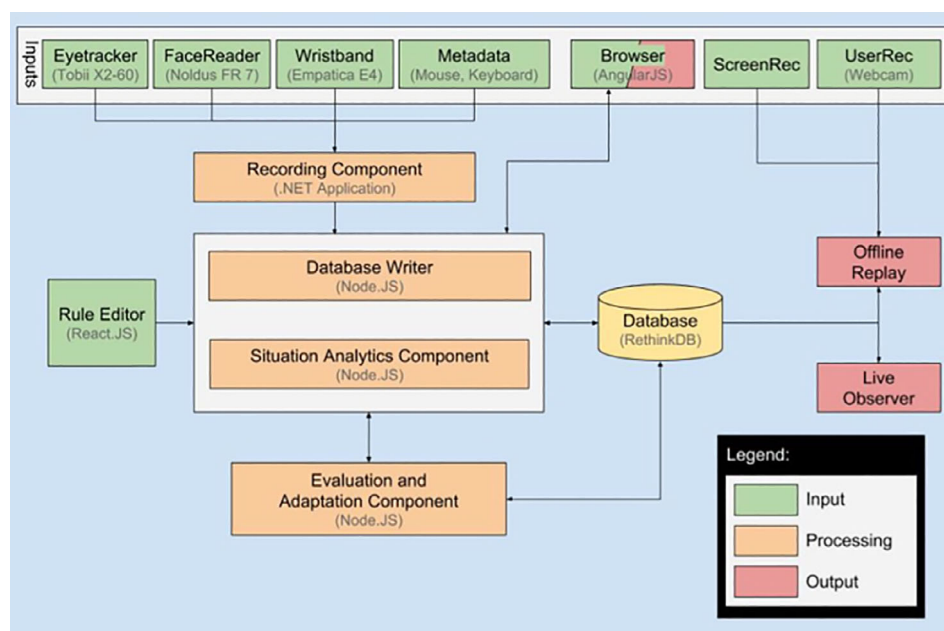
### 2.4.2 | SitAdapt architecture

SitAdapt 2.1 consists of the following parts:

- The *data interfaces* use the different APIs of the devices (eye-tracker, wristband, facial expression recognition software interface, metadata from the application) to collect data about the user. SitAdapt 2.1 uses two different data types for generation and adaptation of the user interface received from the different input devices.

**TABLE 1** Data input from the eye tracking system (Herding & Märting, 2020)

Attribute	Possible values	Description
LeftPupilDiameter	Between circa 2.0 and 8.0	Describes the dilation of the subject's left pupil in mm
RightPupilDiameter	Between circa 2.0 and 8.0	Describes the dilation of the subject's right pupil in mm
LeftEyeX	Between 0.0 and 1.0	Indicates the normalized x-coordinate of the subject's left eye
LeftEyeY	Between 0.0 and 1.0	Indicates the normalized y-coordinate of the subject's left eye
RightEyeX	Between 0.0 and 1.0	Indicates the normalized x-coordinate of the subject's right eye
RightEyeY	Between 0.0 and 1.0	Indicates the normalized y-coordinate of the subject's right eye



**FIGURE 1** Structure and components of the SitAdapt system (Märting et al., 2019)

- The recording component synchronizes the different input records with a timestamp. In Table 1, for instance, the attribute value ranges are listed that can be received from the eye tracking system API. Table 2 shows the possible attributes and values from emotion tracking.
- The *database writer* stores the data from the recording component and from the browser in the database, where the raw situations and situation profiles are managed. It also controls the communication with the rule editor.
- The *rule editor* (Figure 2) allows the definition and modification of situation rules, for example, for specifying the different user states and the resulting actions. The rule editor can use all input data types and attribute values as well as their temporal changes for formulating rule conditions. At runtime rules are triggered by the situation analytics component for adapting the user interface, if the conditions of one or more rules apply. However, situation rules can also activate HCI-patterns in a pattern repository (Märting et al., 2019).
- The *situation analytics component* analyzes and assesses situations by exploiting the observed data. Situation rules are triggered when the rule conditions are satisfied. Situation rules interact with the situation profiles stored in the SitAdapt 2.1 database.
- The *evaluation/decision component* uses the data that are provided by the situation analytics component to decide whether an adaptation of the user interface is currently meaningful and necessary. The component evaluates one or more applicable situation rules and has to solve possible conflicts between the rules.
- The *adaptation component* generates the necessary modifications of the interactive target user application.

### 3 | RESULTS

#### 3.1 | Experimental user study 1: Can emotions be exploited for UX optimization in e-commerce?

To discover what triggers emotions of users, and how this information can be used to optimize the user experience, we did a test in our lab with customers and potential customers of Dr. Grandel GmbH, a German manufacturer in the cosmetics sector. The experimental study was focused on emotional responses at digital touch points. In the study the real world b2c website of the company with an interactive tool, an online shop and an online magazine was used. Other elements were three different online advertising measures.

We wanted to find out whether the usage of these different elements triggers emotional responses of the users. In case they do, we wanted to know which emotions were shown and what the concrete triggers for the measured responses were.

##### 3.1.1 | Research subject

The first part of the study was centered around an interactive tool on the website, which helps users to find the most suitable products for

them. The users were asked to describe themselves with the support of predefined answers and pictures. This is a very individual procedure and lots of decisions need to be made that involve emotions. Another part of the research with the website was focused on the online shop and the process from product search to product selection. The last element of the test that was related to the website included an online-magazine with editorial articles for entertainment and news about trends and products in the cosmetics industry. Additionally, selected advertisements on external websites, advertising banners on the own online channels as well as newsletters and Instagram posts were analyzed. All these elements were tested in order to find out, whether they trigger emotions that can be measured.

According to Jakob Nielsen, the best results for the usability evaluation of an interactive application will appear when only five users are testing the target object with as many small tests as possible (Williams, 2004). As we differentiated between two user groups, we used two groups, each of them comprising of four people, which is recommended when testing with different user groups (Tullis & Albert, 2013).

One group consisted of female customers of the company who already knew the company and its products. The second group consisted of female users, who did not know the products yet, but who did fit into the target group of the company's products.

##### 3.1.2 | Test setting and tools

The experimental study included a pretest to gather information about the earlier experience of the participants and to assign the participants to the different groups, a lab test, which was the main part of the study, and a post-test to enquire the individual personal opinion of the participants.

The lab test was divided into three test scenarios with eight tasks which were building on one another. During the test, the participant was seated in an ordinary office room in front of a personal computer. The researchers could observe the participants through a one-way mirrored window and with a webcam that recorded the sessions and logged interaction details.

To measure emotional responses of the participants during different stimuli, *Tobii Studio* eye-tracking software, *FaceReader 7* facial expression recognition software and an *Empatica E4* wristband to measure the heart rate and skin conductance as indicators for some emotional states were used.

##### 3.1.3 | Selected results of the study

###### *Interactive tool*

The interactive tool with the individual result could trigger emotions which could be measured. Figure 3 shows a section of the results of the facial expression recognition software during the interaction of a participant with the tool. Since emotions do not always occur in a pure form, it is possible that the facial expression shows several

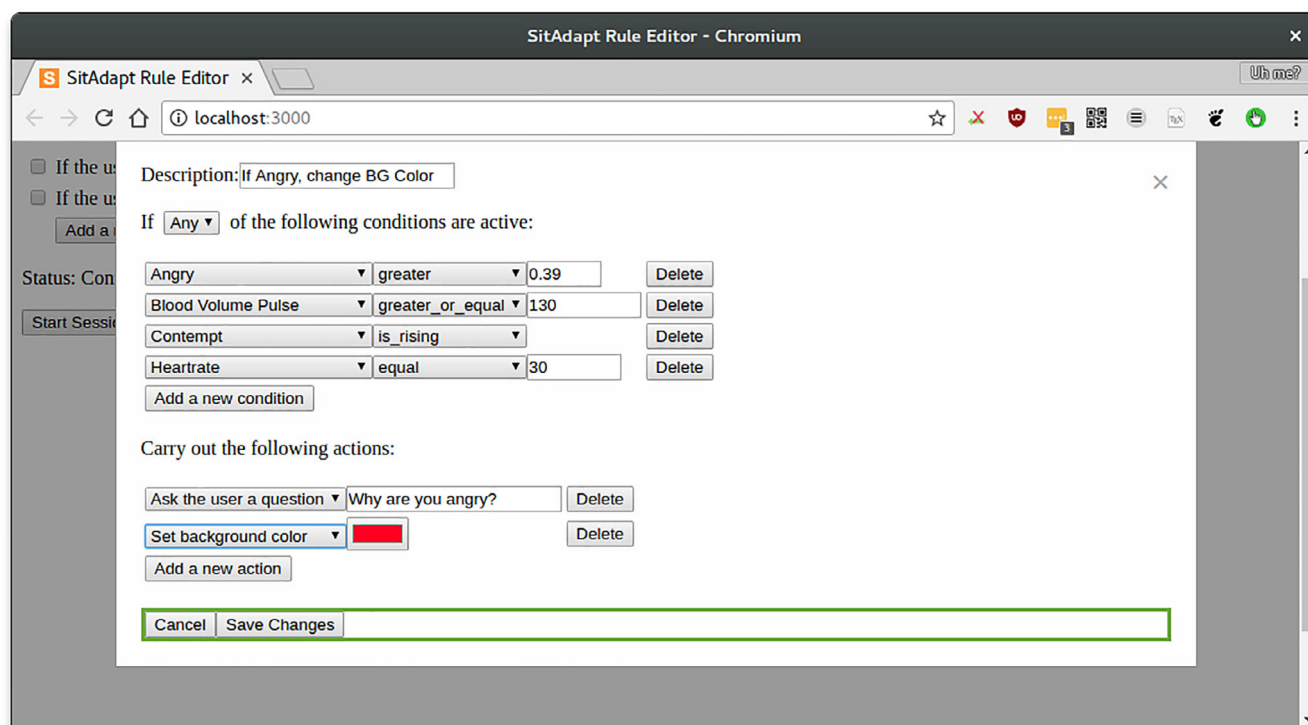
**TABLE 2** Input data from emotion tracking (Märting et al., 2019)

Attribute	Possible values	Description
Angry	between 0.0 and 1.0	Indicates to what degree the user appears angry
Disgusted	between 0.0 and 1.0	Indicates to what degree the user appears disgusted
Happy	between 0.0 and 1.0	Indicates to what degree the user appears happy
Neutral	between 0.0 and 1.0	Indicates to what degree the user appears neutral
Sad	between 0.0 and 1.0	Indicates to what degree the user appears sad
Scared	between 0.0 and 1.0	Indicates to what degree the user appears scared.
Surprised	between 0.0 and 1.0	Indicates to what degree the user appears surprised
Contempt	between 0.0 and 1.0	Indicates to what degree the user appears full of contempt Contempt is defined as the feeling that a person or a thing is beneath consideration, worthless, or deserving scorn
Valence	between -1.0 and 1.0	Describes how positive/negative an emotion is. -1 means very negative.
Arousal	between 0.0 and 1.0	Describes how strong the emotion is. A person that is yelling in anger, for example, has a higher arousal than a person who is only pulling their eyebrows together.
Quality	between 0.0 and 1.0	Roughly describes the quality of the observation
Age	Agerange ("from-to")	Describes a numeric interval for the estimated age of the user
Beard	"None," "Some," "Full"	Describes the extent of the subject's lower facial hair
Moustache	"None," "Some," "Full"	Describes the extent of the subject's upper facial hair.
Glasses	"Yes," "No"	Describes whether or not the user is wearing glasses
Ethnicity	"Caucasian," "Eastern Asian," "South Asian," "African," "Other"	Describes the ethnicity of the subject based on visual appearance.
Gaze Direction Identity	"Left," "Right," "Forward"	Describes in which direction the subject is looking.
Identity	"unknown person," "no identification"	Identifies the user based on the current Noldus Face-Reader session's profiles.
Left Eye	"Open," "Closed"	Describes the state of the user's left eye.
Right Eye	"Open," "Closed"	Describes the state of the user's right eye.
Mouth	"Open," "Closed"	Describes the state of the user's mouth.
Left Eyebrow	"Raised," "Lowered," "Neutral"	Describes the state of the user's left eyebrow.
Right Eyebrow	"Raised," "Lowered," "Neutral"	Describes the state of the user's right eyebrow.

emotional states. The FaceReader software therefore shows the analyzed expressions proportionally. For classifying basic emotions FaceReader uses a deep neural network trained with 10,000

annotated facial images for detecting the basic emotions in the algorithmically runtime-generated 3D model which shows the exact position of 500 relevant key points in the currently observed face. The





**FIGURE 2** SitAdapt rule editor (Märting et al., 2019)

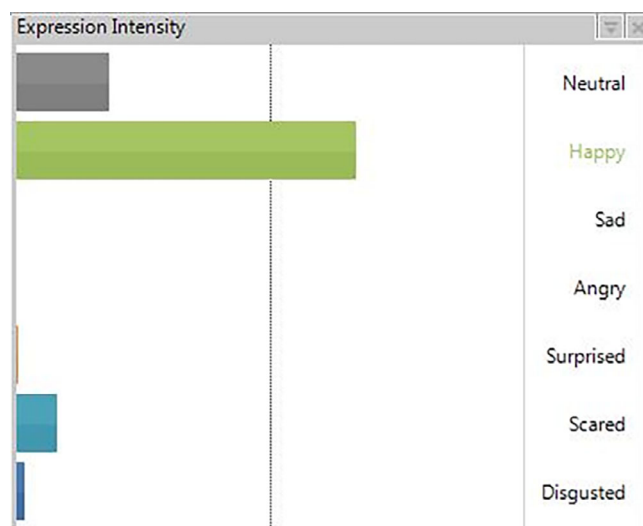
FaceReader software measures the intensity of each basic emotion in a range between 0 and 1. Note, however, that the sum of the intensities of all currently involved emotions is not typically equal to 1, as the intensity of each emotion is handled separately (Loijens & Krips, 2019). In this example, the dominant expression of the participant during the usage of the tool is *happy* which proves a positive user experience during the interaction for this user.

The results also show (see Figure 4a,b) that the arousal and the valence, which are indicators for emotional reactions and are also measured by FaceReader, change with the beginning of the interaction with the tool. The valence indicates, whether an emotional state is positive or negative. The arousal shows the activeness of an emotional state. This example illustrates the correlation of valence and arousal for physical reactions. In the second part of the graph, at 09:37:00, the interaction with the tool starts. For the observed user the graph proves that the activeness of emotional states is higher and more positive during an interactive touchpoint.

#### Magazine and newsletter

Figure 5 shows the emotional reaction of one of the participants, when an unexpected visual appeared, after a button leading to some promotional action was pressed. The values of the basic emotions *happy* and *surprised* are reaching quite significant levels.

In the next example (Figure 6) a participant is looking at a specific winter skin cream. Upon reading the detailed description of the product Winter Silk Cream, the user's emotional state significantly changes to happy. A situation rule could now exploit this knowledge to give additional information about other winter products.

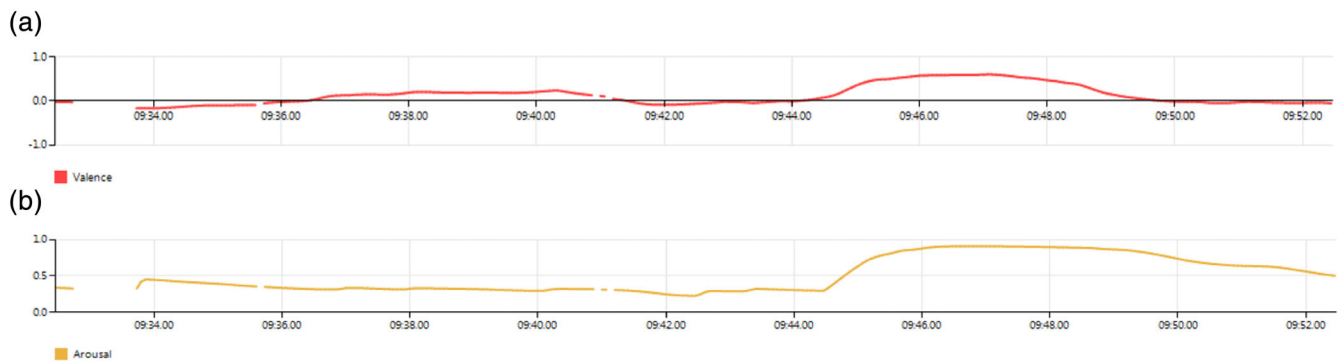


**FIGURE 3** Emotions measured by FaceReader 7 software

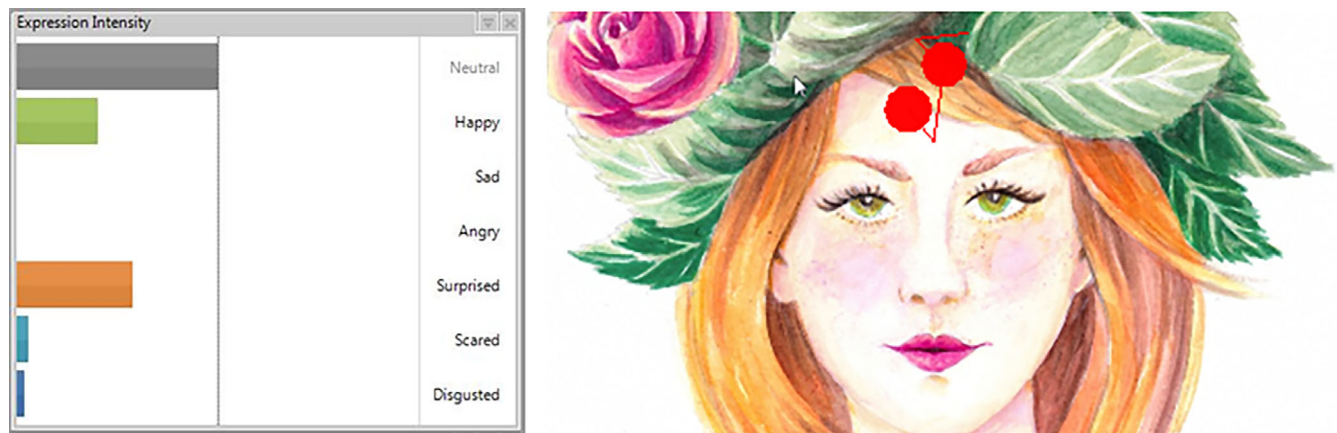
#### Advertisements

In the next example (Figure 7a,b), the system has gathered a priori knowledge about the varying gaze behavior of participants, who are known customers of the business or participants who do not know the products by distinguishing between the lab-created heat maps. These heat maps show that customers focus on the images, while noncustomers concentrate on the textual description of the products. The gaze behavior with respect to this image can be used to categorize anonymous users. The customer experience during the

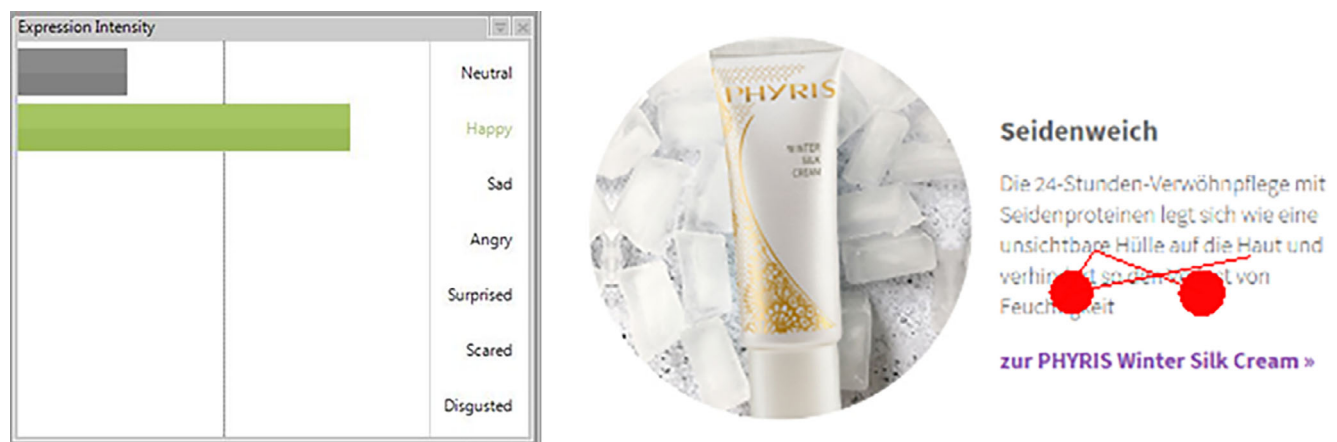




**FIGURE 4** (a) Valence of measured emotions during the test for a specific participant; (b) Arousal of measured emotions during the test for a specific participant



**FIGURE 5** Visual for a special promotion and measured emotional values



**FIGURE 6** A significant value of the emotion "happy" is observed for a candidate, when she is finding the right product

prepurchase phase can be improved. When the system assumes a returning customer, the focus of her further customer journey will be put on showing esthetic images, while in the other case more descriptive information will be given during the rest of the customer journey.

These examples of our experimental findings show that the potential for UX optimization in e-commerce by exploiting emotions is very high and promising. Thus research question Q1 can be answered positively. The findings provide valuable input for the analysis of research questions Q3, Q4, and Q5 in Section 4. In Section 4 we discuss, how the observation

of changes of the emotional and other attribute values can be exploited for triggering situation rules and runtime adaptations.

### 3.2 | Experimental user study 2: How personas can be exploited for optimizing customer experience

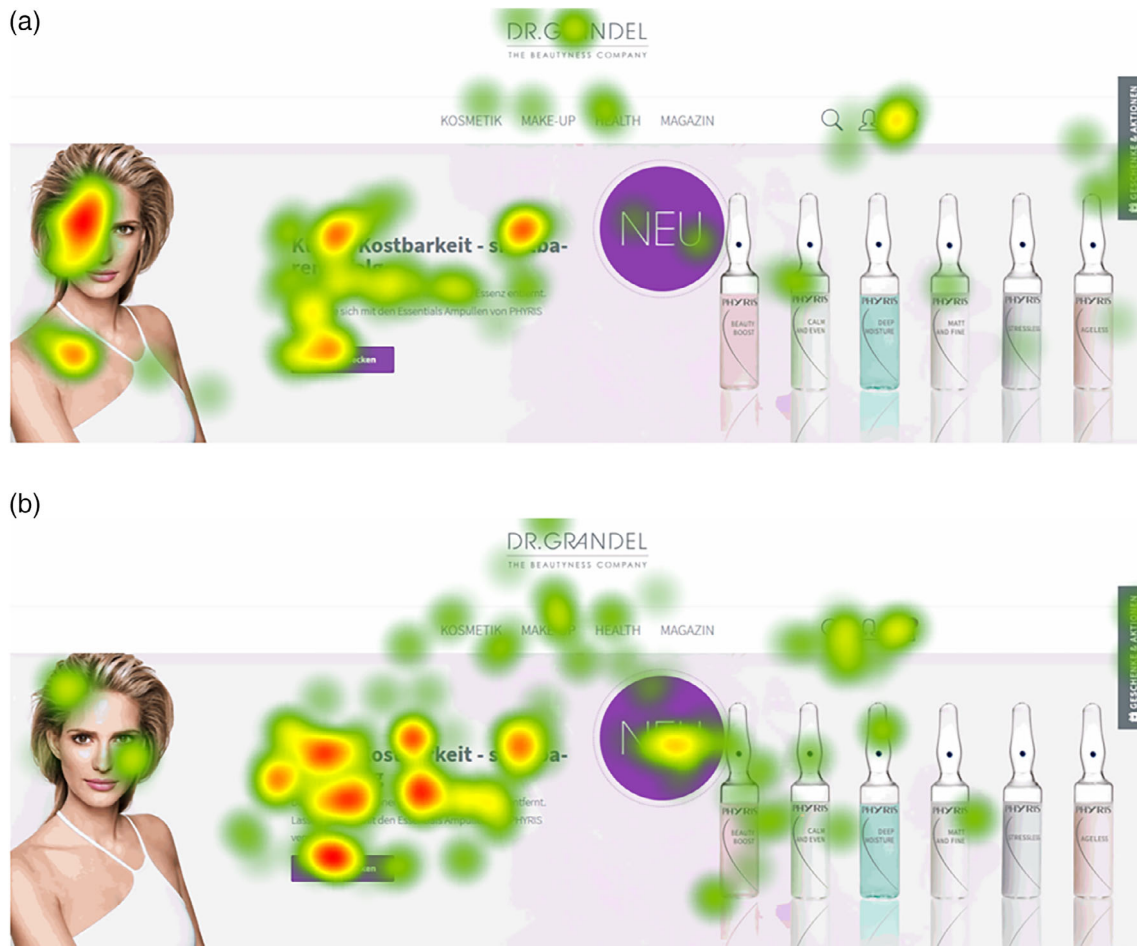
Our co-operation partner has been using personas in digital marketing for a long time. The three recent personas were derived from customer data and refined in a workshop of the marketing and e-commerce teams. The personas reflect the company's main customer groups. Each persona profile contains a short biography as well as information on personality, age, buying behavior, e-commerce and web affinity, motivation to buy, and the preferred reference channels. A psychography is also included.

In order to provide a justification for the preconfigured persona-specific web shop adaptations and to receive important information about product preferences, a usability test was carried out in our lab with 10 female test subjects, who represented the three persona-groups, but so far had not been customers of the company. Test scenarios were developed for gaining insights into product preferences

as well as persona-specific visual and verbal design. For example, the test subjects had to simulate the shopping process as part of a test task and put products into their shopping cart. It was considered whether they would also buy the specific products intended for their persona-group. Which products are preferably bought by which persona had been determined in advance by analyzing real customer data.

In a different task the test candidates had to search the magazine on the company's website and spontaneously click on three articles that particularly appealed to them. It was checked, which articles were clicked on and whether subjects from the same persona-group chose the same articles. In addition, it was tested on which words and verbal approaches the said persons paid particular attention. The participants were also shown pictures from the company's Instagram account. Each participant could select any number of pictures. As with the other tasks before, the existence of persona-specific relationships, especially with regard to visual incentives, was checked.

The knowledge gained through the laboratory tests showed that some, but not all preconfigured adaptations and product offerings that were based on data analysis results could be associated with the relevant personas. Therefore, with respect to the



**FIGURE 7** (a) Gaze heat-map of regular customers of the business; (b) Gaze heat-map of new visitors of the website

tested web-shop environment and the predefined personas, there was no clear positive answer to research question Q2. However, the evaluation results from the visual and textual selection tests were used to re-design the persona-specific configurations of the website. This will lead to significant optimizations of the awareness, consideration and conversion phases of the customer journey. The results have also given us insight into which types of visual and verbal information found on e-business sites are promising candidates for being exploited in situation-rules for individual runtime-adaptation.

## 4 | DISCUSSION

This section discusses, how the findings of the experimental studies can be exploited for generating individualized situation-aware adaptations at runtime with SitAdapt. In Figure 5 the emotional reaction of a test subject is shown, when an unexpected visual appeared, after a button leading to some promotional action was pressed. The values of the basic emotions *happy* and *surprised* are reaching quite significant levels. These data are available in the SitAdapt 2.1 user profile, whereas the current situation (application meta-data, visuals, etc.) is recorded during the entire user session and stored in the situation profile in the SitAdapt database. For all touch points that are visited during this session the information in the situation profile can be accessed at runtime. This combined information can be exploited by a SitAdapt 2.1 situation rule that triggers adaptations at runtime, for example, for promoting a special offer:

```
<SituationRule> SpecialPromotion
  FOR N <Situationi> IN 3s
    <Gaze_Tracking> Contains Field Promotion
      Image(Id) (>0)
    AND <Emotion> happy (>0.30)
    AND <Emotion> surprised (>0.20)
    <Action> SHOW AT 10s Promotion1TextFUI
    <Action> WAIT Promotion1TextFUIInput
    <Action> LINK Promotion1TextFUIInput
      TaskModel PromotionProcessingTask
      (Promotion1)
```

As explained in paragraph 3.1.1 the intensities of emotions measured by FaceReader 7 can vary between 0 and 1. In our tests we found that above a certain threshold each emotion can also clearly be noticed by a human observer. The levels chosen in our situation rules represent such clearly perceptible levels.

Thus, if the user focuses on the image and after 3 s the emotions have changed to perceptible levels, a promotion dialog box is displayed in the user interface. The web application will wait for a user input and activate the promotion processing task specified in the task model.

In the next example we specify a situation rule that could be used in the situation in the web shop environment that is shown in

Figure 6 where SitAdapt recognizes the user's interest in a certain product, that is, the winter silk cream, because of the repeated gazing to the field and the raised level of emotion "happy." After 2 min a text is displayed that notifies the user that in case of the purchase of product (Id) within a certain time span, a voucher is granted for the user's next purchase. A link to the voucher-processing task in the task model is activated:

```
<SituationRule> OfferingVoucher
  FOR N <Situationi> IN 120s
    <Eye_Tracking> Field Product Product (Id)
    <Gaze_Tracking> Contains Field Product
      Product (Id) (>5)
    AND <Pulse> (85-100)
    AND <PulseRate> rising
    AND <Emotion> happy (>0.25)
    AND <StressLevel> orange
    <Action> SHOW AT 120s VoucherText1FUI
    <Action> WAIT VoucherText1FUIInput
    <Action> LINK VoucherText1FUIInput
      TaskModel VoucherProcessingTask
```

The activation of the voucher processing task in the task model at runtime will trigger the generation of a dialog box with the voucher text and the possible user options. A special reusable pattern for this task could be available in the pattern repository. At runtime the individual product would be mapped to the pattern and the final user interface with the voucher text and the possible user options would be displayed.

Another interesting topic would be the automatic recognition of the persona of an unknown customer. Figure 7a,b from the first experimental study demonstrate the different gazing behavior of two different groups of customers. Such knowledge in the form of heat-maps could also be assembled for a group of regular customers, whose persona is known. In addition, the emotional and gazing behavior ranges of the members of a specific persona-group could be measured during some typical standard tasks when working with the website. The results of the persona-related experimental study described in paragraph 3.2 have provided knowledge about which visual and textual characteristics of web user interfaces and business content can be correlated to a specific persona. Our findings suggest that atmospheric settings showing real persons with different styling and hair or fashion colors rather allow the selection of a specific persona than the visual confrontation of a candidate with the product basket associated with the personas by a-priori analysis of real customer data. We are currently defining the most promising relationships between visual content characteristics and specific personas. The best matches will then be coded as the left-hand-sides of a group of persona-related situation-rules.

A decision about the probable persona of a new customer could be made with such rules and the persona-specific content, style and layout adjustments of the website could be triggered by the SitAdapt system.

By assessing the potential of our experimental results and their exploitation by the situation-aware adaptation process possible with the SitAdapt system we can clearly state that our lab-based approach paves the way for giving positive answers to our research questions Q3, Q4, and Q5. We are now able to orchestrate larger studies with fine-tuned scenarios in order to statistically evaluate our experimental findings.

## 5 | CONCLUSION AND FUTURE WORK

In this paper we have discussed a new software approach for accompanying and optimizing the customer journey that combines analysis of existing customers' data, persona-based design and situation-aware runtime adaptations in order to allow for better task accomplishment of both, the e-commerce provider, and the client. Two experimental studies directed on measuring usability and user experience for a real-world b2c e-commerce portal for beauty products have demonstrated that a high-level of customer experience can be achieved, if the capabilities of the available tools are exploited consequently.

We are currently evaluating the observation data of a larger study conducted between November 2020 and January 2021 targeted on emotion recognition in visual and motion picture settings where, in addition to the SitAdapt version described in this paper, the participants also used an EEG-based brain-computer interface (BCI). We will carefully analyze the results of this new study and consider the consequences for the creation of new e-business scenarios.

The next step will be to get the SitAdapt 2.1 system from the lab into real life by using advanced camera-based visual tracking technology. Also, a set of situation rules that fulfill the standards and requirements of both service providers and customers has to be specified and evaluated. For optimizing the quality of the situation rules we are planning to add a reinforcement-learning component to the SitAdapt system.

In contrast to using SitAdapt within a pure lab environment, the real-world application of such an individualized emotion tracking and adaptation system could lead to major privacy and ethical issues. In order to manage these aspects, we will apply accepted principles of value sensitive design as, e.g., discussed in (Friedman & Hendry, 2019).

## ACKNOWLEDGMENTS

Part of this work was carried out in cooperation with Dr. Grandel GmbH, Augsburg, Germany. We greatly acknowledge the opportunity to run the SitAdapt tools and user tests on their enterprise e-business platform. We also greatly acknowledge the valuable hints of the reviewers.

## DATA AVAILABILITY STATEMENT

Data available on request from the authors

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**How to cite this article:** Martin, C., Bissinger, B. C., & Asta, P. (2023). Optimizing the digital customer journey—Improving user experience by exploiting emotions, personas and situations for individualized user interface adaptations. *Journal of Consumer Behaviour*, 22(5), 1050–1061. <https://doi.org/10.1002/cb.1964>