Towards a Psychophysiological Investigation of Perceived Trustworthiness and Risk in Online Pharmacies: Results of a Pre-study

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Abstract. Perceived trustworthiness and risk are crucial impact factors for a website's success. While they have been frequently applied to diverse e-commerce contexts, an investigation of these constructs for the special case of online pharmacies is still scarce. In an attempt to measure these constructs in a neural experiment, this paper offers a pre-study with the aim to gain first insights and select appropriate stimuli for the upcoming study. Therefore, five operating online pharmacies are tested in an online survey with 121 participants which rated scales of perceived trustworthiness, perceived risk, attitude towards the website, and use intention for each of the included pharmacies. Results show that online pharmacies with high reputation are rated higher in the included constructs. Consequently, reputation, perceived risk, and trustworthiness are crucial impact factors on attitude and use intention. Thus, two promising online pharmacies could be selected for the follow-up study.

Keywords: Online pharmacy · Perceived trustworthiness · Perceived risk · Attitude · Use intention

1 Introduction

Online pharmacies provide quick and convenient solutions for both the elderly and younger people because they offer a convenient solution to purchase medicines through home delivery [1]. Especially older people benefit from this, as they need to rely less on third parties. Unsurprisingly, the online pharmacy market is expected to grow, with the main drivers of growth being the increasing proportion of the elderly population, the growth in chronic diseases [2], the general increased availability of high-speed internet, and the improving healthcare infrastructure worldwide [3]. Next to North America, Europe has the largest online pharmacy market shares, with particularly the German market experiencing tremendous growth due to the increasing awareness of cheap over the counter (OTC) products which can be purchased online [2]. This is due to the relaxation of legal regulations for the sale of OTC products, but also the increased switch of prescription medicines to OTC status [4].

However, this development does not only come with opportunities. As illegal online pharmacies continue to be found worldwide despite increased regulatory controls, the

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online purchase of medicines poses an increased risk compared to other online shopping contexts. Consequently, the risk of purchasing from online pharmacies is twofold: on the one hand, it may be an illegal online pharmacy selling counterfeit medicines and, on the other hand, laypeople may purchase and use a medicine that is unsuitable or even harmful to their health due to a lack of advice and expertise [3]. Therefore, the consideration of perceived risk and trust in online pharmacies is of special interest as a misuse can harm the consumers' physical health.

The constructs of perceived risk and trust have been investigated in several e-commerce contexts and have shown to generally impact a website's acceptance [5–8]. Furthermore, prior NeuroIS research has also covered perceived trust and trustworthiness and has shown to reveal distinct neural activations associated with high perceived trustworthiness in e-commerce contexts [7, 9]. However, in the area of health services and medicines, studies considering website design and its impact on perceived risk and trust are still scarce. Since perceived risk might differ severely between an online shop selling clothes and an online pharmacy [10], this paper tackles this research gap by investigating the rated perceived risk and trustworthiness for five different operating online pharmacies. Thus, the goal of this work-in-progress is to introduce the constructs of perceived risk and trustworthiness in the context of online pharmacies and to provide a first data basis that is used to select stimuli for a follow-up FaceReader and neuroimaging experiment. To embed this goal in a research context, this working paper first presents the state of research on perceived trustworthiness and risk for purchasing medication primarily online and presents the context of NeuroIS research. Within this study, hypotheses were derived and tested for the non-neuronal part of the research. Five selected pharmacies were the subject of the empirical online survey. The results of the study are then discussed, and the study design for the follow-up experiment is presented.

2 Background: Perceived Trustworthiness and Risk

2.1 Perceived Trustworthiness and Risk in Online Pharmacies

Trust is an important component in the interaction between patients and healthcare providers such as pharmacies [11]. Patients trust that they will receive the right advice in pharmacies and that their condition will be cured with the recommended medicines. In turn, pharmacists trust that they will receive all the information truthfully to be able to recommend medicines to patients in the best possible way. With trust being a domain-specific construct in terms of operationalisation [10], even within the healthcare domain, several different definitions of trust can be found. Some studies define it as a stand-alone construct, while others define it in terms of sub-constructs like credibility and benevolence. The disagreement among researchers on the definition leads to a variation in the understanding and language use of the construct in literature [12]. In this working paper, trust is defined as the willingness to expose oneself to exploitation by another agent due to the prospect of potential benefits [13, 14], with the agent being the presented online pharmacy. This is based on the optimistic expectation that the other agent(s) will protect the rights of all involved [15]. In other words, it is based on the expectation that the commitments made by another person or organisation will be fulfilled [16], especially in relationships where the trusting party has no control over the other party but still needs

to depend on them [15, 17–19]. This expectation is built on the other party's different characteristics, which result in its' perceived trustworthiness.

When considering online pharmacies, it can be seen that the interaction between patients and pharmacists has changed compared to offline pharmacies. While in offline pharmacies, trust is usually developed through the salesperson's expertise and the shop atmosphere [11, 20], these aspects are absent in online pharmacies. Consequently, in online environments, the website's reputation and visual design might ultimately impact the online pharmacy's perceived trustworthiness and, thus, the trust in it [11, 21]. Consequently, we hypothesise that there will be a positive correlation between the online pharmacy's rated reputation and the perceived trustworthiness:

H1. There is a positive correlation between reputation and perceived trustworthiness.

A meta-analysis of studies on the use of health websites, which include all websites with information on diseases and medicines, thus also online pharmacies, found backgrounds that are important for building trust [12]. Usability, beliefs, design elements, brand name and ownership, persuasion, and social influences [22–26] have emerged as major antecedents. All of the named constructs further add up to the attitude consumers build towards a website in general and an online pharmacy in particular [27, 28]. While they also have shown to impact the perceived trustworthiness of the website significantly, it is further hypothesised that the user's attitude towards an online pharmacy will have a positive correlation with the perceived trustworthiness and that both attitude and perceived trustworthiness have a positive impact on use intentions [28]:

H2. There is a positive correlation between perceived trustworthiness and attitude towards the website.
H3. There is a positive correlation between perceived trustworthiness and use intention.
H4. There is a positive correlation between attitude towards the website and use intention.

A closer look at the concept of trust and trustworthiness reveals an important component: uncertainty. This is made clear by the fact that the trusting party has no control over the other party, and thus the mutual relationship is characterised by uncertainty. Uncertainty about the occurrence of consequences is a dimension of perceived risk [29], which therefore poses an important counter-position to trust [30]. While being introduced as a concept by Bauer [31] in the context of online pharmacies, the perceived risk might be distinguished between product-related risk (the medicine to be purchased) and retailer risk (the online pharmacy) [31, 32]. With risk being a counter-position to perceived trustworthiness, we hypothesise the contradicting correlation of the first three hypotheses for perceived risk:

H5. There is a negative correlation between reputation and perceived risk.
H6. There is a negative correlation between perceived risk and attitude towards the website.
H7. There is a negative correlation between perceived risk and use intention.

2.2 Perceived Trustworthiness and Risk in NeuroIS Research

Based on two recent literature reviews about the state of the art in NeuroIS research [33, 34], related work for the constructs of perceived trustworthiness and risk is identified. Because our follow-up study focuses on decision making on online pharmacies, the following results are limited to brain regions in the prefrontal cortex (PFC). The main results are summarised in Table 1.

Table 1. Overview of NeuroIS Paper associated with perceived trustworthiness and risk (Abbreviations: functional magnetic resonance imaging (fMRI), electroencephalography (EEG), orbitofrontal cortex (OFC), dorsolateral prefrontal cortex (dlPFC), ventromedial prefrontal cortex (vmPFC))

Authors	Context	Method	Results (in areas of the frontal cortex)
Dimoka [9]	Trust in online shopping offers	fMRI	• Trust associated with lower activations in the (right) OFC
Riedl et al. [7]	Trust in Online shopping offers	fMRI	• Trustworthy offers activated right dlPFC in male, but not in female participants • Untrustworthy offers activated the left dlPFC in exclusively in women, and the left vmPFC exclusively in men
Riedl et al. [35]	Trust in humans vs. avatars	fMRI	• MPFC activated more for trustworthiness evaluation of humans compared to avatars
Vance et al. [36]	Risk in information security behavior	EEG	• Activations in approx. frontal (right) & motor cortex regions associated with risk perceptions (in P300)
Wang et al. [37]	Risk in social cues in ecommerce	EEG	• Frontal cortex (F3, FZ, F4) activated in purchase decision/associated with risk (in N2)

The provided overview shows that trust and risk evaluations in different research contexts trigger several areas in the PFC. However, since the context of the studies ranged from ecommerce to human-human interactions, a more thorough review of neuroscientific studies investigating perceived trust and risk is required to derive hypotheses for

our main study. Nevertheless, this overview reveals two promising aspects relevant for the follow-up study: firstly, none of the reviewed studies used functional near-infrared spectroscopy (fNIRS) to investigate the selected constructs, which offer room to validate these prior findings by means of fNIRS. Secondly, even in the cited fMRI studies, several activations could be identified on cortical surfaces in the PFC, which are also assessable through EEG and fNIRS. This further calls for adding validation through research in different contexts that considers the constructs of perceived trust and/or risk and assess these evaluations through neural activations in PFC areas. This paper offers a first approach in this direction by evaluating potential stimulus material for a follow-up fNIRS study.

3 Method

Sample. We recruited 144 participants to fill out the online survey through the online platform clickworker. Out of the 144 participants, 23 data sets needed to be filtered out because participants either did not fill out the questionnaire completely, or they did not answer the attention check correctly (which was a statement hidden somewhere between the scales in which they were asked to click "4"). As a result, an included sample of $N = 121$ data sets is considered for further analyses. Average age is $M = 41.6$ years ($SD = 12.8$), 63.6% are male, 36.4% are female. 50.4% of the sample are currently employed, 23.1% are freelancers, 12.4% are students, 9.1% are searching for employment, and 3.3% are retired. We further included questions regarding the participants' disposition to trust and familiarity with online pharmacies with 5-point Likert scales (adapted from [33, 34]). Mean disposition to trust was $M = 3.52$ ($SD = 1.02$) and familiarity was $M = 3.38$ ($SD = 1.12$).

Stimuli. To test the here stated hypotheses and select appropriate, real-life stimuli that will be extreme opposites regarding their associated perceived risk and trustworthiness, we took a look at the top ten online pharmacies operating in Germany [9]. From this, we selected the top 2, namely *DocMorris* and *Shop-Apotheke*, the bottom 2, namely *Aponeo* and *Eurapon*, and one from the middle being *Apotal*. For each online pharmacy, we used the product page of *IBU-ratiopharm* 400 mg pain killers with 10 pills per package and manipulated the prices on the screenshots to avoid biases due to different pricing (two examples of stimuli can be seen in Fig. 1).

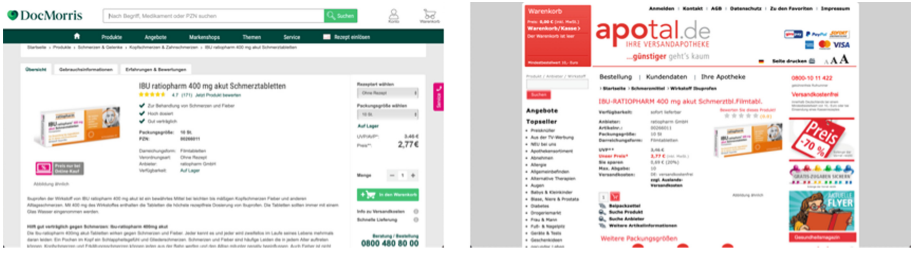

Fig. 1. Two examples for used stimuli

In the survey, participants were shown the online pharmacy screenshot and below, they had to rate the scales explained in the next paragraph. The order in which the questions and the websites were shown was completely randomised – only the scale for reputation was always asked first before the other scales came in randomised order. After having rated all included websites, participants had to give their demographics and answer the control questions for disposition to trust and familiarity, after which they were thanked and debriefed.

Table 2. Questionnaire Items and Cronbach's Alpha

Questionnaire items	CA (*if dropped*)
Perceived Risk [38]	**.837**
Do not trust that my credit card number will be secure on this online pharmacy	*.794*
It is difficult to judge quality of a product/service on this online pharmacy	*.831*
Do not trust that my personal information will be kept private by this online pharmacy	*.790*
I loose too much time when buying products on this online pharmacy	*.823*
Overall, I feel making a purchase on this online pharmacy is risky	*.781*
Perceived Trustworthiness [39]	**.895**
I can trust this online pharmacy	*.815*
I trust the information presented on the online pharmacy	*.859*
I trust the transaction process on this online pharmacy	*.875*
Attitude Towards the Website [27]	**.930**
I liked the online pharmacy	*.908*
I enjoyed being on the online pharmacy	*.918*
I would like to return to the online pharmacy	*.901*
I will recommend to others to browse the online pharmacy	*.909*
The online pharmacy made me feel like buying	*.933*
Use Intention [40]	**.892**
I would use this online pharmacy to inquire what others think of a medicine	*.856*
I would use this online pharmacy to inform myself about the effects of a medicine	*.853*
I would use this online pharmacy to read the reviews of a medicine	*.856*
I would use my use my credit card to purchase from this online pharmacy	*.896*
I am very likely to purchase medicine from this online pharmacy	*.879*

Scales. We asked participants how they would rate that "the online pharmacy has a very good reputation" on a 5-point Likert scale (strongly agree to strongly disagree)

for each online pharmacy. After that followed scales for perceived risk adapted from [38], perceived trustworthiness adapted from [39], attitude towards the website adapted from [27], and finally, use intention adapted to online pharmacies from [40, 41]. All included scales were measured with a 5-point Likert scale. The used constructs and items provided sufficient reliability through Cronbach's Alpha (CA) and were all included in the following analysis (Table 2).

4 Results

In order to test our hypotheses and draw conclusions regarding the prior stated hypotheses, we ran one-way ANOVAs with post-hoc Tukey tests to identify significant differences between the five included online pharmacies in the included constructs. Further, since we were interested in correlations between the included constructs, we ran Pearson's correlation analyses across all five included pharmacies for all constructs. One-way ANOVAs resulted in significant differences between the included online pharmacies for all selected constructs ($F_{reputation}$ (4, 600) = 18.5; F_{risk} (4, 600) = 3.73, $F_{trustworthiness}$ (4, 600) = 10.45; $F_{attitude}$ (4, 600) = 12.65; F_{use} (4, 600) = 9.27, all p's < .005). Since perceived risk and trust may be rated differently between men and women, we ran a MANOVA including our dependent variables to check for effects due to gender. Results show that, although there are significant differences between male and female participants in the constructs of risk, trust, and use intention ($F(4, 592) = 6.916$, $p < .001$), no significant interaction effect between online pharmacy and gender was identified ($F(16, 1809) = 0.417$, $p > .05$).

As a result, *DocMorris* was consistently rated highest for all included constructs, while *Apotal* was consistently rated lowest. Simultaneously, significant difference between *Shop-Apotheke* and *DocMorris* could only be identified for reputation. Differences between *Aponeo* and *Eurapon* compared to *DocMorris* were found for reputation, perceived trustworthiness, attitude, use intention, but not for perceived risk.

To test our hypotheses, we further ran Pearson's correlation analysis (Table 2). As a result of this analysis, all of our hypotheses are supported by showing significant positive correlations between reputation, perceived trustworthiness, attitude, and use intention, while the correlations with perceived risk are continuously negative. The next steps are briefly discussed in the following section.

5 Discussions of the NeuroIS Follow-Up Study and Conclusion

This study has shown that an online pharmacy's perceived risk and trustworthiness are crucial predictors for use intention. Furthermore, as pointed to in the introduction, online pharmacies pose the risk to sell illegal or counterfeit drugs which may have a harming impact on the buyer's health. This might explain the significant correlation of reputation with the other included constructs. As a result, and along with the included constructs, this study allows us to select two operating pharmacies as stimuli for the upcoming study. Since *DocMorris* was rated highest in the included constructs and *Apotal* was

Table 3. Pearson's r correlation matrix and related hypothesis support (grey numbers not used for hypothesis' support, ***p < .001)

	Risk	Trustworthiness	Attitude	Use	Results
Reputation	- .333***	.637***	.666***	.588***	H5 ✓, H1 ✓
Risk	-	- .584***	- .378***	- .324***	H6 ✓, H7 ✓
Trust-worthiness		-	.695***	.668***	H2 ✓, H3 ✓
Attitude			-	.769***	H4 ✓

rated significantly lowest, we will use these two websites as opposing stimuli regarding their associated perceived risk and trustworthiness.

Needless to say, this pre-study also comes with limitations. One major limitation is that the included constructs were evaluated using only one screenshot of each pharmacy, and thus, actual use of the websites, as well as risks due to different medication types are not considered. Consequently, we wonder in our follow-up study how the risk and trustworthiness of the selected websites is evaluated during and after actual use. As means to assess this, emotional reactions will be measured through facial expression capturing during actual use of the selected websites in two different buying situations: a prescription and an OTC drug. We thereby control the effect of a low- and high-risk drug and thus, an additional risk dimension which is exclusive for online pharmacies.

The participants' faces will be recorded during the purchases and analysed via automated facial expression recognition software Facereader™ Version 8.0. The software recognises the emotions happy, sad, angry, disgusted, surprised, scared and contempt. It also measures a neutral state. We want to examine the emotions' effects on perceived trust and risk by analysing the emotions durations and frequencies. Additional information about emotions will be provided by surveying the participants with PANAS scale for both conditions. Correlations will be figured out between experienced and rated emotions, experienced emotions and perceived risk and trust, and rated emotions and perceived risk and trust. The conditions of low- and high-risk drug purchases will be compared to ascertain differences.

After that, the pharmacies' screenshots are to be shown in an event-related experimental paradigm together with the questionnaire scales used in this study. During the latter, neural activity is to be assessed through fNIRS to get additional insights into neural correlates of perceived risk, perceived trustworthiness, attitude, and use intention in decision making related brain areas – namely the PFC. As pointed out in prior related literature, several different activation patterns can be observed in frontal areas related to risk and trust evaluations [7, 9, 35–37]. In order to derive hypotheses for the fNIRS experiment, a more thorough literature review is planned that is not reduced to NeuroIS research, but also considers neuroeconomics literature as well. From the latter, prior related studies have found i.e. that activations in the OFC are strongly related to increased purchase intentions [42, 43]). Furthermore, within neuroeconomic literature,

fNIRS has proven to be a reliable method for assessing neural activations on cortical surfaces in the frame of (economic) decision making [44, 45], which is also transferable to online shopping contexts [46, 47]. Yet, although fNIRS has proven to be more robust against artefacts in field studies, EEG is still the most commonly applied method to investigate neural correlates in similar contexts [33, 48].

Therewith, although the included constructs have been already investigated with neuroimaging methods in other ecommerce contexts, both the assessment of facial expressions and subsequent measurement of neural activity with fNIRS during and after use, are two rather novel approaches. Both of these methods offer rich data and might provide further insights not only into risk perceptions of online pharmacies, but also into the relation between facial expressions, neural activity, and self-reported scales in a timely research context.

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