Bachelor Thesis

Resilience and behavior change in cybercrime victimization - Usefulness of nudges in preventing individuals to mindlessly accept third-party tracking cookies

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Bachelor Thesis

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Abstract

The current experimental research studied whether different manipulations in the layout of cookie banners could lead to a reduced acceptance of tracking cookies in internet users in Europe, as four years ago the General Data Protection Regulation (GDPR) was enacted. Based on the protection-motivation theory, Dual Processing Model, as well as the concept of inattentional blindness we created an exemplary cookie banner to which we added three manipulations in different constellations to the banners. Those included an informative text that should influence the threat appraisal of participants, a third button allowing the participants to easily decline cookie usage and the addition of color to the preferred response option to nudge participants towards choosing this option. In total eight cookie banners that differed in the composition of manipulations were shown to the participants who were instructed to rate their likeliness to accept cookie usage for each banner. In the analyzed sample (N=101, M_{age}=23.4, SD_{age}=7.101) we found that each of the three manipulations had a significant negative effect on the likeliness of participants to click on accept. Moreover, we found that the effect of the manipulations increased the more different manipulations were present in a banner simultaneously. These mechanisms that can nudge users towards a certain choice should be carefully applied to achieve a safer behavior in internet users thus, lower cookie acceptance. Finally, it should be researched further how to counteract malicious use of these mechanisms and determined who is responsible for the enforcement of more secure tracking cookie regulations as this is crucial in making internet interaction safer for users.

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1 Introduction

In the past 33 years, the world wide web developed in an extraordinary speed. In 1991 only one website could be found. The first ever website was “info.cern.ch” and is still reachable through that same web address. Originally, the world wide web was developed as a project at the Conseil Europeen pour la Recherche Nucleaire (CERN) by the British physicist Tim Berners-Lee in 1989. Two years later the first website followed and two more years later the world wide web was finally made available to the public. From then on, in the last 22 years alone, from the year 2000 to 2022, the usage of the internet has risen by 1,355% (Miniwatts Marketing Group, 2021). Nowadays, it is used by more than 3 billion users and approximately 1.92 billion websites can be found in the world wide web (InternetLiveStats, 2022).

Almost every single one of those websites that is not 100% static uses cookies to ensure for its services to function properly. (Pierson & Heyman, 2011). There are different types of cookies websites use for different kinds of purposes. Mainly, first party cookies and third-party cookies will be part of this research paper. More types of cookies exist but that is beyond the scope of this paper.

A cookie is a small text file that contains information that was sent by a website a user visited. Initially invented to give the website a memory. They give a website the ability to remember actions performed by the user. For this to work several steps are necessary. First, the user sends a request to the server, such as logging in on a website. Then, the server answers and automatically sends a cookie within the answer, which is then stored on the user’s pc and submitted with every following request that is sent by the user to the server. The cookie in that case contains a unique identifier which gives the server the ability to remember the user, so that they do not have to log in every time they are sending a request, which would be time-consuming to say the least. The information that is handled is encoded and therefore other individuals are not able to access it (Pierson & Heyman, 2011). Adding to that, such cookies can also enrich the user experience by remembering and keeping preferred configurations the user has set. These cookies are called first party cookies, as they mostly serve the purpose of user convenience concerning the website the user is on. They are stored on the user’s pc (Miyazaki, 2008).

Next to the first party cookies there are third-party cookies. While first party cookies are collected from a user by giving an answer to a request of the page, the third-party cookies are collected by ads or images through a third-party server which have been placed on a first party website and require no direct interaction from the user. Moreover, they are saved for longer periods of time than first party cookies (Pierson & Heyman, 2011). These are not automatically

deleted after the browser is closed but stored on the user's pc and activated when the browser is opened the next time. Their storage can last up to 30 years. (Europäische Kommission, n.d.)

A major issue with these third-party cookies is that they can follow users around the internet. They are constantly collecting data and building a profile for the user to show them more accurate content Networks of advertising companies spread their advertisements across different websites and thus, can recognize if a user is visiting a website on which they display advertisements. Additionally, the ad network can remember that a user once visited the website and can therefore identify which users return to which websites, how often they return and which websites they also visit where the ad network displays advertisements (Leenes & Kosta, 2015)

In opposition to what most users can notice while they are browsing, third-party cookies can track a lot of personal user data and more importantly track those data across a great quantity of websites and store them for an unexpectedly long time. If not deleted by the user or a dedicated program, some cookies can be stored for up to 30 years. This way an extensive interconnected web of user data that can be used for advertising and so-called fingerprinting purposes comes to life as Nikiforakis and Acar (2014) thoroughly explain in their research "Browse at your own risk". They highlight the risks but also the potential advantages third party tracking cookies can have. One of the discoveries they make is that some tracking cookies are even implemented in a Trojan horse like manner on the users' PCs.

In their work "Third-party web tracking: Policy and technology" from 2012, Mayer and Mitchell explain several ways how third-party tracking can be potentially harmful for the user. (Mayer & Mitchell, 2012) Besides others, some potential harms for the user include their data being stolen, sold, and used for several malicious purposes that can either harm the user mentally, financially or physically. Third parties that collect personal user data do not do this for fun. The data is collected and sold for targeted and personalized advertising.

For the user it is oftentimes very difficult to distinguish the several parties that offer services on a website, especially when those services are not for the user themselves but for example for the website owner or even for third parties. This is the case for web-analytics that give the website owner an overview of how much traffic their site generates, and which target group visits their site. These services are oftentimes provided by (third-party) analytics companies which place (third-party) cookies on the first party website for to be able to deliver the service. Moreover, also ad companies use such tracking cookies to provide more tailored ads to the internet user. (Leenes & Kosta, 2015)

One important detail to point out is that the source of human technology interaction and its errors is not only human failure/incompetence but rather that the technology is not built to suit the human way of thinking, acting, and reacting. For them to function properly and build a symbiosis the technology needs to be built around the user instead of the user needing to adapt to the systems they use. As Adams and Sasse (1999) point out in their research "The user is not the enemy" it is not seldom the case that human error stems from the fact that only limited knowledge was available to those individuals beforehand or limited to no resources were used for education. Oftentimes users lack security knowledge that would otherwise influence the user's behavior. Therefore, educating users in terms of internet security can contribute to a safer behavior of users.

A first step in increasing the protection of European internet users was made by the European Union. In 2018 the General Data Protection Regulation (GDPR) was enacted in Europe. This regulation forces websites to include information about which first party cookies and third-party cookies will be used on the website. Moreover, it must be stated which data the cookies will collect or what it will be used for. Lastly, it is a requirement that most third-party cookies are opt-in meaning they are deselected by default and have to deliberately be selected by the users to activate them (Proton AG, 2022). These regulations have led to an increased display of cookie banners in the region of Europe. They are displayed by 62.1% of websites in Europe which is an increase of 16% in comparison to the times before the implementation of the GDPR (Degeling et al., 2019).

This arises the question whether changes in the architecture of cookie banners can influence and nudge users towards a safer behavior and followingly accepting fewer tracking cookies as accepting fewer tracking cookies increases the safety and privacy of internet users. In a recent study of Bauer, Bergstrom, and Foss-Madsen (2021) they found that manipulations of the choice architecture of cookie banners can highly influence the likeliness for consent to third-party tracking. They manipulated the choice architecture of cookie banners in such a way that users should be nudged towards sharing more of their data. The study found that the changes they made to the cookie banners could lead to an increase of 17% in the amount of data users shared. Additionally, they conclude that the way websites handle their cookie information display was not how the GDPR was intended to work. Instead of increasing users' safety by informing them of the potential risks and giving them freedom of choice, websites started to alter their cookie banners as no specific regulations are currently active for their layout which led to users accepting cookies more often. In addition to what Bauer, Bergstrom, and Foss-Madsen (2021) found, Bavel et. al (2019) conducted a study where they designed cookie banner

messages in line with the Protection motivation theory of Rogers (1975) and found that the display of a message which told participants how to behave best to protect their privacy increased their caution.

Protection motivation theory

According to the protection motivation theory (PMT) that was developed by R.W. Rogers, an individual protects themself based on two factors. The first one is assessing the severity and seriousness of a situation, also called the threat appraisal. When assessing the seriousness of a situation the individual estimates how vulnerable they are in the situation and how high the chance is that they will be harmed. The second is by responding to the present situation in a certain for the situation appropriate way, also called the coping appraisal. The individual then needs to decide how to react accordingly, depending on the threat they are facing to achieve a reduction or removal of the threat. Both factors play an important role in determining the extent to which an individual will act in a certain situation, more precisely the extent and way an individual responds to a threat. (Rogers, 1975)

The decision to undertake an action to act against the threat is not only a decision made depending on the severeness of the threat but also the expectation if the selected response will have any, or the estimated, degree of efficacy, hence the response efficacy. Moreover, to successfully implement the chosen way of coping the individual must believe that they are capable of performing the action, hence their self-efficacy. If an individual assesses a situation as dangerous and chooses a course of action in an appropriate extent, they also need to be convinced that this response is purposeful and that they are able to perform it, otherwise they will not follow this course of action. So, in the case of cookies, the user needs to assess the threat in such way that they see a need to react on that threat as well as be of the opinion that interacting with the cookie banner and opting out of all third-party cookies actually has a positive influence on the privacy of the user. (Maddux & Rogers, 1983)

Dual processing model

According to the dual processing model (Kahneman & Tversky, 1979) an individual has two initial systems to react to a certain situation. Those are system 1 and system 2. The purpose of system 1 is to allow an individual to make fast, automatic responses which are based on emotion. In contrast, system 2 is used when there is space for slower, effortful responses which are based on logic. Applying this theory to the matter of cookie banners implies that an internet user whose initial aim is to get to a certain webpage first must battle the cookie banner. (Kahneman & Tversky, 1979) Another important element in this theory is response-cost.

Response-cost describes the amount of work or other resources that are required to get to one's aim. If the cost of responding in a certain way is too high, the individual will instead choose another path of response that can lead to maladaptive behavior.

When the users encounter the banner, system 1 quickly decides which button to click on to effortlessly get to the desired webpage which can lead to mindlessly accepting tracking cookies if a quick option to decline cookies is not obvious enough. Followingly, two possible ways for improvement become apparent, being finding a way to get the individual to use system 2 or lowering the response-cost to make it easier for system 1 to select the safer response option. In this research we will focus on the latter.

Inattentional blindness

In their 1998 published book "Inattentional blindness: Perception without attention" Arien Mack and Irvin Rock describe the phenomenon of blindness to a stimulus in a sense of not noticing the stimulus due to either the circumstance that the attention is concentrated on another stimulus or due to habits and routines. As internet users encounter a lot of cookie banners during browsing the world wide web, they eventually become used to them and develop habits in their style to treat these cookie banners. In their study which focused on researching which features would be perceived by participants without directing their attention on it, Mack and Rock found that besides other stimuli, color was perceived 75% of the time. With the theory of inattentional blindness in mind, there is therefore reason to assume that the preferred response options in cookie banners need to contain alterations that differ from the rest the of cookie banner to attract the attention of the user and drag it to the preferred response option to nudge the user towards accepting less cookies, which could presumably be achieved by adding color to this preferred response option.

Nudging

One way of influencing users to act in a more secure way when it comes to third party tracking cookies, is the technique of nudging. When influencing users in such way, they are presented with a so-called nudge that slightly pushes, or *nudges*, the user into the desired direction without taking their freedom of choice away. The user needs to be able to choose which course of action they want to undertake still freely. This nudging is oftentimes done by framing the threat in a different way and priming the user with specific information about the severity of the threat.

Research questions and hypotheses

As pointed out earlier, information and education can have an impact on the way an individual behaves, not least because it influences their threat appraisal as well as coping appraisal. Therefore, the question arises if a highlighted message on a cookie banner that contains information about the severity of the threat that cookie banners create can have an influence on the behavior of the user. Moreover, users are also influenced by the general choice architecture of the banner which leads to the assumption that the addition of a button that allows the users to directly decline cookie usage via one click and therefore lowers the response-cost, has an influence on the likeliness to accept tracking cookie usage. Lastly, taking the occurrence of inattentional blindness into consideration, emphasizing the response option that we define as preferred behavior could also have an influence on the likeliness of users to accept tracking cookies. Thus, the following research questions and corresponding hypotheses are proposed:

Research questions:

RQ1: Does including a PMT nudge text in cookie banners negatively affect the likeliness to click accept in a cookie banner in internet users in Europe compared to their general cookie acceptance?

RQ2: Does including a “decline” button in cookie banners negatively affect the likeliness to click accept in a cookie banner in internet users in Europe compared to their general cookie acceptance?

RQ3: Does adding color to the “decline” or “options” button in cookie banners negatively affect the likeliness to click accept in a cookie banner in internet users in Europe compared to their general cookie acceptance?

Hypotheses:

H1: Including a PMT nudge text in cookie banners negatively affects the likeliness of internet users in Europe to click accept in a cookie banner compared to their general cookie acceptance.

H2: Including a “decline” button in cookie banners negatively affects the likeliness of internet users in Europe to click accept in a cookie banner compared to their general cookie acceptance.

H3: Adding color to the “decline” button or the “options” button in cookie banners negatively affects the likeliness of internet users in Europe to click accept in a cookie banner compared to their general cookie acceptance.

2 Methods

2.1 Design

The present study was a quantitative experimental study with a within-subject design. The dependent variable that was measured is the participants’ self-reported likeliness to click the accept button that is displayed in each of the shown cookie banners. The independent variables are the general cookie acceptance of participants which was assessed with a self-report question as well as the influence of the manipulations, namely the PMT nudge text, the addition of a decline button and the addition of color to a cookie banner on the dependent variable, namely the participants’ likeliness to click on the accept button in the shown banner. Additionally, for further exploratory research, participants’ risk-taking attitude, previous knowledge, risk perception, self-efficacy, response efficacy, and future intentions were assessed.

2.2 Participants

The sample that was used for this study included 101 participants, which were gathered through snowball sampling via ‘WhatsApp’ by the contacts of the researchers as well as convenience sampling using the subject pool Sona-Systems (SONA) of the University of Twente. Fifteen participants were students who got compensation for their participation in the form of credits. The remaining participants participated for the experience. With that, the sample consisted of 54 male, 38 female & nine other participants ranging from approximately 18 to 33 years of age with two outliers being 51 and 83 (M=23.4, SD=7.101). Most participants were German and had obtained a high school degree or higher. Conducting attention checks showed a high attentiveness of the sample, where 91,83% of attention checks were answered correctly.

The participants needed to have access to a computer or a mobile device with internet access. Additionally, the participants needed to be fluent in English and above the age of 18. Three inclusion criteria applied to the study, the first one being giving consent to participate in the study. Seven people did not give consent to participate and were therefore removed from the dataset immediately. Second, it was an inclusion criterion for the participants to have lived

in a European country for at least one year during the last four years. Two people of 113 stated to not have lived in a European country for at least one year and were therefore excluded from the study, as this study partially focuses on the GDPR which is only active in European countries. Third, it was an inclusion criterion to consent to the participation again after the debriefing. Ten participants dropped out of the study during the process and consequently did not give their consent after debriefing and were therefore removed from the dataset which led to a final dataset with 101 participants that was used for the further analyses.

2.3 Materials

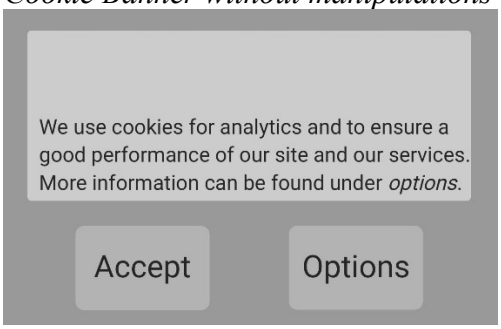
The survey was focused on finding out whether participants could be nudged toward accepting less cookies, primarily by showing them a text message and secondarily by coloring the "decline" button or alternatively the "options" button in a bright color, in this case green. Additionally, a third mode namely the number of buttons was assessed, too.

Experimental manipulation

The first step in this study was to create eight cookie banners in which we included the three manipulations. In three banners, only one manipulation each was included, and four banners included the manipulations in different combinations. There was one banner without any of the three manipulations (see Figure 1) and to this banner we added each of the manipulations. The cookie banner acceptance was assessed by asking participants to estimate their likeliness to click accept in the cookie banner on a five-point Likert scale ranging from "very unlikely" (1) to "very likely" (5) which participants had to answer independently per each cookie banner.

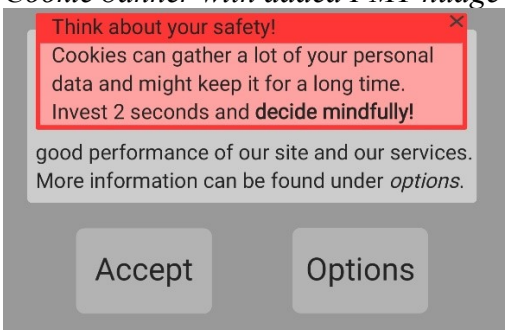
Figure 1

Cookie Banner without manipulations



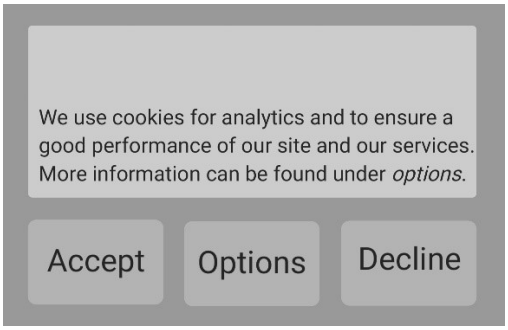
The first manipulation that we added to the different banners was the PMT nudge text (see figure 2). The text was created with the Protection-Motivation Theory in mind and addresses the threat appraisal of participants by informing them of the potential risks of accepting tracking cookies.

Figure 2
Cookie banner with added PMT nudge text



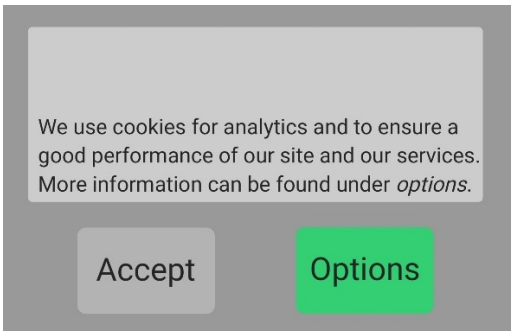
The second manipulation was the addition of a third decline button (see figure 3) that was based on the dual processing model and was included to address system 1 of participants and make it easier for them to decline tracking cookies.

Figure 3
Cookie banner with added decline button



And the third manipulation was the addition of color to the preferred response option (see figure 4) which was included based on the phenomenon of inattentional blindness to attract the attention of the participant. The preferred response option is always either the options button or the decline button, as far as one is included in the banner, to achieve the aim that participants accept cookies less.

Figure 4
Cookie banner with color added to options button



Moreover, we combined the manipulations with each other to see if they were more effective which resulted in four additional banners. One cookie banner entailed a PMT nudge text and a third decline button (see Figure 5). One banner entailed a third decline button that was also colored in green (see Figure 6). One banner entailed a PMT nudge text and a third decline button that was not colored (see Figure 7). Finally, the last banner entailed all three manipulations, namely the PMT nudge text and the third decline button that was also colored in green (See Figure 8).

Figure 5
Cookie banner with PMT nudge text, decline button and without color

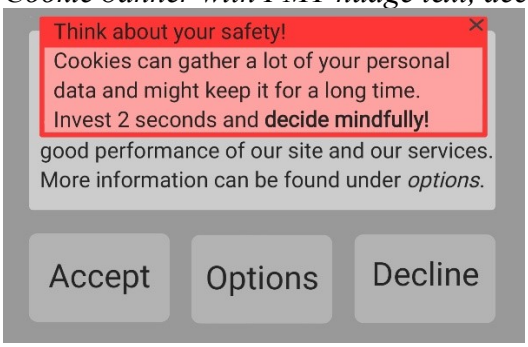


Figure 6
Cookie banner without PMT nudge text, with decline button that is also colored in green

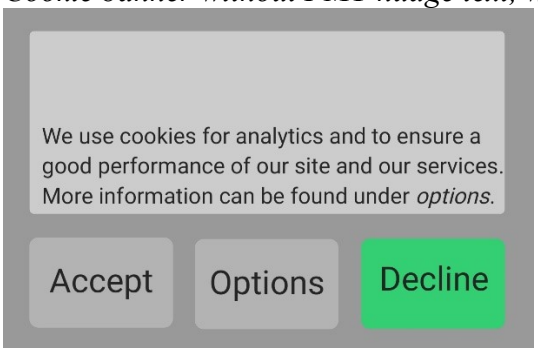


Figure 7
Cookie banner with PMT nudge text, without decline button and with color added to the options button

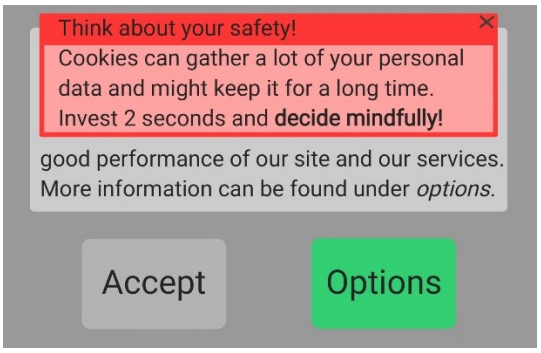
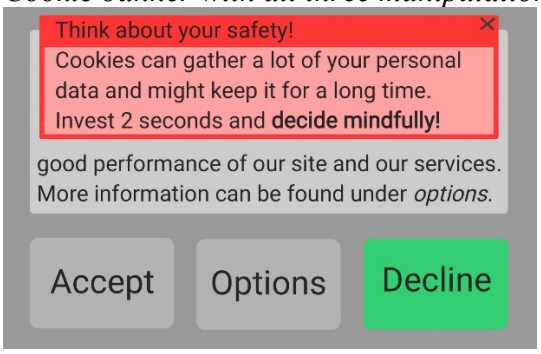


Figure 8
Cookie banner with all three manipulations (PMT nudge text, decline button, added color)



General cookie acceptance

To assess the general attitude participants perceive themselves to have towards cookie banners, they were asked to state how likely in general they are to click the accept button in a cookie banner. This was assessed through a single question, the questionnaire therefore had one item.

DOSPERT Scale

To assess the general likelihood of the participants to engage in risky behavior we used the revised and improved 30-Item DOSPERT scale of Blais and Weber (2006). The Cronbach's Alpha found for this questionnaire in our survey was $\alpha = .83$.

Knowledge questionnaire

To assess the previous knowledge of the participants concerning tracking cookies as well as cookie banners we included a self-constructed knowledge questionnaire. It entailed eight items that were measured on a 5-point Likert scale ranging from "definitely wrong" (1) to "definitely correct" (5). The Cronbach's Alpha found for this questionnaire in our survey was $\alpha = .74$.

Risk perception

To assess how high the participants appraised the risk concerning several events to happen in connection to tracking cookies, the participants were faced with a self-constructed risk perception questionnaire. It consisted of seven items measured on a 5-point Likert scale ranging from “I don’t fear it” (1) to “I fear it a lot” (5). The questionnaire had a Cronbach’s alpha of $\alpha = .76$.

Self-efficacy

To measure the extent to which people perceive themselves as being capable of taking action and solving difficulties they may face in life the participant was faced with a self-efficacy questionnaire. For this the general self-efficacy questionnaire (GSE) by Schwarzer & Jerusalem (1995) was used which measured self-efficacy in ten items on a 4-point Likert scale ranging from “Not at all true” (1) to “Exactly true” (4). The Cronbach’s alpha for this questionnaire was $\alpha = .84$.

Response efficacy

To assess how participants perceive their actions concerning making a difference the response efficacy of participants was measured. This was measured with help of a self-constructed scale which entailed six items. In imitation of the self-efficacy scale the response efficacy was measured on a 4-point Likert scale ranging from “Not at all true” (1) to “Exactly true” (4). For this questionnaire, a Cronbach’s alpha of $\alpha = .57$ was found.

Doing an exploratory factor analysis on the response-efficacy questionnaire that did not have a satisfactory Cronbach’s alpha showed a clear division into two factors. The first three questions belong to one factor and can be conceptualized as “finding ways to decline cookies”. Questions four to six belong to the second factor and can be conceptualized as “perceiving own behavior as being influential”. After calculating Cronbach’s alpha for each item set separately again, the first set showed a Cronbach’s alpha of $\alpha = .78$, the second set had a Cronbach’s alpha of $\alpha = .39$. The first set does not in fact measure response efficacy and the second set, that does, has an even lower Cronbach’s alpha. Therefore, this questionnaire will be excluded from the analysis.

Future Intention

The intention of the participants concerning their future behavior was measured by three questions asking for the participants’ intention to decline cookies more often in the future, decline cookies by hand more often in the future and reading the description of the cookie

banner more often in the future. A 5-point Likert scale was utilized for this purpose ranging from “very unlikely” (1) to “very likely” (5). A Cronbach’s alpha of $\alpha = .76$ was found for this questionnaire.

Attention Measures

In order to ensure the participants were not selecting their answers randomly but be sure their response was valid, there were four attention measures built into the questionnaires meaning the participants were instructed to deliberately pick a specific answer on the Likert scale. These attention measures were added in the middle of the DOSPERT questionnaire, the risk perception questionnaire, the self-efficacy questionnaire, and the response efficacy questionnaire. They were measured in the same answer scale as the questionnaire they were included in.

2.4 Procedure

Prior to the distribution of the study, it was presented to the BMS Ethics Committee of the University of Twente on for ethical approval. After ethical approval was confirmed on 14.05.2022, the study was distributed via social media and SONA. This survey consisted of an informed consent, an experimental manipulation element, several questionnaires, and a debriefing.

First, participants were presented with information about the nature of the study, and it was explained to them which tasks they will have to carry out (see Appendix B). They had to actively consent to participate in the study. Individuals that declined the consent were excluded from the study. After giving consent they were asked for demographic data and their screen- as well as internet time per week. Thereafter, they had to complete the DOSPERT questionnaire. Following that, they had to give insight into their previous knowledge about tracking cookies and cookie banners.

Thereafter, the experimental manipulation element took part. Every participant was shown each of the eight cookie banners one by one and the participants had to rate how likely (on average) they were to click accept on the cookie banner that was presented to them. All participants saw all eight cookie banners in the same order. Next, four brief questionnaires were presented to the participants one by one assessing their risk perception, general self-efficacy, response efficacy and intention for future behavior. Finally, the whole purpose and intention of the study was clarified to the participants by including a debriefing (see Appendix C). Underneath the debriefing the researchers’ contact data for questions was repeated. After

reading the debriefing, the participants again had to actively consent to their participation and the use of their data. On the last page of the survey, the participants could voluntarily enter their SONA ID, to be able to receive SONA credits as a form of compensation for their participation if they wished so. Lastly, the participants were thanked for their participation.

2.5 Data analysis

The first step of the analysis was to conduct paired samples t-tests comparing the general cookie acceptance of participants, which we asked the participants for in the beginning of the questionnaire, with the likeliness to click accept per each cookie banner. In total eight paired samples t-tests were conducted, each per cookie banner in comparison with general cookie acceptance. The corresponding scores from the paired samples t-test will be named after the name of the cookie banner that was compared to general cookie acceptance.

Next, we conducted a repeated measures ANOVA to compare the likeliness to click accept in the cookie banner with each other. For that, the eight cookie banners were sorted three times into groups of four cookie banners each dependent on the main factors, namely “text”, “color” and “buttons”. The corresponding scores from the repeated measures ANOVA were named after these conditions. In total, six groups were created. The first group was named “text” and contained all four cookie banners that included a PMT nudge text. It was compared to the second group named “no text” with all four cookie banners that did not include a PMT nudge text. The third group was named “color” and contained all four cookie banners that included either an “options” or “decline” button that was highlighted in green. It was compared to the fourth group named “no color” that contained the cookie banners that included no colored buttons. The fifth group was named “3 buttons” and contained all four cookie banners that included three buttons on the banner. It was compared to the last group named “2 buttons” that contained all four cookie banners that included only two buttons on the banner.

Finally, Pearson’s correlation coefficient was calculated for comparison of general cookie acceptance and each of the additional questionnaires that participants were asked to fill out in the survey, namely risk-taking, knowledge, risk perception, self-efficacy, and future intention. It was not calculated for response efficacy as this questionnaire was excluded from the analysis as stated above.

3 Results

The first paired samples t-tests aimed to compare the reported general cookie acceptance of participants with the reported likeliness of each participant to click accept in each of the eight shown cookie banners. The most prominent significant finding with a mean difference of -2.010 appeared in the comparison between the general cookie acceptance and the cookie banner with the PMT nudge next, three buttons and a colored decline button. Meaning that participants clicked less often on accept in the shown cookie banner. The second biggest significant mean difference could be found in the comparison between the general cookie acceptance and the cookie banner without the PMT nudge text, but again with three buttons and a colored decline button. The mean difference was -1.644 and showed that participants were less likely to click on accept in the shown cookie banner. The third highest mean difference was found in the comparison between the general cookie acceptance and the cookie banner with a PMT nudge text, with three buttons, but without color added to the decline button, thus all buttons looking the same except for what was written on them. The mean difference was -1.406 and therefore showed that people were less likely to click accept in the shown cookie banner. Following to that the remaining cookie banners also scored better than the general cookie acceptance of participants, meaning participants clicked on accept less in each of the cookie banners compared to their reported general cookie acceptance. However, there is one exception. The only positive mean difference was found in the comparison between general cookie acceptance and the cookie banner in which no manipulations were present. The cookie banner entailed no PMT nudge text, only two buttons, and no color was added to the banner buttons. The mean difference was .020 meaning participants stated to be more likely to click accept in this shown cookie banner than in general. However, this comparison was non-significant with $p>0.05$.

When looking closely at the significant results of these paired samples t-tests (table 1) it can be seen that we found the highest difference in likeliness to accept tracking cookies in the comparison with the banner that entailed all three manipulations. We found the three next highest differences to be in comparison to the three banners that each entailed two manipulations and the three least highest differences to be in comparison with the banners that each entailed one manipulation.

Table 1

Paired samples t-tests comparing each cookie banner to general cookie acceptance; sorted ascending by t-value

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
General Cookie Acceptance – Nudge, 3 Buttons, colored	-2.010	1.603	.160	1.693	2.326	-12.600	100	.000
General Cookie Acceptance – No nudge, 3 Buttons, colored	-1.644	1.616	.161	1.325	1.963	-10.221	100	.000
General Cookie Acceptance – Nudge, 3 Buttons, no color	-1.406	1.387	.138	1.132	1.680	-10.188	100	.000
General Cookie Acceptance – Nudge, 2 Buttons, colored	-1.267	1.483	.148	.975	1.560	-8.591	100	.000
General Cookie Acceptance – Nudge, 2 Buttons, no color	-.970	1.403	.140	.693	1.247	-6.949	100	.000
General Cookie Acceptance – No nudge, 2 Buttons, colored	-.733	1.341	.133	.468	.997	-5.492	100	.000
General Cookie Acceptance – no nudge, 3 Buttons, no color	-.495	1.285	.128	.241	.749	-3.870	100	.000
General Cookie Acceptance – no nudge, 2 Buttons, no color	.020	1.095	.109	-.236	.196	.182	100	.856

Next, the cookie banners were sorted into six different groups of four where three groups entailed the banners with and three groups without the experimental manipulation (see Appendix D, Table 2). This was done to compare the impact of a specific manipulation whilst controlling for the other conditions. Always two groups were compared with each other, one containing the banners with the respective experimental manipulation and one without it. The results from the repeated measures ANOVA show that participants clicked on accept less in the banners with the PMT nudge text compared to the banners that lacked a PMT nudge text (table 2).

Table 2

Pairwise comparisons of the banners with a text present and the banners without a text present

		Mean Difference			95% Confidence Interval for Difference[b]	
(I) text	(J) text	(I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	.700*	.072	.000	.558	.843
2	1	-.700*	.072	.000	-.843	-.558

Note: 1 = no text present, 2 = text present

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Comparing the banners with three buttons present with the banners where two buttons were present the repeated measures ANOVA shows that participants reported to be less likely to click on the accept button in the banners with three buttons that included a decline button compared to the banners without the third decline button (table 3).

Table 3

Pairwise comparisons of the banners with three buttons and the banners with two buttons

		Mean Difference			95% Confidence Interval for Difference[b]	
(I) buttons	(J) buttons	(I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	.700*	.097	.000	.508	.893
2	1	-.700*	.097	.000	-.893	-.508

Note: 1 = two buttons present, 2 = three buttons present

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Finally, comparing the reported likeliness of participants to click accept in the banners where color was added to the preferred response option, namely the options button or the decline button, to the banners where no color was displayed showed that participants were less likely to click accept in the banners where color was present (table 4).

Table 4

Pairwise comparisons of the banners with color present and the banners without color present

					95% Confidence Interval for Difference[b]	
(I) color	(J) color	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
1	2	.651*	.093	.000	.467	.835
2	1	-.651*	.093	.000	-.835	-.467

Note: 1 = no color, 2 = colored

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

As it can be seen, the groups that contained the banners with the experimental manipulation always scored lower on likeliness to be accepted than the groups without it, meaning participants reported to be less likely to click accept in a banner that contained a certain nudge compared to a banner without that specific nudge. In that, the PMT nudge text and adding a third decline button were slightly more effective than adding color to the banner buttons.

Exploratory analyses were conducted to find out if any of the characteristics that were measured in additional questionnaires have any correlation with general cookie acceptance. For this Pearson's correlation coefficient was calculated for each of the questionnaires and "general cookie acceptance". The results (table 5) show that the only significant finding is a correlation between general cookie acceptance and risk-taking attitude. This shows that the higher the participant scored in risk-taking attitude the higher they reported their general cookie acceptance to be.

Table 5

Pearson Correlations between additional questionnaires and "general cookie acceptance"

	General Cookie Acceptance	RT	KN	RP	GSE	FI

General Cookie	Pearson Correlation	1	.205*	-.148	-.189	.132	.158
Acceptance	Sig. (2-tailed)		.040	.139	.058	.189	.114
	N	101	101	101	101	101	101

Note. RT = Risk-taking, KN = Knowledge, RP = Risk Perception, GSE = General self-efficacy, FI = Future Intention.

*p < .05 (2-tailed).

4 Discussion

This research aimed at finding out whether the addition of nudges and certain choice architecture in a cookie banner influence the reported likeliness of internet users to accept tracking cookie usage. We wanted to examine whether adding a nudge text, a third decline button or color with the preferred response option has a significant influence on the behavior of individuals and could nudge them in a way that we classify as preferred behavior. This had the goal to find out how we can nudge people into that preferred behavior best to make interaction with internet services safer for them. In total, they were shown eight different cookie banners which entailed the different manipulations differing in composition. We found that all manipulations were effective and altered the behavior of the participants in a way that led to them reporting to be less likely to click accept in each cookie banner.

Main findings

The first hypothesis of this study was that the addition of an informative text to the cookie banner negatively affects the likeliness of the participants to click accept in a cookie banner compared to their reported general cookie acceptance. For our sample we found that tracking cookie usage was less likely to be accepted by users when they were shown the banners that entailed an informative text than when they were shown the banners without the text. Therefore, we accept the first hypothesis.

This result is supported by the protection motivation theory of Rogers (1975) as there is reason to assume that participants' threat appraisal was increased by the added text which informed them of potential privacy risks that accepting cookies involves. Participants might have both evaluated the risk that is involved in the acceptance of cookies as more severe as well as assessed themselves in the situation as more vulnerable than they previously judged them to be. The text therefore fulfilled its function in informing about and raising awareness for the risk potential of accepting tracking cookie usage. This also fits with the results of the study of Bavel

et. al (2019) who found that showing participants a message telling them how to behave to protect their security best, increased their cautiousness. However, when Bavel and RodrÃguez-Priego (2016) tested the effect of several different kinds of cookie banner messages on the behavior of participants towards the banners, they found that the default message which tells users that cookies will be collected, led to an increase in the acceptance of cookies. Furthermore, they found that a message that was designed to include all elements of PMT, led to a decrease in users' behavior of reading more information about cookie usage. Thus, the display of messages in their study had an opposite influence than what we would like to see. Therefore, more research is needed on which messages increase and decrease the likeliness of users to click on accept in a cookie banner.

Our second hypothesis was that the addition of a decline button negatively affects the likeliness of the participants to click accept in a cookie banner compared to their reported general cookie acceptance. For our sample we found that tracking cookie usage was less likely to be accepted by users when they were shown the banners that entailed a decline button than when they were shown banners without the button. Therefore, the second hypothesis is accepted.

These results are seconded by the dual processing model (Kahneman & Tversky, 1979). It supports the idea that participants' behavior follows their two systems. System 1 leads to fast, automatic, and emotional responses whereas system 2 leads to slow, effortful, and logical responses. In the light of this study, there is reason to assume that participants accepted tracking cookie usage less often when a "decline" button was present as a compromise for system 1 and system 2. Internet users do not visit a website to look at the cookie banner but instead access the information on the website. Therefore, system 2 rather wants to decline cookies, as it knows that that is the safer option, whereas system 1 reacts emotionally and wants to arrive at the desired website quickly and effortlessly. Thus, when a decline button is present and noticed the response cost for clicking on decline is as low as for clicking on accept which increases the probability of the participants of not clicking on accept. In comparison, when no decline button is present and participants are not able to decline cookies with the click of one button, the response cost for declining cookie usage is higher than that for accepting cookies, which might lead to a higher probability of participants accepting cookie usage.

Lastly, our third hypothesis was that the addition of color to the preferred response option negatively affects the likeliness of the participants to click accept in a cookie banner compared to their reported general cookie acceptance. For our sample we found that tracking

cookie usage was less likely to be accepted by users when they were shown the banners that entailed a green decline or options button than when they were shown banners without the color. Therefore, hypothesis 3 is accepted, as well.

These findings are in line with the concept of inattentional blindness. When participants encounter a cookie banner, they might have already seen a lot of them in that week which can lead to habitual and maladaptive behavior. As our findings show participants were less inclined to click accept in a cookie banner when the decline button - as well as the options button when no decline button was present - was highlighted in green. This can be ascribed to the increased attention that is drawn to the highlighted button in comparison to the other button(s). The emphasis on the preferred response option lowers the response-cost for the user because they have to invest less time searching as the safer choice automatically draws their attention to it. This might have led to the lower acceptance of tracking cookies in the banners with added color.

These findings align with the findings of Sun et. al (2008). When they researched how individuals behave towards advertising banners, evidence was found for the phenomenon of banner blindness meaning that individuals are becoming unaware of advertising banners even when they are very visible. Although advertising banners use a lot of attention raising elements like colors and movement, individuals still become used to their presence which leads to eventually becoming unaware of their presence. This arises the question whether the same happens to cookie banners if a overarching regulation for their layout would be introduced. For further research it might therefore be interesting to concentrate on researching whether varying cookie banners across websites attract more attention from users compared to when cookie banners generally look and function in the exact same way across different websites and if internet users becoming used to their layout positively or negatively affects the behavior of internet users towards them.

To conclude, all three hypotheses were accepted as every manipulation had a negative influence on cookie acceptance and therefore serve their purpose in nudging users towards the preferred behavior of accepting cookies less often. However, the addition of solely one of the manipulations had less of an influence than adding two or even better three manipulations at once. It therefore became apparent that the more manipulations were present, the higher the difference was. That multiple interventions can have an increased behavior change compared to the implementation of just one intervention at a time was also found by Edwards, Mill, and Kothari (2004) who researched the effectivity of the implementation of multiple interventions in community health. They found the effectiveness increased as the different interventions targeted different individuals and therefore had a higher chance of influencing their behavior.

This is the same for this current research. There is a high probability that individuals are influenced by the manipulations differently and the combination of the manipulation therefore increases the chance that they affect the behavior of the internet user. The three best banners, meaning the ones that were accepted the least, were those with an added decline button, but the fourth banner that entailed the decline button was in turn the least influential banner, showing that the decline button is only making a difference when paired with other manipulations that attract the attention of the user. This shows that in the design of cookie banners and interventions to protect users from accepting tracking cookies, the protection-motivation theory, the dual processing model and the concepts of response-cost and inattentional blindness play an important role and should be taken into consideration.

Further findings

We conducted further analyses to find out if some individual differences between the participants' mindset that were measurable have an influence on the general cookie acceptance of participants. The results indicate that the only trait that showed to influence the general cookie acceptance of participants was their risk-taking attitude. Meaning that the higher an individual's risk-taking attitude is, the higher is their cookie acceptance, too. This is a reference point that signs that the risky behavior of accepting tracking cookies indeed correlates with the self-reported risk-taking attitude of participants. These findings give reason to assume that counteracting the risky behavior of participants can have a negative influence on cookie acceptance which leads to accepting less cookies. In a study from 2008 it was researched how risk-taking attitude differs in individuals of different ages, researched through a computer-based gambling task. It was found that age can have an influence on the risk tolerance of individuals as well as their IQ (Deakin, Aitken, Robbins, & Sahakian, 2004). The current study primarily studied the effect of cookie banner architecture on tracking cookie acceptance and touched on the influence of several additional features that to some degree concern the personality of participants. As we found a significant correlation between the risk-taking attitude of respondents and their general cookie acceptance, future research might benefit from digging deeper in this area and researching potential correlations between personality traits of users with tracking cookie acceptance.

Strengths and limitations of this study

One strength of this study was the extensive coverage of different cookie banner layouts. In total, three kinds of manipulation were displayed in eight different cookie banners, and it was therefore possible to assess every different layout separately. The design of this study makes it

therefore stronger than other studies which assess less manipulations or layouts as it can be better distinguished which influence the different factors have.

Moreover, the majority of questionnaires that were used in this study had a satisfactory Cronbach's alpha and therefore showed a good internal consistency and reliability. Additionally, the study sample majorly consisted of students within a narrow age group which gives the study results an increased generalizability for this population.

A flaw of this study is that we worked with fake banners in an unnatural testing environment. Usually, we want to observe the actual behavior of individuals in a real environment. Unfortunately, this was not possible for this study as for that we would have to observe users' browsing behavior for a distinct period and track their data. Ironically enough, this would involve a data privacy concern in itself.

Moreover, a widely known issue with studies where participants have to self-report arises two questions: How good are people at estimating and how good are people at remembering? This study is no exception from this. The results of the analyses rise and fall with the reliability of the participants' estimation and memory skills, if the participants of the sample overestimate or underestimate the amount of which they click accept in a cookie banner and if they can even remember that they saw a cookie banner. In terms of the current study, the results may thus have been influenced by the factor that participants forget the amount of cookie banners they mindlessly accept due to their routine and can only remember their responses to the cookie banners they actually paid attention to and consequently declined cookie usage. This potential distortion of memory can have an influence on how the participants evaluated their general cookie acceptance and therefore, together with the testing conditions that were somewhat diverging from real life circumstances, might have led to a distortion of the results. An improved approach might be to create several realistic webpages, let participants browse for a distinct period and track their actual cookie acceptance.

Lastly, this study included an experimental manipulation in which the button that was classified as the preferred response option was colored green to attract the attention of the user. Unfortunately, colorblind people were not taken into account with this design. As color-blindness leads to difficulties in distinguishing green from red and grey, participants who suffer from color-blindness may not have been able to recognize that the button which was highlighted in green was different from the others. As it was not asked in the preceding questionnaires whether the participant was colorblind or not, it cannot be indicated if or how many of the participants were colorblind and thus were not able to accurately assess the banners. Therefore, a potential effect of color-blindness on the results can neither be excluded nor measured as we

did not control for color-blindness. Next time, this should be considered when creating a questionnaire where color plays an important role.

Conclusion

To summarize this study, the results clearly show that manipulations of cookie banners and their layout have an influence on how users behave towards them. As virtually everything in this world, this can be used for good as well as bad. We must keep in mind that weaponizing users against vicious use of these techniques is a major responsibility. Consequently, the question arises whose task is it to protect and/or educate the users to make them more resilient against potential cyber risks. The GDPR was a step in the right direction of the European Union in taking command of protecting citizens. But it is still open who is responsible for the remaining concerns and it is necessary for user's cyber safety to discuss and determine which roles the government, the internet providers, and the internet users themselves must take over. Clear arrangements and agreement are crucial to assure for long term cyber safety.

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Appendices

Appendix A

Hello participant!

Thank you for considering to partake in this research study. This study with the title "**Using PMT to nudge online users towards more conscious behavior in their choice of cookie acceptance**" researches the influence of messages shown in cookie disclaimers on the behavior of web users to accept or deny them.

You will be asked to fill in several general questionnaires and will be presented with different cookie disclaimers and asked to rate them in their likelihood to be accepted by you.

To participate, you need to be at least **18 years** old and have to have lived in a **European country for at least 1 year** during the last 4 years. The study will take you approximately **15-20 minutes** to complete. Your data will be analysed in an anonymous manner and handled confitentially. Your response will be deleted after 6 months the latest. **You can withdraw your consent and stop the participation at any point in time without giving any reason.**

There are no risks associated with participation in this study and the Ethics Committee of Behavioral, Management and Social Sciences (BMS) Faculty of the University of Twente approved this research. In case you have any questions, please do not hesitate to contact me, Franziska Wolters via f.wolters-1@student.utwente.nl or my supervisor Iris van Sintemaartensdijk via i.vansintemaartensdijk@utwente.nl (the contact information will be repeated at the end of the study)

Appendix B

You are almost finished

In the beginning, the aim of this study was explained to you. This information was incomplete with the purpose to not let the researchers' expectation have an influence on your behavior. This study has the aim to nudge users towards accepting either less tracking cookies or simply those which the user actively wants themselves to be tracked instead of accepting all of them because it is easier. We want to find out how it can be made even easier for the user to deselect the tracking cookies and have control over them.

In case you have any questions, please do not hesitate to contact me, Franziska Wolters via f.wolters-1@student.utwente.nl or my supervisor Iris van Sintemaartensdijk via i.vansintemaartensdijk@utwente.nl

Are you okay with that? If yes, click accept. If not, you can withdraw your participation here.

[ ] Yes that's fine

[ ] No that's not okay, I don't want my data to be used and I want to drop out of the study

Appendix C

Table 2

Grouping of cookie banners for paired samples t-test analysis

Name nudge group	Cookie banners	Name comparison group	Cookie banners
"text"	Nudge, 2 buttons, no color Nudge, 3 buttons, no color Nudge, 2 buttons, colored Nudge, 3buttons, colored	"no text"	No nudge, 2 buttons, no color No nudge, 3 buttons, no color No nudge, 2 buttons, colored No nudge, 3buttons, colored
"3 Buttons"	Nudge, 3 buttons, no color Nudge, 3buttons, colored No nudge, 3 buttons, no color No nudge, 3buttons, colored	"2 Buttons"	Nudge, 2 buttons, no color Nudge, 2 buttons, colored No nudge, 2 buttons, no color No nudge, 2 buttons, colored
"color"	Nudge, 2 buttons, colored Nudge, 3buttons, colored No nudge, 2 buttons, colored No nudge, 3buttons, colored	"no color"	Nudge, 2 buttons, no color Nudge, 3 buttons, no color No nudge, 2 buttons, no color No nudge, 3 buttons, no color