"So I Sold My Soul": Effects of Dark Patterns in Cookie Notices on End-User Behavior and Perceptions

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***Abstract*—Cookies are widely acknowledged as a potential privacy issue, due to their prevalence and use for tracking users across the web. To address this issue, multiple regulations have been enacted which mandate informing users about data collection via. so-called *cookie notices*. Unfortunately, these notices have been shown to be ineffective; they are largely ignored, and are generally not understood by end-users. One main source of this ineffectiveness is the presence of *dark patterns* in notice designs, i.e. user interface design elements that nudge users into performing an action they may not otherwise do, e.g. consent to data collection.**

In this paper, we investigate the mental models and behavior of users when confronted with dark patterns in cookie notices. We do this by performing a mixed-method study (on Danes in their late-20s) which integrates quantitative and qualitative insights. Our quantitative findings confirm that the design of a cookie notice does influence the decisions of users on whether or not to consent to data collection, as well as whether they recall seeing the notice at all. Our qualitative findings reveal that users do in fact recognize the presence of dark patterns in cookie notice designs, and that they are very uncomfortable with standard practices in data collection. However, they seldom take action to protect their privacy, being overall resigned due to decision fatigue. We conclude that website maintainers need to reconsider how they request consent lest they alienate their users, and that end-users need better solutions that alleviate their burden wrt. protecting their privacy whilst visiting websites that collect data.

I. Introduction

Cookies serve a very useful function on the web. They enable websites to store information specific to a user's visit on the user's device, such as site preferences (e.g. language), site state (e.g. shopping cart), and session identifier (i.e. who is logged in). Cookies are, however, widely acknowledged as a potential privacy issue, since this very same feature can be—and frequently is—used to track users across the web. As web tracking becomes ubiquitous, measures and policies to help users gain control over their personal data and protect their privacy are being discussed. As part of these measures (mandated by several legislations), companies are obligated to inform users on when and how their data is being collected and used. The purpose is to enable users to consent to or decline data collection, and to provide users with additional control, such as requesting data deletion. In particular, multiple regulations have been introduced that mandate informing website visitors about the collection of cookies, most recently, the European General Data Protection Regulation (GDPR) and follow-up decisions by data protection authorities. The assumed role of these notices is to ensure *informed consent* among website visitors.

However, studies have shown that the notices used for this purpose are often ineffective, being ignored and generally not understood by end users. Moreover, the issue commonly raised is the prevalence of so-called *dark patterns* in the design of theses notices—that is, user interface design elements that are meant to nudge the users into performing an action they would not otherwise do—potentially leading the website visitors to consent to data collection against their intention. So far, multiple quantitative studies have been conducted [12], [17] among the users in UK and Germany, showing that these dark patterns are indeed effective in influencing the behavior of end users and whether they consent to data collection. Other studies performed qualitative investigations into the mental models[1] of users, without focusing on the dark patterns and the perceptions of particular designs of cookie notices [10].

In this paper, we describe the results of a mixed-method study designed to integrate quantitative and qualitative insights to better understand mental models of interactions with cookie notices. We conduct two studies with participants from Denmark in their late-20s, focusing on the following *research objectives*:

- *How do dark patterns in cookie notices affect people?* Do dark patterns affect whether people (1) notice the notice and (2) consent to or decline data collection? (3) Does this depend on the website type?
- *How do people perceive their interactions with cookie notices with dark patterns?* (1) How do they make decisions when confronted with such a notice? (2) What is their attitudes towards commonly seen notices? (3) What are their expectations of what they are consenting to? (4) What are their preferences towards particular designs of cookie notices?

Our quantitative study ($n = 40$) confirms that the design of a cookie notice does substantially influence whether or not

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[1]Commonly defined as "mechanisms whereby humans generate descriptions of system purpose and form, explanations of system functioning and system states, and predictions of future system states", see [19], [29]

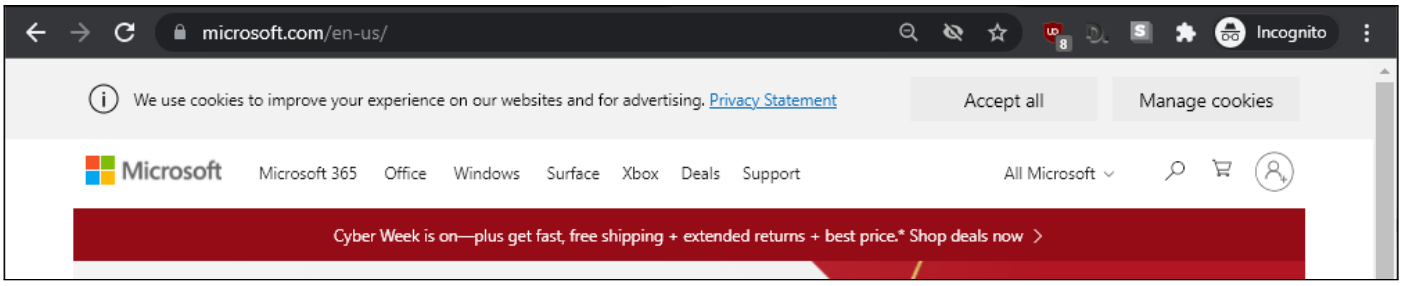
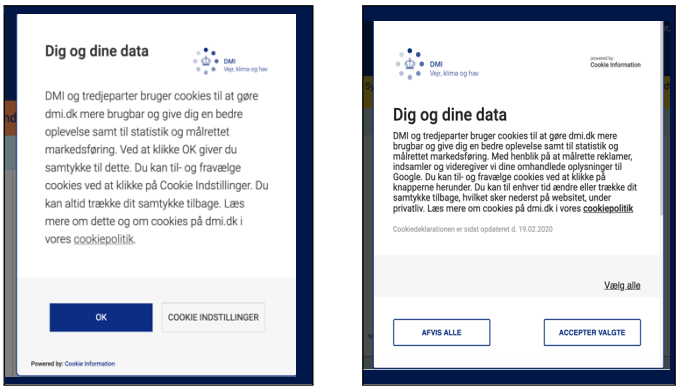


Fig. 1: Cookie notice at https://www.microsoft.com/. Notice that users can ignore the disclaimer and continue using the site.



(a) Old notice. (b) New notice.

Fig. 2: Danish Meteorological Institute (DMI) notices [8]. Note the presence of the "reject all" button in the new notice, replacing the button leading to cookie settings, and the lack of emphasis on the "accept selected" button as opposed to the highlighted "OK" button in the old notice.

people consent to data collection, as well as whether they recall seeing the notice at all. More interesting, however, is the outcome of our qualitative study ($n = 10$), where we conduct interviews to further elaborate on this influence. While our participants acknowledge that they are more likely to click on the "accept" button if the alternative is hard to find, they do in fact recognise this as manipulation, and would prefer to have an easier way to limit their data sharing. Our participants furthermore express uncertainty to many of the aspects of data sharing, i.e. regarding what data is collected, how it is used, who has access to it, what their legal rights are with regards to collected data, and what the procedures for exercising these rights are. Overall, many participants feel like they are forced to give up their privacy, that they do not have a choice in the matter, and that they do not know how to protect themselves.

The results of our study indicate that cookie notices fail in their purpose to ensure informed consent from users, and while the users might agree to data collection, one possible reason—aside from lack of concerns about privacy—is the lack of self-efficacy, with users believing that there is nothing they can do to protect themselves and that they have no choice but to consent. We therefore conclude that there is a need for better protection measures, including providing users with actionable guidelines on how to protect their privacy, as well as pushing companies into providing usable and understandable controls, addressing user concerns about sharing their data and providing them with actionable choices, lest they alienate their users.

II. Background

A. Dark Patterns

Dark patterns are user interface (UI) design elements that are meant to nudge users into performing an action they would otherwise not do [7]. Brignull introduced the concept in 2010 on https://www.darkpatterns.org/ along with a taxonomy; several taxonomies have since emerged (notably Gray et al. [5]), surveyed by Mathur et al. [13]. While the intuition behind the concept is quite clear, there is not a clear consensus on exactly what characteristic a UI must have, and what effect it must have on the user, for the UI to contain dark patterns (e.g. trickery, mislead, and deception, are three subtly different ways to nudge users). In this paper, we therefore explain on a per-UI basis what the dark pattern is, and how it nudges users.

B. Cookie Notices

A Cookie notice, also known as cookie policy or cookie consent notice, is a document outlining the types and use of cookies on the website. Whereas most sites use cookies to store site state, preferences, and session information, many also use cookies to track users, to then sell their behavior information to third parties or facilitate targeted advertising. Upon first visit to a website, the website includes a cookie notice in its response to the user. The user can then indicate their preference with respect to how the website uses cookies. Dark patterns are frequently seen in cookie notices. For instance, in the notice in fig. 2a, users are nudged towards "OK" (i.e. accept-all), as this option is highlighted. Similarly, in the notice in fig. 1, users are nudged towards ignoring the notice, since the site can be used without indicating a choice, and since it requires effort to make a choice. However, this implies acceptance (i.e. accept-all). In both notices, it is more laborious to configure or reject cookies, since these options are behind a level of indirection ("Manage cookies" & "Cookie indstillinger" button).

C. Regulations

Cookie notices were introduced on EU websites following the ePrivacy Directive [24] that mandates informing users about cookie usage. Recital 30 of the EU General Data Protection Regulation (GDPR) [25] declares cookie identifier as one of the ways to identify users, making cookies subject to GDPR. Several countries introduced follow-up regulations [1],

[3], [4], specifying the requirements regarding the usage of cookie notices. Notably, in February 2020 the Danish Data Protection Agency published guidelines, following a verdict on a complaint filed against the cookie notice design on the Danish Meteorological Institute (DMI) website [4]. The guidelines, in particular, include the requirement that consent given by a user should be provided with meaningful choice, namely a button for rejecting cookies should be present next to the button for accepting them. The updated notice is shown in fig. 2b.

D. Related Work

The difficulties of designing usable and understandable settings-interfaces and notices that would support end-users privacy decisions has been widely recognised in previous work, with a number of studies revealing such challenges as the complexity of available notices, lack of actionable choices, notice fatigue, and misconceptions prevalent among the end users, as well as recognising the importance of understanding the mental models of users [2], [6], [11], [14]–[16], [18], [20], [21], [23], [27]. Notably, several studies conducted in recent years looked at cookie notices in particular [9], [10], [12], [17], [28], concluding that certain design choices (such as placement on the notice) on the web page can affect the acceptance rate of cookies, and that while some people have privacy concerns, many perceive cookie notices more as a nuisance and tend to click them away immediately after seeing the notice instead of attempting to study the information provided in the notice.

In contrast, our work combines quantitative and qualitative methods in order to further investigate the effects of dark patterns in cookie notices and to understand how perceptions and attitudes of users are affected by them. With this, our *contribution* extends on the work in [12], [17], [28] as follows:

- we include qualitative interviews to elaborate on our quantitative findings.

While we look at dark patterns similar to the ones investigated by Nouwens et al. [17],

- we involve participants from EU (as opposed to US) who have experience interacting with such notices in daily life (thus confirming previous findings on US participants, for EU participants), and
- we get additional insights, such as whether participants consciously register clicking the cookie notice, or whether there is a difference in behavior between different kinds of websites.

Further, we extend on the qualitative evaluation in [9], [10]:

- we focus on dark patterns rather than on attitudes towards cookie notices in general.

III. Approach

We follow a mixed methods approach, conducting two studies with quantitative and qualitative elements.

The first study, *Study 1*, i.e. our quantitative study, aims to understand the impact of how the design of the cookie notices and the type of the website influences the behavior of users in our sample. For this study, we conduct an experiment based on the work by Nouwens et al. [17] by using similar kinds of notices. In this way, study 1 is designed partially to confirm previous findings in a different setting: while Nouwens et al. put their own notices on websites that otherwise would have none (US participants), we test people's behavior given real-world notices that resemble ones they encounter on a daily basis (EU participants). We also wish to get additional insights, such as understanding whether people consciously register clicking the cookie notice, or whether there is a difference in behavior between different kinds of websites. Furthermore, different from [17], our study involves a lab experiment where participants are asked to perform some tasks with selected websites (e.g. search for a certain type of product) and observed with regards to their reactions to the shown cookie notice.

The second study, *Study 2*, i.e. our qualitative study, is informed by Study 1, and aims to understand the underlying effects of dark patterns (given designs similar to the ones used in Study 1 as well as additional ones), the participants' preferences for particular designs, and their concerns regarding data collection on websites. This study has a qualitative approach, involving interviews. We describe the procedure for both studies in more details below.

Danish		**English**	
Dig og dine data		You and your data	
Hjemmesiden bruger cookies		The website uses cookies	
Denne		This	
Danish	**English**	**Danish**	**English**
Læs mere	Read more	Accepter	Accept
Om	About	Afvis	Reject
Vores brug af	Our use of	Alle	All
Vis detaljer	Show details	[Ud]Valgte	Selected
Indstillinger	Settings	Nødvendig[e]	Necessary
Præferencer	Preferences	Funktionelle	Functional
Kun	Only	Statisti{k, ske}	Statisti{c, cal}
Tillad	Allow	Marketing	Marketing

TABLE I: Translation of common phrases in cookie notices.

All cookie notices in this paper are written in Danish. Table I contains a translations (to English) of common keywords and phrases which appear in the cookie notices which appear in this paper. When these translations are insufficient, we include a detailed translation alongside the cookie notice.

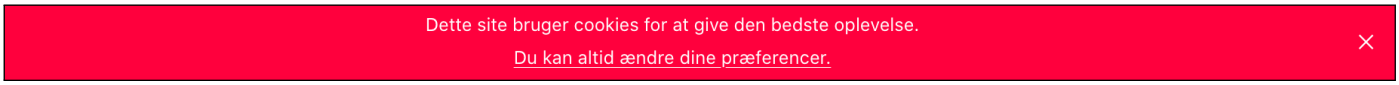
A. Ethical considerations

While there is no mandatory ethical review board in our institution, we took several measures to protect the privacy and overall well-being of our participants. As such, the participants were promised that the results of the study will be anonymous. While study 1 included deception, the participants were debriefed afterwards and received an explanation on why the deception was needed for the research. They were furthermore given information on how to delete their cookies, in case they regretted accepting them within our study. The participants did not receive any reimbursement for their participation.

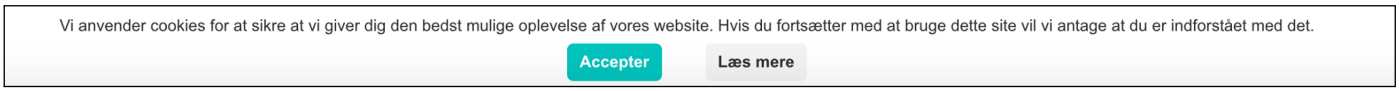
IV. Study 1: Quantitative Study

A. Methodology

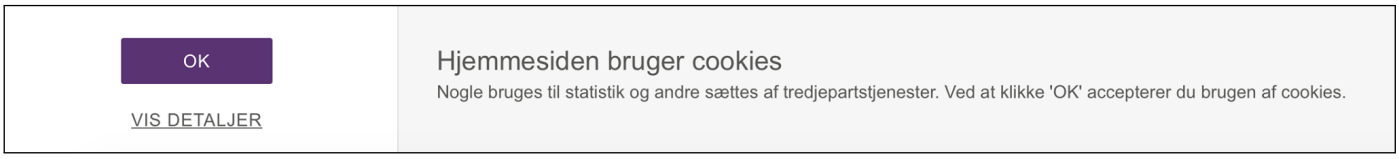
The participants for the first study were recruited using the authors' own networks via snowball sampling. Due to the COVID-19 outbreak, studies that were initially planned to be



(a) Undo Insurance.



(b) Danish Athletics Union.



(c) Billund Airport.

Translation fig. 3a: "This site uses cookies to give the best experience. You can always change your preferences."

Translation fig. 3b: "We use cookies to ensure that we give you the best possible experience on our website. If you continue using this site, we will assume that you consent to this."

Translation fig. 3c: "Some are used for statistic and others set by third-party services. By clicking OK, you accept the use of cookies."

Fig. 3: Quantitative study, Banner notices

(a) Topdanmark.

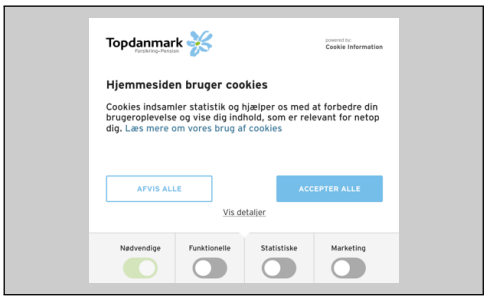
(b) Danish Soccer Union.

(c) Copenhagen Airport

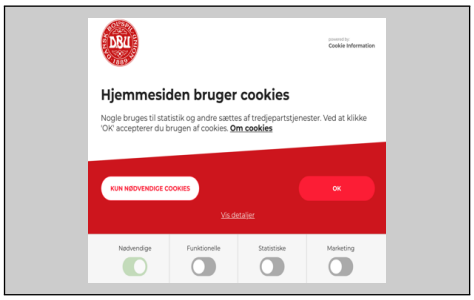
Translation figs. 4a and 4b: see translation for fig. 3c.

Translation fig. 4c: "We use cookies to personalize your user experience and to investigate how our website gets used as well as for targeted advertising. This information is shared with third parties. You provide consent to our cookies if you continue using this website. Read CPH's cookie policy, where you can also withdraw your consent."

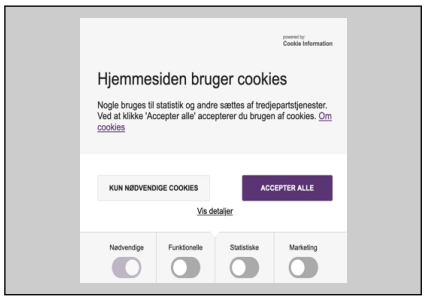
Fig. 4: Quantitative study, Barrier notices



(a) Topdanmark



(b) Danish Soccer Union



(c) Billund airport

Translation fig. 5a: "Cookies collect statistics and help us improve your user experience and show you content which is relevant for you."

Translation figs. 5b and 5c: see translation for fig. 3c.

Fig. 5: Quantitative study, websites that changed their notices during the study.

(a)	neither	one	both
Banner	6	8	6
Barrier	0	1	19

(b)	Sport		Insurance	
	Accept	Reject	Accept	Reject
Banner	20	0	17	1
Barrier	11	9	12	8

(c)	Accept	Reject
CPH	15	3
BIL new	7	6
BIL old	6	0

TABLE II: Study 1, results. Number of participants (a) noticing a notice on neither, one, or both, websites they saw, (b) accepting/rejecting the notice (by group and type of website), (c) accepting/rejecting the notice (per airport website).

conducted in person were moved online, with participants asked to share their screen with the examiner. The participants were informed that the study session will be recorded on video for further evaluations. Prior to the study, they were told a cover story, namely, that the purpose of the study was to investigate the usability of different websites, to avoid bias in how they interact with cookie notices on these websites. The participants were debriefed about the real purpose of the study afterwards.

1) Notices and websites: The study involves variations of two overall cookie notice designs that are commonly seen on websites. *Banner* notices (see fig. 3) are shown as part of the web page (most commonly either on the top or on the bottom) but do not block access to the webpage itself. *Barrier* notices (see fig. 4) appear as a pop-up which the user has to interact with (e.g. by choosing either to consent to or decline data collection) before they can access the web page.

Previous research has shown that users claim making decisions regarding cookie notices based on the website which shows the notice To assess whether this is the case, we therefore chose to direct participants towards actual websites that present either the banner or the barrier notice to them, and to furthermore include different types of website in our study. We initially included the following website types: (1) an official website of a Danish airport (Copenhagen airport (https://www.cph.dk/en) for the barrier notice, Billund airport (https://www.bll.dk/en-en) for the banner notice), (2) a website dedicated to a sports union (Danish Soccer Union (https://www.dbu.dk) for the barrier notice, Danish Athletics Union (http://dansk-atletik.dk) for the banner notice), and (3) the website of an insurance company (Topdanmark (https://www.topdanmark.dk) for the barrier notice, Undo (https://www.undo.app) for the barrier notice). The websites were chosen to cover a variety of services, i.e. a governmental website (airport), a website from private organisation (insurance company) that might collect sensitive data (e.g. if the user is looking for insurance plans covering specific health conditions) and a website from a non-governmental organisation that is unlikely to collect sensitive data (sport-related websites).

The initial notices that were displayed on these websites are shown in figs. 3 and 4. However, during our study, some of the chosen websites changed their design, as a result of a court ruling on the design of cookie notices (see Section II-C), see Figure 5. While we consider these changes to be relatively minor for Topdanmark insurance and Danish Soccer Union, the Billund airport website changed their notice from banner to barrier. We took this as an opportunity to study user interaction of *identical pages* that differ only in the notice used; we decided to continue using it in the study, and to evaluate the responses involving that website separately from the rest of the data.

The resulting notices that were shown to the participants are shown in figs. 3 to 5. The notices include elements that can be classified as dark patterns of following types: (1) notice being easy to miss (while stating that by browsing the website consent towards cookie acceptance is implied), (2) "reject" option being harder to access (e.g. requiring the participant to click on "settings", as opposed to being able to accept immediately) and (3) "reject" option being immediately available but displayed in a less prominent manner (e.g. by highlighting the "accept" option, an example of nudging). In particular, the notices in the banner group included the dark patterns of types (1) and (2), while the notices from the barrier group included dark patterns from type (2) and (3), with reject button being either hidden (before the legislation change) or featured in a less prominent color (after the legislation change).

2) Study hypotheses: We evaluate the following hypotheses:

- $H1$: There is a difference in whether participants notice the cookie notice depending on the notice design
- $H2$: There is a difference in whether participants consent to data collection depending on notice design
- $H3$: There is a difference in whether participants consent to data collection depending on website type

3) Study procedure: The study took place online via remote video calls. The participants of the study were randomly assigned into either the "Banner" or the "Barrier" group, each group being presented with websites showing a corresponding design of the notice. Each participant was given three tasks, one for each website, presented to them in random order:

- **Airport website:** "You have arranged a trip to Iceland. You'd like to see which 'tax-free' spirits you can buy in the airport. How would you do this?"
- **Sports-related website:** Danish Athletics Union: "You'd like to view results within athletics in Denmark. How do you do this?" Danish Soccer Union: "You'd like to see which soccer clubs are in your proximity. How would you do this?"
- **Insurance company website:** "You have heard about {Undo, Topdanmark}; you'd like to get an overview of their insurance products. How would you do this?"

We recorded each participant's interaction with the websites. After the participants were finished with all three tasks, we informed them about the real purpose of the study (i.e. to investigate their interactions with the cookie notices) and asked them to fill in a survey with follow-up questions. These questions included whether they noticed the notice, how they reacted to the notice, and whether their reaction was different than usual due of the study setting, as well as general questions on their behavior with cookie notices, such as what their most common action is, how often they read information on these notices or how often they leave a website because of the notice.

B. Results

There were a total of 44 participants in the study, of which four were removed before the analysis since they either answered that they would behave differently outside of the lab, or had an ad blocker installed, hence, did not see any of the cookie notices. The remaining 40 participants, 23 women and 17 men, were mostly in the age group 25-31.

Noticing the notice. For each group ("banner" or "barrier"), we counted on how many websites each participant noticed the notices[2]. The numbers are presented on fig. 6a.

As can be seen, while most of the participants in the barrier group noticed the notice on all the websites, the participants in

[2]Note that a few participants did not see notices on all three of the websites, thus we did not include these websites into their total count. We furthermore exclude the airport notices, as these were changed mid-study

the banner group mostly failed to notice a notice on at least one of the websites. The Fishers exact test furthermore revealed significant statistical difference between the banner and the barrier group ($p < .01$). $H1$ is therefore confirmed.

Accepting or rejecting cookies. Looking at the decisions participants made on websites, we distinguished between two classes of decisions[3]. One of them, referred to as "accept", consisted of either accepting cookies explicitly by clicking on "OK" or ignoring the notice (note, that the notices used in the study mentioned that the cookies will be collected if the participant continues browsing the website). The other class, "reject", consisted of participants rejecting either all or all but necessary cookies ("reject"). We provide the numbers for participants' decisions on both sports website and the website of an insurance company on fig. 6b.

For the airport websites, we compare: the participants in the banner group (i.e. the ones who interacted with the Copenhagen airport notices which did not change its design during the study), the participants interacting with the old version of the Billund airport notice (i.e. barrier), and the participants interacting with the new version of the Billund notice (i.e. banner). The distribution of participants' answers is provided on fig. 6c.

As with the rest of the banner notices, all participants took an action that lead to accepting the cookies when confronted with the old notice. There were, however, differences between the actions of the participants on the websites of Copenhagen airport (the vast majority accepting the cookies) and the Billund airport (almost as many participants accepting as rejecting).

Comparing designs. To test for the differences in whether the participants accepted cookies based on the notice design, we conducted three Fisher's exact tests, one for each type of the website, thus ensuring that each test only included one data point for each participant[4]. For both types of websites (sports and insurance), there were significant differences between the banner and barrier groups (Fisher's exact test, $p = .003$, $p = .04$ correspondingly). However, no significant differences between the groups with the airport website (Copenhagen airport with the barrier notice, and Billund airport with either banner or barrier notice) were identified (Fisher's exact test, $p = .059$), possibly because of the low sample size. $H2$ is therefore confirmed, albeit with these caveats.

Comparing websites. Given that almost all of the participants accepted the cookies given the banner notice, we furthermore compared the actions of participants in the barrier group on different websites. The Cochran Q test revealed significant differences ($p = .02$). However, the pairwise McNemar post-hoc tests did not confirm these differences for any of the websites types ($p > .05$). $H3$ is therefore not confirmed.

V. Study 2: Qualitative Study

A. Method

The second study consisted or semi-structured interviews and follow-up surveys, the participants for which were recruited via the author's personal networks. As with Study 1, the study was conducted online due to the COVID-19 pandemic. The goal is to investigate the participants' mental models, including insights about their expectations on what they consent to when they consent to data collection in a cookie notice, their perceptions of cookie notices of different designs and their attitudes towards data protection issues with cookies in general.

The study consists of two parts. The first part consists of an interview structured in the following way. First, we ask general questions about what the participants believe happens when they click OK/accept on a cookie notice, what they believe their data is used for, and the types of websites that might affect their choices when met with cookie notices. Afterwards, the participants are presented with four different cookie notice designs (two banners, and two barrier designs) on a mock website, see Figure 8[5]. For each design, we ask the participants about their opinion on the design and whether this type of design would make them leave a website. After going through all four designs, we ask the participants to rank them in terms of which design they believe provides the most freedom of choice regarding accepting or declining cookies. In the second part, two weeks later[6], we contact the participants again. We present the participants with the same four cookie designs as in the interview (Figure 8) and ask which one they would prefer to be confronted with on websites and why.

B. Results

Overall ten interviews were conducted, with five interviewees being women and five men, and an average age of 25.4 years. Nine of the participants were students, and one a full-time employee. Four participants were studying within the field of computer science, and the other participants were studying business, humanities and law. All of the ten interviewees have also participated in a follow-up survey.

Interviews were transcribed and analysed using thematic analysis and open coding by several of the paper authors. The resulting codes were then iteratively discussed and agreed upon. We describe the codes and relationships between them in more details in the subsections below, grouped into two themes:

- Mental models of web tracking and cookie notices, including (1) perceptions of what data is being collected and for what purpose, (2) possible concerns related to data sharing, and (3) attitudes towards cookie notices and reflection on common actions taken when confronted with such notices.
- Mental models of dark patterns, given their example on specific cookie notices.

As the goal of the study was to provide qualitative insights, we use the quantifiers, summarized on Table IV, to indicate relative frequencies with which a particular theme emerged. For some statements, we provide a supporting quote from a participant, to provide a better illustration of the responses.

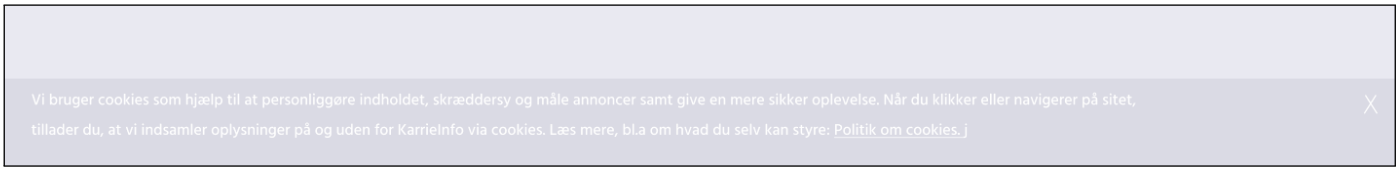
[3]As stated above, note that some of the participants did not see a notice on a specific website, e.g. due to already having visited the website before.

[4]For all the three comparisons, the Bonferroni-Holm correction was applied

[5]Design 1 and 4 was inspired by DMI's previous and current designs. The cookie notice on facebook.dk inspires banner design 3, and banner design 2 is inspired by cookiebot.dk, a widely used consent management platform.

[6]The purpose of the two week break was to avoid participants being biased by their own previous answers

(a) Design 2

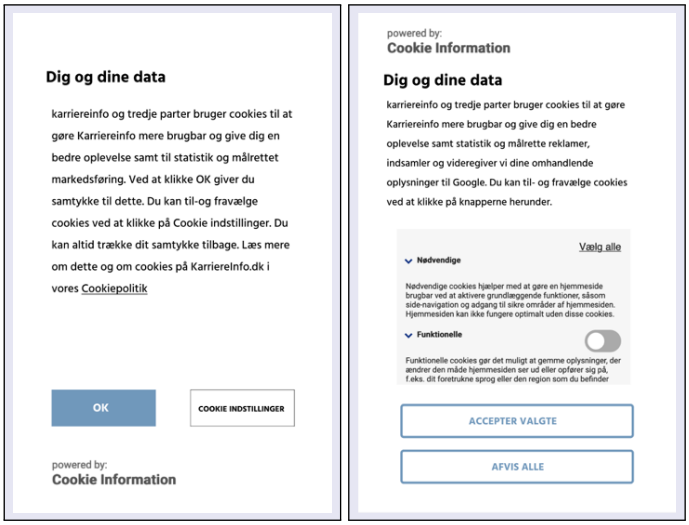


(b) Design 3

Translation fig. 7a: "We use cookies to customize our content and advertisements, to show you functions for social media, and to analyze our traffic. We also share information about your use of our page with our social media-, advertising-, and analysis-partners. Our partners can combine this data with other information which you have given them, or which they have collected about your use of their services."

Translation fig. 7b: "We use cookies to help personalize content, tailor and measure advertisements, and give a more secure experience. By clicking or navigating the site, you consent to our collection of information, on and outside KarriereInfo, via. cookies. Read more, e.g. on what you can control. Policy on cookies."

Fig. 7: Quantitative study, mock website cookie notices.



(a) Design 1 (b) Design 4

Translation fig. 8a: "KarriereInfo and third parties use cookies to make KarriereInfo more usable and to give you a better experience, as well as for statistics and targeted advertising. By clicking OK, you give consent for this. You can include and exclude cookies by clicking cookie settings. You can always withdraw your consent. Read more about this and about cookies on karriereinfo.dk in our cookie policy."

Translation fig. 8b: "KarriereInfo and third parties use cookies to make KarriereInfo more usable, to give you a better experience, for statistics, for targeted advertising, and we collect and forward your processed information to Google. You can en- and dis-able cookies by clicking the buttons below. [...] Necessary cookies help make a website usable by activating basic functions, such as site-navigation and access to secure areas of the page. The website will not function optimally without these cookies. [...] Functional cookies make it possible to store information that changes the way the website looks or behaves, e.g. your preferred language or region."

Fig. 8: Quantitative study, mock website cookie notices.

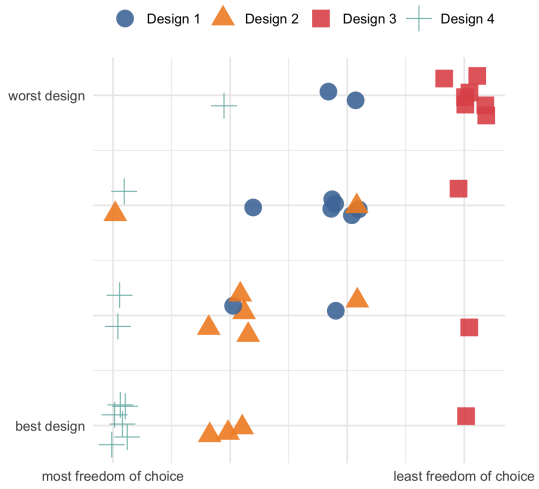


Fig. 9: Design rankings. Each point represents the ranking of a particular participant for a particular design with regards to freedom of choice (x-axis) and overall preference (y-axis).

design	dark patterns: visual nudges	dark patterns: hidden "reject"	dark patterns: easy to miss	issues: presented information	issues: forced to interact
1	✓	✓		-	+/-
2				+/-	
3		✓	✓	-	
4				+/-	+/-

TABLE III: Dark patterns & issues identified in presented notices. "✓" means a the dark pattern was noticed and commented on by participants, "+" and "-" mean that the issue was noticed and commented on in positive and negative sense respectively.

	0%	none	up to	60%	many
up to	20%	few	up to	80%	most
up to	40%	some	up to	100%	near-all
ca.	50%	half		100%	all

TABLE IV: Quantifiers used in describing the results, based on how many participants expressed a particular sentiment.

1) Mental models of web tracking: The first part of the study consisted of questions about participants' general attitudes and behaviors with regards to cookie notice and general data collection. Using the semi-structured interview approach, follow-up questions were asked to some participants when we deemed it necessary to elaborate on their responses.

Data collection. Most of the participants had a good general understanding of what kind of data is collected by the website providers, being able to name specific data that they believed are collected from them. The most commonly mentioned data type was the data that is directly connected with using the website, such as behavior on the website or information about the device that the website was accessed from.

> "I actually think they collect quite a lot. My impression is that they collect both how I scroll on their site, where my cursor has been, what I've shown interest in, what I clicked".

> "I think when you clicks a cookie disclaimer, the site collects information on what browser you are running. I also imagine a bit more technical information about your computer".

While a few participants also mentioned more specific information about the visitors, several participants did not have a clear understanding of exactly what data is being collected.

> "[..] they look a lot at, what's it called, like, demographics in general, I think. Sex, age, and civil status".

> "I actually think [..] that when I accept a cookie disclaimer, they collect some data that we are not fully aware of".

Such diverging answers indicate that websites do not sufficiently inform visitors about what data is collected from them, either not providing this information, or not presenting it in a transparent and understandable way.

The participants furthermore expressed concerns over their data collection, citing a variety of reasons for their concerns, such as *profiling*, *manipulation*, *tracking*, *surveillance*, *potential for abuse*, and power of *tech-giants* and *governments* as reasons.

> "I don't think that cookies as such are dangerous, it's just the potential for manipulating people [..] that is dangerous."

> "I am not so afraid of what they do now, since it's just ads. But I am afraid of what can emerge from that same data. [..] It's the China standard right now. It's 1984, like when the government surveils all the time [..] can also be Google [..] They know you, and can follow you in everything."

> "Then it becomes, like, "Yes, she's 28 so, okay, within the next year, she'll try to get pregnant, she'll start a family, then she'll buy a house, she also likes makeup because she's a woman", no for hell's sake, [..] I think that's crazy weird."

> "My main problem, I hear that from almost all young people, not necessarily IT educated people, is "I have nothing to hide". That is true, until you do. This data stays there, for ever and ever."

Many further expressed a negative attitude towards collectors selling their data, finding it "annoying", "wrong", "lame", "uncomfortable", and "fear-inducing", and were concerned about transferring data outside of EU due to jurisdictional issues.

> "I think it's wrong to profit from my data. To profit from information that I feel that I have not willingly provided."

> "What?! I didn't quite know they did that. Maybe my subconscious knew. That's a bit of a dirty trick. This must be written in these disclaimers that one never reads since they are so long. [..] How I feel about it? Very uncomfortable."

> "It's easier to prosecute Danish companies at home than it is to sue foreign companies [..] I would be more at ease if the data is within Denmark's borders."

Somewhat surprisingly, near-all of the participants furthermore expressed negative attitudes towards personalized ads, a use case for data collection that is often cited as the one that can actually benefit the users by presenting them with ads that are more relevant to them. Our participants, however, reported thoughts and feelings ranging from "annoying", "irritating", and "provocative", through "uncomfortable", "scary", and "creepy", to "manipulative", "disgusting", "wrong", and "unnecessary", as well as speaking of being manipulated.

> "I think it's a bit provocative, and quite unnecessary. [..] [Ads] reinforce some materialistic values that I am actually trying to suppress. So it's a bit disgusting."

> "We all know that the things we get prompted with all the time, leave a little impression in here. And then my desire to buy it next time increases. So I actually feel that I am being limited in my decision-making."

Some recognize the benefits for such ads on behalf of companies, and acknowledge that these ads might also be useful. At the same time, some of the participants were not concerned, stating that they *do not understand* the consequences of data collection, *see no harm* in it, have *nothing to hide*, and that *their information is not valuable*.

> "I think it's nicer to look at [targeted ads] than if some car ad came up. [..] I think it's fine, a bit annoying because you get tempted to buy clothes, but I think it's fine."

> "I think that's super lame, but on the other hand, I feel a bit, they are welcome to [sell my data]. I don't think there's any information about me that I would have anything against, or maybe a little."

Interactions with cookie notices. Despite their concerns and negative attitude to data collection, participants are very lax when offered to configure their privacy preferences in cookie notices. Most of them *dismiss* the notice, by hitting OK or accept, ignoring it, or making it go away.

> "Accept all. But it's actually funny, [..] because I've never really thought about it. If I click or not."

Others minimize the amount of consent that they give.

> "I always go in and see if I can choose what I consent to. Because I don't want "all". They already collect a lot of data about you."

Such attitudes from the participants are consistent with related work, reporting that cookie notices are often perceived as annoyance rather than useful information, and that users consent to cookies despite having concerns over data collection [10].

As further insights into such behavior, our participants gave a multitude of reasons why they do not take measures to protect their privacy when faced with a cookie notices, finding it *too*

bothersome, mentioning *decision fatigue* or being *in a rush*, saying that they *need the service* or believing that *consent is required* to use the page.

> "It's too difficult to hit "no". The times I've gotten a banner, I rarely get one where I can say "no". Then I must either say "accept all", or there's another option for "settings", where I configure my cookies. And when I press it. I actually wouldn't bother, because I just image a hell of nonsense. And I feel a bit, I can't deal with that. So I sold my soul."

> "I don't want to spend half an hour accepting cookies. [..] Because I want to shop fast, or find some information fast."

> "Yes to it. Or else it has resulted in me being unable to access the site, and then I have just accepted anyways."

Near-all of the participants use some websites *despite distrusting* them with their personal information, many mentioning that they do so because they are *dependent on* the service.

> "I can't live without Google. So what the hell should I do?."

> "I use Facebook because that's where most of my communication with the world takes place. [..] I hope there soon will be a slow revolution in the generation that says "no, thank you". I myself am beginning to pull out of it. That does not change the fact that there is a generation over ours that uses it religiously."

At the same time, many say that a cookie notice could make them leave a page if no meaningful options to reject data collection are provided.

> "[..] they should give us the option to, and be able to choose not to have our information shared, so I might leave, just out of spite."

> "If I can't go in and choose it myself, then I'm already, like, okay, I don't know if I feel like accessing this website."

2) Mental models of dark patterns: In this part of the study, the participants were shown four notice designs and asked to rank them (on a scale from 1 to 4) in terms of how much freedom of choice the notice provides. Two weeks later, they were furthermore asked to rank the same designs in terms of general preference ("best" to "worst")[7]. The results of the rankings are in fig. 9[8]. The comments on each design reveal a number of issues that can be perceived as dark patterns by participants, namely, being *visually nudged* to accept (e.g with highlighting certain options), *hidden "reject"* option, or notice being *easy to miss*. Moreover, some of the participants commented on these design elements being intentionally misleading, hinting at malicious intent on behalf of website providers. Other aspects of notice design were perceived from both positive and negative side, namely, either amount or content of *presented information* on the notice, or being *forced to interact* with the notice, suggesting ambiguity in whether these design elements can be defined as dark patterns. The mentioned issues for each design are summarised on Figure 9. We describe the findings from the participants' comments about each notice in more details below.

Design 1. Most participants dislike this design, rating it as second-worst (overall median ranking of 3 out of 4). Most also ranked the notice as providing second-worst freedom of choice (median ranking of 3 out of 4). The participants' comments criticized the *nudging* aspect of the notice, noting the highlighted OK button.

> "Yeah, so, I would press cookie settings, but it's OK that's highlighted, so that one's suggestive I think."

Some further mentioned the notice design making it too *bothersome to search* for the "reject" option, and expressed an overall belief that rejecting should be as easy as accepting.

> "I think it's irritating that I can only say OK or enter settings, then I must go in and go all sorts of things, so I would just say OK. It's too bothersome to do anything else."

> "It should be just as easy to say no, as it is to say yes."

Few mentioned being frustrated by the *large amount of text* on the notice. Some participants were furthermore frustrated that the notice would fill the whole screen, *forcing them to make a decision*; at the same time, few mentioned this aspect as a positive factor, noting that the notice would be hard to miss. Roughly half of the participants would dismiss the notice (by picking *allow-selected*), whereas half would configure their consent. Few would consider leaving the page.

> "If it's because I'm just sitting and browsing, and this pops up, I might be like, "nah, fuck that", and then leave."

Design 2. Most participants like this design, ranking it as second-best (median ranking of 2 out of 4), also ranking as providing second-best freedom of choice (median ranking of 2 out of 4). In particular, the participants liked that the opt-out options are up-front in that the reject option was *not hidden*, although some of them did comment on pre-selected options or wondered what necessary cookies are.

> "It's quite good because I can say allow-selected. [..] Making it user-friendly to opt-out, that means a lot to me."

Some were concerned about the *information provided* in the notice, in particular, the mentioning of third parties. Few, however, saw the presented information as positive.

> "This becomes a bit creepy. Here, it becomes a bit more 'We use analysis partners'. Who the fuck is that. [..] I believe this is one of the designs I would read more carefully.."

Some commented about the text on the notice being too long. Some further commented on the fact that the notice *does not force* the user to take an action; some found this "sneaky", others wondered whether their consent is implied if they do not select any option, and some were satisfied that they would not necessarily need to spend time interacting with the notice. Near-all would configure their consent, whereas few would dismiss the notice, i.e. press *allow-selected* without configuring their consent. Some might leave the page.

> "I would have un-toggled everything [..] so it only said *necessary*"

> "That depends on how important the page is. I can imagine that I press *allow selected* for a page that I am very interested in. But if it's just some short search [..] then it's not worth it"

Design 3. The design was ranked as the worst both in overall preference and in freedom of choice (median ranking of 4 out of 4). Near-all participants pan this design for being *difficult to notice* and hard to read, or outright deceptive. Few, however, see this aspect as positive, albeit for misguided reasons.

[7]The purpose of the two-week waiting period was to avoid participants being biased by their own earlier answers.

[8]Due to the qualitative nature of our study and our small sample size, analysing the extent to which these rankings generalize is out of scope.

> "It's bad, it's almost impossible to see, because they have hidden it as much as possible."

> "It's better [..] because it's even easier to avoid making a choice."

Some furthermore comment on *lack of visible choice*, and while the presented notice itself did not provide a lot of information, some participants commented that it *requires effort to read it*, and expected that the "read more" button would lead to a long and complicated privacy policy. Near-all would dismiss the notice, either by ignoring it or hitting the ⊠. Few participants would configure their consent, and few might leave the page.

> "If no options came up, I'd [leave], unless I think it would further my understanding of something. [..] I'm not putting up with that."

Design 4. Near-all participants like this design, ranking it as the best one in terms of overall preference and with regards to freedom of choice (median ranking 1 out of 4). Participants praised the design for being up-front with what is collected and for presenting an *easy option to reject* all cookies.

> "[..] it's a more user-friendly experience, it's easier to configure what data gets collected and what shouldn't."

A few were concerned about the *information provided in the notice*, commenting about too much text and lack of guidance.

> "Sucks to have so much text [..] nothing is clearly marked, and there's nothing highlighted where it's preferred that I click."

Several commented on the notice *forcing them to make an active choice*, however, with conflicting opinions about that.

> "It's an annoying design, since one cannot proceed on the website without making a choice. But that's maybe also a good thing."

All but one would configure their consent when met with this notice. At the same time, few participants expressed concerns that rejecting cookies might lead to either being unable to use the website at all, or its functionality being greatly reduced. None of the participants would leave the page.

> "But I believe, I think, that then I might not get access."

> "I would actually start with *reject-all*, and use the page, and see if something became less usable."

VI. Discussion and Conclusion

We conducted a two-phase investigation, looking at how people interact with cookie notices of different designs, including designs with dark patterns.

Our results show that people are more likely to consent to cookies when the design nudged them to do so. In particular, the absence of an immediately available "reject", and notice being easy to ignore, lead to significantly less participants attempting to reject cookies. This supports and confirms earlier findings by Nouwens et al. [17] by means of an independent study on substantially different subjects (i.e. from Europe).

Our fresh insight comes from our investigation into *why* people behave in this manner, which yielded surprising results. In the follow-up interview, many of the participants reported that (despite exhibiting the above behavior,) they are quite concerned about their privacy, yet feel like they have no choice but to consent if they want to use the Web. While several of the notice designs, that participants saw both in our studies and recalled seeing before, did provide them with an option to reject cookies, the participants felt that these options were too cumbersome to use, and recognized that the designs nudged them into choosing the "accept" option.

Hence, while participants feel that they are often sidetracked in their everyday decisions (i.e. choosing to access the website rather than spend significant time looking for the "reject"-options in the cookie settings), many acknowledge that they are not happy with the choices they felt they were forced to make, and with the perceived lack of control over their data. The attitudes of resignation and losing control over privacy has been recognized in previous research [22]; our study confirms that the presence of cookie disclaimers furthers this resignation, instead of giving control back to the users.

Limitations. Our studies have several limitations. We had to deal with changes of the study procedure, such as switching from in-person to remote observation due to COVID-19 restrictions, and changing in the design of the notices. Using existing websites can further lead to confound effect, both in notice designs (e.g. due to presence of design elements that were not the subject of evaluation of our study) and in people's familiarity with particular websites. Further, the participants in both studies were mostly young and well-educated – it therefore remains an open question on how the results transfer to the rest of the population. However, given that the "digital natives", who are often assumed to be more comfortable with personal information sharing and more knowledgeable about using digital technologies, are struggling with cookie notices, we expect even worse effects among other age groups.

Implication of results. Building upon the findings from related work, the resignation demonstrated by our participants when it comes to their privacy choices indicates that free consent cannot be assumed in many of the interactions with cookie notices, unless meaningful choices are provided to the user. One way to implement such choices would be to enforce the use of notices that provide user-friendly option towards rejecting web tracking; while such steps are already done in some jurisdictions (see e.g. [4]), recognizing and defining dark patterns that would need to be made non-compliant remains an open challenge. Furthermore, to facilitate adoption of privacy-friendly notices, it is necessary to address the website providers, raising awareness both regarding legal compliance issues in case dark patterns are used, as well as regarding potential negative feelings their customers might have if, similar to participants in our study, they feel manipulated regarding their privacy choices. Another alternative would be the development of centralized solutions, e.g. in form of browser plugins, enabling the users to configure their privacy preferences once and for all, without having to manually confirm their choice on every website. While several browser plugins for management of cookie notices exist, they often lack in functionality (e.g. either accepting or rejecting all cookies, lacking the option to e.g. accept only necessary cookies) or do not work or all websites, and have an overall limited adoption. A centralized solution, similar to the option to block tracking requests in all apps recently introduced in iOS (https://developer.apple.com/app-store/user-privacy-and-data-use/, as of 12.05.2021) could be helpful (recent survey showing that such a feature was used to block app tracking by 96% of iOS 14.5 users [26]). It remains an open question, whether and how such solutions could be effectively implemented for web tracking.

REFERENCES

[1] C.-E. Armingaud and L. Rolinet, "French data protection: French supervisory authority publishes updated guidance on cookie and other tracking technologies," 2020, the National Law Review: https://www.natlawreview.com/article/french-data-protection-french-supervisory-authority-publishes-updated-guidance, last accessed on 25.02.2021.

[2] F. Chanchary and S. Chiasson, "User perceptions of sharing, advertising, and tracking." in *11th Symposium on Usable Privacy and Security (SOUPS)*, 2015, pp. 53–67.

[3] Court of Justice of the European Union, "Press release no 125/19. judgment in case c-673/17 bundesverband der verbraucherzentralen und verbraucherverbände - verbraucherzentrale bundesverband ev v planet49 gmbh," 2020, https://curia.europa.eu/jcms/upload/docs/application/pdf/2019-10/cp190125en.pdf, last accessed on 25.02.2021.

[4] Danish Data Protection Authority, "Nye retningslinjer om behandling af personoplysninger om hjemmesidebesøgende," 2017, https://www.datatilsynet.dk/presse-og-nyheder/nyhedsarkiv/2020/feb/nye-retningslinjer-om-behandling-af-personoplysninger-om-hjemmesidebesoegende/, last accessed on 3.10.2020.

[5] C. M. Gray, Y. Kou, B. Battles, J. Hoggatt, and A. L. Toombs, "The dark (patterns) side of ux design," in *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 2018, pp. 1–14.

[6] V. Ha, K. Inkpen, F. Al Shaar, and L. Hdeib, "An examination of user perception and misconception of internet cookies," in *CHI'06 extended bstracts on Human factors in computing systems*. ACM, 2006, pp. 833–838.

[7] Harry Brignull, "Dark patterns," 2010, https://www.darkpatterns.org/, last accessed on 03.12.2021.

[8] D. M. Institute. (2020) Dmi.dk frontpage. www.DMI.dk. Visited 23-02-2020, 25-02-2020.

[9] O. Kulyk, N. Gerber, A. Hilt, and M. Volkamer, ""this website uses cookies": Users' perceptions and reactions to the cookie disclaimer," in *3rd European Workshop on Usable Security (EuroUSEC), London, England, April 23, 2018*. Internet Societa, Reston 8VY), 2018.

[10] ——, "Has the gdpr hype affected users' reaction to cookie disclaimers?" *Journal of Cybersecurity*, vol. 6, no. 1, p. tyaa022, 2020.

[11] P. G. Leon, B. Ur, Y. Wang, M. Sleeper, R. Balebako, R. Shay, L. Bauer, M. Christodorescu, and L. F. Cranor, "What matters to users?: factors that affect users' willingness to share information with online advertisers," in *9th Symposium on Usable Privacy and Security (SOUPS)*. ACM, 2013, p. 7.

[12] D. Machuletz and R. Böhme, "Multiple purposes, multiple problems: A user study of consent dialogs after gdpr," *Proceedings on Privacy Enhancing Technologies*, vol. 2020, no. 2, pp. 481–498, 2020.

[13] A. Mathur, M. Kshirsagar, and J. Mayer, "What makes a dark pattern... dark? design attributes, normative considerations, and measurement methods," in *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 2021, pp. 1–18.

[14] A. McDonald and L. F. Cranor, "Beliefs and behaviors: Internet users' understanding of behavioral advertising," *TPRC*, 2010.

[15] A. M. McDonald and L. F. Cranor, "Americans' attitudes about internet behavioral advertising practices," in *9th Workshop on Privacy in the Electronic Society (WPES)*. ACM, 2010, pp. 63–72.

[16] A. D. Miyazaki, "Online privacy and the disclosure of cookie use: Effects on consumer trust and anticipated patronage," *Journal of Public Policy & Marketing*, vol. 27, no. 1, pp. 19–33, 2008.

[17] M. Nouwens, I. Liccardi, M. Veale, D. Karger, and L. Kagal, "Dark patterns after the gdpr: Scraping consent pop-ups and demonstrating their influence," *arXiv preprint arXiv:2001.02479*, 2020.

[18] K. Renaud and L. A. Shepherd, "How to make privacy policies both gdpr-compliant and usable," in *2018 International Conference On Cyber Situational Awareness, Data Analytics And Assessment (Cyber SA)*. IEEE, 2018, pp. 1–8.

[19] W. B. Rouse and N. M. Morris, "On looking into the black box: Prospects and limits in the search for mental models." *Psychological bulletin*, vol. 100, no. 3, p. 349, 1986.

[20] F. Schaub, R. Balebako, and L. F. Cranor, "Designing effective privacy notices and controls," *IEEE Internet Computing*, 2017.

[21] F. Schaub, R. Balebako, A. L. Durity, and L. F. Cranor, "A design space for effective privacy notices," in *11th Symposium On Usable Privacy and Security (SOUPS 2015)*, 2015, pp. 1–17.

[22] J. S. Seberger, M. Llavore, N. N. Wyant, I. Shklovski, and S. Patil, "Empowering resignation: There's an app for that," in *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 2021, pp. 1–18.

[23] F. Shirazi and M. Volkamer, "What deters jane from preventing identification and tracking on the web?" in *13th Workshop on Privacy in the Electronic Society (WPES)*. ACM, 2014, pp. 107–116.

[24] The European Parliament and of the Council of European Union, "Directive 2009/136/EC of the European Parliament and of the Council of 25 November 2009 amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services, Directive 2002/58/EC concerning the processing of personal data and the protection of privacy in the electronic communications sector and Regulation (EC) No 2006/2004 on cooperation between national authorities responsible for the enforcement of consumer protection laws," 2009, http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0136&from=DE, last accessed on 6.03.2018.

[25] ——, "Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)," 2016, https://eur-lex.europa.eu/eli/reg/2016/679/oj, last accessed on 25.02.2021.

[26] Tim Hardwick, MacRumors, "Analytics suggest 96% of users leave app tracking disabled in ios 14.5," 2021, https://www.macrumors.com/2021/05/07/most-iphone-users-app-tracking-opt-out/, last accessed on 12.05.2021.

[27] B. Ur, P. G. Leon, L. F. Cranor, R. Shay, and Y. Wang, "Smart, useful, scary, creepy: perceptions of online behavioral advertising," in *8th Symposium on Usable Privacy and Security (SOUPS)*. ACM, 2012, p. 4.

[28] C. Utz, M. Degeling, S. Fahl, F. Schaub, and T. Holz, "(un) informed consent: Studying gdpr consent notices in the field," in *Proceedings of the 2019 ACM SIGSAC Conference on Computer and Communications Security*, 2019, pp. 973–990.

[29] M. Volkamer and K. Renaud, "Mental models–general introduction and review of their application to human-centred security," in *Number Theory and Cryptography*. Springer, 2013, pp. 255–280.