

Survey of academic studies measuring the effect of dark patterns on acceptance consent rate of users in consent banners

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Almost any website today presents the user with the choice to be made in a consent banner: *Do you want to accept or reject online tracking?* While the [ePrivacy Directive requires a valid consent](#) before reading or writing of cookies and other tracking technologies, the General Data Protection Regulation (GDPR) has set only high-level requirements for such consent to be valid, leaving website owners and consent providers a large design space for testing various consent banners on users. This paper starts with an overview and comparative analysis of scientific research papers on the effect of consent banner design on users' decision-making. Then we describe and compare the studies with respect to the design process of data collection, commenting upon the adopted design of some studies and highlighting best practices. This overview presents major results of the effect of design of consent banners on user's decision making and may be useful for regulators. Finally, we discuss the possibility for regulators to rely on user studies as evidence of dark patterns in their legal proceedings: what conditions and design of such studies can be beneficial to regulators.

Introduction

In the European Union, the ePrivacy Directive ([ePrivacy 2009](#)) requires a valid consent before reading or writing of cookies and other tracking technologies, while the General Data Protection Regulation ([GDPR 2018](#)) has set only high-level requirements for such consent to be valid, leaving website owners a large design space for testing various consent banners on users.

Such situation, where law allows space for interpretation, and design space is unlimited, gave rise to the use of manipulative tactics in UX/UI commonly known as dark patterns ([Brignull 2015](#)), ([Gray et al 2018](#)), ([Luguri et al 2021](#)), ([Mathur et al 2021](#)). These design patterns have been often used by website owners and consent banner provider companies to increase "consent accept rate" (Santos et al 2021) – in other words to nudge more users to click on "accept" rather than searching for a way to reject cookies and other trackers ([Gray et al 2021](#)).

Since the GDPR came in force in 2018, The European Data Protection Board (EDPB), have provided additional guidelines ([EDPB 2020](#)) with more detailed requirements for consent to be valid under the GDPR. Numerous guidelines, including the one by the CNIL ([CNIL 2020](#)), case laws and other soft law ([Santos et al. 2020](#)) gave more concrete requirements on the design of acceptance and rejection modalities in consent banners. Nevertheless, the design space for consent banners remains enormous.

Since 2019, researchers have performed studies with end users, testing and trying to quantify how different designs of consent banners influence users' decision making [2], [3], [6], [9]. In these papers, researchers present a "base line" consent banner to participants – that is, a banner where accept and reject buttons are shown in exactly the same way. This is needed to understand users' "usual" behavior when they are not manipulated. Then, participants interact with another banner that contains a studied dark pattern. Researchers would collect data about interaction with both banners by such participants, and prove that the difference in behavior is strong enough and is statistically significant.

CNIL has already mentioned one user study in *in its decision* regarding the validity of consent in a consent banner ([CNIL 2021](#)). Though in the recent years EU DPAs made numerous decisions regarding validity of consent ([Gunawan et al. 2022](#)), to the best of our knowledge, *there are only few of them where user studies are used by DPAs*. While such research studies are extremely valuable to regulators, they are scattered across various disciplines, such as computer science, social science, design, law and may not be known by regulators at the moment of decision making or could just be considered inadequate.

In this paper, we propose to close this gap: we collected and analyzed 10 research user studies that exist up to date on how dark patterns in consent banners impact users' decision-making. While analysing the user studies with the idea to use them as *evidence of dark patterns in consent banners*, we discuss the limitations of the studies and reflect about the reasons why they may not be used as evidence in regulatory cases. We aim to study the possibility for regulators to rely on user studies as evidence of dark patterns in their decision making: what conditions and design of such studies can be beneficial and what are the conditions to rely on user studies as evidence for dark patterns in a legal case.

Finally, we propose to reflect on guidelines that would contain best practices about the ecological validity of user studies and provide recommendations on how to perform follow-up user studies based on the overview of the research literature and reflections from the discussion with the various stakeholders, including research community.

In summary, we propose to open a discussion on the following questions and goals:

- We propose to *inform or remind legal experts of existing and ongoing research efforts across disciplines* (computer science, social science, design and law) about factual evidence on the impact of dark patterns on users' decision-making in consent banners via user studies.
- We analyze the limitations and designs of performed user studies on consent banners while identifying *potential barriers and levers towards relying on user studies as evidence of dark patterns*.
- Finally, we propose to reflect on *building guidelines for regulators* that would allow them to ensure the needed ecological validity of user studies and rely on them as evidence in decision making.

Basic conditions for user studies

Regulators may be interested to obtain knowledge of how the users in their country interact with a given user interface in order to evaluate whether a given type of interface integrates manipulative tactics and uses "*dark patterns*" to nudge users towards a certain decision that they would not otherwise make.

To evaluate the presence of such "*dark patterns*" in the given interface of a consent banner, a regulator in a given country could rely on a user study that replicates the user experience. For this, the study has to be designed with a critical view about the limitations of the experimental methods, often referred to as *ecological validity* (Brunswik 1949) or *external validity* (Mool 1983). Recently, researchers in psychology have argued that *ecological validity* "falls short of addressing the problem of generalizability" ([Holleman et al. 2020](#)). Nevertheless, when designing an experimental study, one has to critically evaluate conditions in which the study is performed. For the specific context of user studies on "*dark patterns*" in consent banners, by analysing research papers in the field, we have identified basic conditions we believe must be taken into account (the list is not exhaustive):

- *Sample size*: there should be enough participants in the study to draw conclusions – in statistics, the sample size is determined by the type of statistical test and the statistical significance level.

- *Location*: since privacy regulations differ between countries and regions of the world, participants have different experiences with interfaces not only because of different regulations but also because of different enforcement strategies across countries. Therefore, participants should be located in the country or region of the regulator.
- *Audience*: participants should be recruited from a general audience. Any specific, limited and biased audience should be avoided.
- *Context*: Context of the experiment has to be as close as possible in replicating the users' behavior in their actual daily experience.

Additionally, participants' consent for the study is needed for the ethical and legal considerations, we hence propose to consider one more condition for a user study – user consent.

- *Consent*: participants should be able to give their consent to the study, however informing the participants about the actual goal of the study can create bias in their consequent behavior when interacting with banners and would invalidate the results. In practice, for studies subject to GDPR rules, where information is required, the balance could be achieved by informing the participant prior to the study that their online behavior will be analysed, however without specifically underlining the topic of consent banners. Similarly, for studies subject to GDPR, rights of data subjects should be given the possibility to exercise their rights (especially right to oppose and right to access) which can be typically proposed at the end of the study.

Ten user studies on cookie banners

We analyze the user studies on consent banners and demonstrate how the four conditions (sample size, location, audience and context) impact the results of the studies and should be considered with caution when user studies are used by regulators as evidence.

We have analyzed all research papers we could find that evaluate users' interactions with the consent banners in the presence of "dark patterns". Table 1 presents ten research papers we have found – all of them were published since 2016. The majority of papers are state-of-the-art academic publications in the fields of Computer Security and Privacy (ACM CCS, PoPETs), Human- Computer Interaction (ACM CHI, USEC, EuroUSEC, Journal of Computers in Human Behavior), Social Computing (ACM CSCW, Journal of Digital Social Research). We have also included the very first study in the field back in 2016 – a technical report of the EU Commission.

Article citation	Title and authors	Venue of publication	Year of publication	Open access
[1]	<i>Testing the Effect of the Cookie Banners on Behaviour.</i> Rene van Bavel, Nuria Rodríguez-Priego.	EU Commission Joint Research Centre's Technical Reports	2016	LINK
[2]	<i>(Un)informed Consent: Studying GDPR Consent Notices in the Field.</i> C Utz, M Degeling, S Fahl, F Schaub, T Holz.	ACM Conference on Computer and Communications Security (ACM CCS)	2019	LINK
[3]	<i>Dark Patterns after the GDPR: Scraping Consent Pop-ups and Demonstrating their Influence.</i>	ACM Conference on Human Factors in	2020	LINK

	Midas Nouwens, Ilaria Liccardi, Michael Veale, David Karger, and Lalana Kagal.	Computing Systems (ACM CHI)		
[4]	<i>Multiple Purposes, Multiple Problems: A User Study of Consent Dialogs after GDPR.</i> Dominique Machuletz and Rainer Böhme.	Proceedings on Privacy Enhancing Technologies (PoPETs)	2020	LINK
[5]	<i>This Website Uses Nudging: MTurk Workers' Behaviour on Cookie Consent Notices.</i> Carlos Bermejo Fernandez, Dimitris Chatzopoulos, Dimitrios Papadopoulos and Pan Hui.	ACM Conference On Computer-Supported Cooperative Work And Social Computing (ACM CSCW)	2021	LINK
[6]	<i>Dark and bright patterns in cookie consent requests.</i> Paul Graßl, Hanna Schraffenberger, Frederik Zuiderveen Borgesius, and Moniek Buijzen.	Journal of Digital Social Research	2021	LINK
[7]	<i>Are you sure, you want a cookie? – The effects of choice architecture on users' decisions about sharing private online data.</i> Bauer, J.M., Bergstrøm, R. and Foss-Madsen, R.	Journal of Computers in Human Behavior	2021	LINK
[8]	<i>"So I sold my soul": Effects of Dark Patterns in Cookie Notices on End-user behavior and perceptions.</i> Ida Borberg, Rene Hougaard, Willard Rafnsson, Oksana Julyk.	Workshop on Usable Security and Privacy (USEC)	2022	LINK
[9]	<i>"Okay, whatever": An Evaluation of Cookie Consent Interfaces</i> Hana Habib, Megan Li, Ellie Young, Lorrie Cranor.	ACM Conference on Human Factors in Computing Systems (ACM CHI)	2022	LINK
[10]	<i>Factors that Influence Cookie Acceptance. Characteristics of Cookie Notices that Users Perceive to Affect Their Decisions.</i> Julia Giese and Martin Stabauer	HCI in Business, Government and Organizations Conference	2022	Paywall link

Table 1. Overview of research studies analyzed in this article.

Table below presents the information about the four conditions for each paper: sample size, location, audience and context of the experiment. For sample size, we only report on a number of participants per consent banner, since papers differ in total amount of participants and number of banners they have included. We further analyze these four conditions in the rest of this section.

Article citation	Year	Total number of participants	Sample size per cookie banner	Location of participants	Audience recruitment procedure	Context of the experiment
[1]	2016	602	86	Spain	Laboratory experiment	Mock-up e-commerce website
[2]	2019	82,890	~1,700 mobile	Germany	Real website visitors	E-commerce website

			~300 desktop ¹			
[3]	2020	40	~40 ²	USA	University students	Browser extension that inserts banners in user's browsing
[4]	2020	150	48 to 52	Austria, Germany	University students	Mock-up flight search website
[5]	2021	1,100	~137 ³	Unknown: 60% from North America	Amazon MTurk	Fill in online survey about smart home scenarios
[6]	2021	483	228 and 255 ⁴	UK	Prolific Academic platform	Mock-up news websites
[7]	2021	1,493	219 for "neutral" 270 for "highlighted accept" ⁵	Denmark	Real website visitors	B2B website
[8]	2022	40	20	EU	Authors' acquaintances	Video of interaction with real websites
[9]	2022	1,109	92	USA	Prolific Academic platform	Mock-up e-commerce website
[10]	2022	46,512	28,720 mobile, 17,792 desktop	Germany (45.9%), Austria (37.5%), others	Real website visitors	Online shop website

Sample size and Audience

Three studies [3][4][8] had a rather small dataset between 40 and 150 participants, where users recruited from a narrow and non-general audience. In two studies [3][4], the majority were university students, representing a particular niche of website audience, with specific age and background. In another study [8], authors recruited their own acquaintances, representing again a very small and

¹ On average, 4,044 participants have been exposed to each banner, however on average around 50% of them have interacted with the banner, that was not blocking access to the website. As a result, each banner was tested by approximately 2,000 participants.

² We have computer 40 participants per banner given that the study contained 40 users, and each has been exposed to 4 banner interfaces (160 tests) and made two such experiments (320 tests), while 8 interfaces were tested, thus making 40 user tests per banner interface on average.

³ 1100 participants were randomly assigned to 8 different interfaces [5], approximately getting 137 users per interface.

⁴ 228 participants were involved in Experiment with dark patterns, while 255 of them interacted with bright patterns [6].

⁵ This information is extracted from Figure 2A of the supplementary materials of [7] available at <https://doi.org/10.1016/j.chb.2021.106729>

specific audience with specific background knowledge. These studies may violate the *Audience* condition, requiring that participants represent the general audience and not a limited group with specific age and background.

Recruitment platforms or Real-world websites? Three studies managed to recruit a high number of participants with controlled characteristic of the audience using recruiting platforms, such as Amazon Mechanical Turk [5] and Prolific Academic [6][9]. Such recruiting platforms can be used to obtain a large and suitable set of participants for such studies. However, the highest number of participants was obtained by placing a consent banner on real-world website and obtaining data from the website owner via a partnership set with the website. Such approach is the most appropriate to ensure the Context condition. One study [2] obtained 82,890 unique website visitors by integrating their consent banners on a German e-commerce website. A similar approach was taken by [10], where authors tested two consent banners on an online shop German website and gathered logs of 46,512 users. Nevertheless, to ensure *Audience* condition, usage of a real-world website with a very specific audience should be avoided.

Location of participants

EU users started interacting with consent banners back in 2009 when the ePrivacy Directive was amended, and therefore have been continuously interrupted in their daily website experience and developed a “consent fatigue”. Only some US users have started facing the consent banners only since 2020, when CCPA came into force in California, however the legal requirements for valid consent from CCPA differ from those in the EU. Therefore, location of participants in the study of consent banners plays a crucial role when the goal of the study is to replicate user experience in EU country. Moreover, since ePrivacy Directive is implemented differently across EU countries, participants in a given country should be hired for the experiment thus ensuring the *Location* condition.

Out of nine conducted studies in research literature, five studies aimed at EU participants [1][2][4][7][10]. One study [6] recruited UK residents, which are no longer in the EU, however had a similar experience with consent banners as the other EU users, and thus may be appropriate despite the *Location* condition. Two studies [3][9] have recruited participants from the US, which had a different experience with consent banners than EU users due to the differences in the privacy regulations. Moreover, US participants did not experience the consent banners which EU users have encountered since 2009 when the ePrivacy Directive (ePrivacy 2009) was amended. One study [5] does not report the precise origin of participants, but 60% of them were from North America, thus it is unknown whether participants were exposed to the consent banners in the past. Therefore, studies [3][5][9] might not ensure the *Location* condition in the EU legal experts.

Context of the experiment

The context, in which participants were placed to interact with consent banners, can also make an impact on the overall result of the experiment. In [3], participants were contacted by email asking them to participate in a study about web-tracking activity. They therefore knew about the context of the study and weren't put in a realistic context of daily web browsing.

To simulate users' behaviors as close as possible to their usual browsing habits, five studies out of nine offered participants to analyze the interface of mock-up websites [1][4][5][6][9] and one [3] inserted its own banners in the users' browsers, without mentioning cookies, tracking or privacy. The participants were informed about the actual purpose of the study after completion. Other three studies used real-world websites to evaluate users' behaviors: they have put their own banners on a partner website [2][7][10]. In terms of context of the experiment, these studies ensured that Context condition is achieved since users were placed in a context, similar to their daily routine [1][4][5][6][9] or even better, were browsing the real websites [2][3][7][10] without knowing the real goal of the study.

Consent for the experiment

While using real-world websites is best from the point of view of number of participants, it is difficult to have a direct communication channel with the study participants and thus it hard to ensure the *Consent* condition. While some studies informed the users after the study was complete, such design may impact the rights of the data subjects. Study [2] showed all visitors a pop-up explaining that they just participated in the study 30 seconds after the interaction with the banner. They were also asked to participate in user survey run by the university and were asked for email addresses that were stored separately for that survey. Moreover, participants in [7] remained unaware of the study⁶.

Other studies, where users were recruited in the lab [1] or via a platform [5][6][9], managed to obtain their consent and sometimes to contact them after the study. Authors of [3] had a direct contact with the participants by email, therefore, it would have been easy to ask for users' consent and ensure their rights are respected because users would have a direct contact back with the authors.

Insights for experimental conditions from 10 user studies on cookie banners

We have identified the basic experimental conditions of such studies and analyzed the limitations of performed user studies with the goal to *build guidelines for regulators* that would allow to critically evaluate the methodologies of user studies and rely on them as evidence in regulatory cases. We draw the following insights of user studies on consent banners:

- **Sample size** condition: The highest number of participants can be obtained by partnering with the owner of a website and testing consent banners on real-world website. A high number of participants can also be obtained on recruiting platforms however it would require a higher financial involvement since such platforms pay each participant for their work.
- **Location** condition: to study consent banners in an EU context, participants should be located in the studied EU country.
- **Audience** condition: Recruiting platforms can be used to obtain a large and suitable set of participants closely resembling the targeted audience: regulators often consider general audience but could also include studies with underrepresented audiences, such as minority groups, elderly etc. If the study uses real-world website, it should be chosen to guarantee access to a targeted audience of users.
- **Context** condition: To ensure that the behavior of users is not altered, participants should not be aware of the actual goal of the study that would otherwise bias the results. Participants should be informed about the actual purpose of the study after completion.
- **Consent** condition: To obtain user consent for their data collection and exercise of their rights, recruiting platforms and other tools that allow to collect consent prior to the data collection is suited the best for such studies.

Comparing results of user studies

To rely on user studies as evidence of user manipulation and “dark patterns”, it is necessary to identify quantifiable metrics. The most common ones observed in the literature are the acceptance and refusal rate of users in particular designs of consent banners and, additionally, success of statistical tests to identify whether the users' behavior is statistically significantly different on a given banner with “dark pattern” with respect to the control banner.

⁶ The ethical approval in [7] was obtained from Copenhagen Business School.

We compare results of user studies, and for simplicity we consider only two measures:

- a) acceptance rate among users that interacted with the banner, and
- b) whether the behavior of users is statistically significantly different.

Since various studies analyzed different types of designs of cookie banners, in our report we compare the results of three common refusal modalities in consent banners that have been extensively studied in the research literature:

- **Neutral:** both accept option and reject option are shown with identical design elements, such as buttons with identical shape, size and color;
- **No reject:** reject option is not available on the first layer of the banner but is accessible under “personalize” option on the second layer;
- **Highlighted accept:** both accept option and reject option are shown with identical design elements, however accept option is “highlighted” in a more visible color or a more noticeable shape (such as button vs link).

The Table below demonstrates which studies have tested the three types of interfaces of reject modalities in cookie banners that we explore in this article. In the follow-up analysis, however we do not include results from paper [8] because of a very small number of participants in the study.

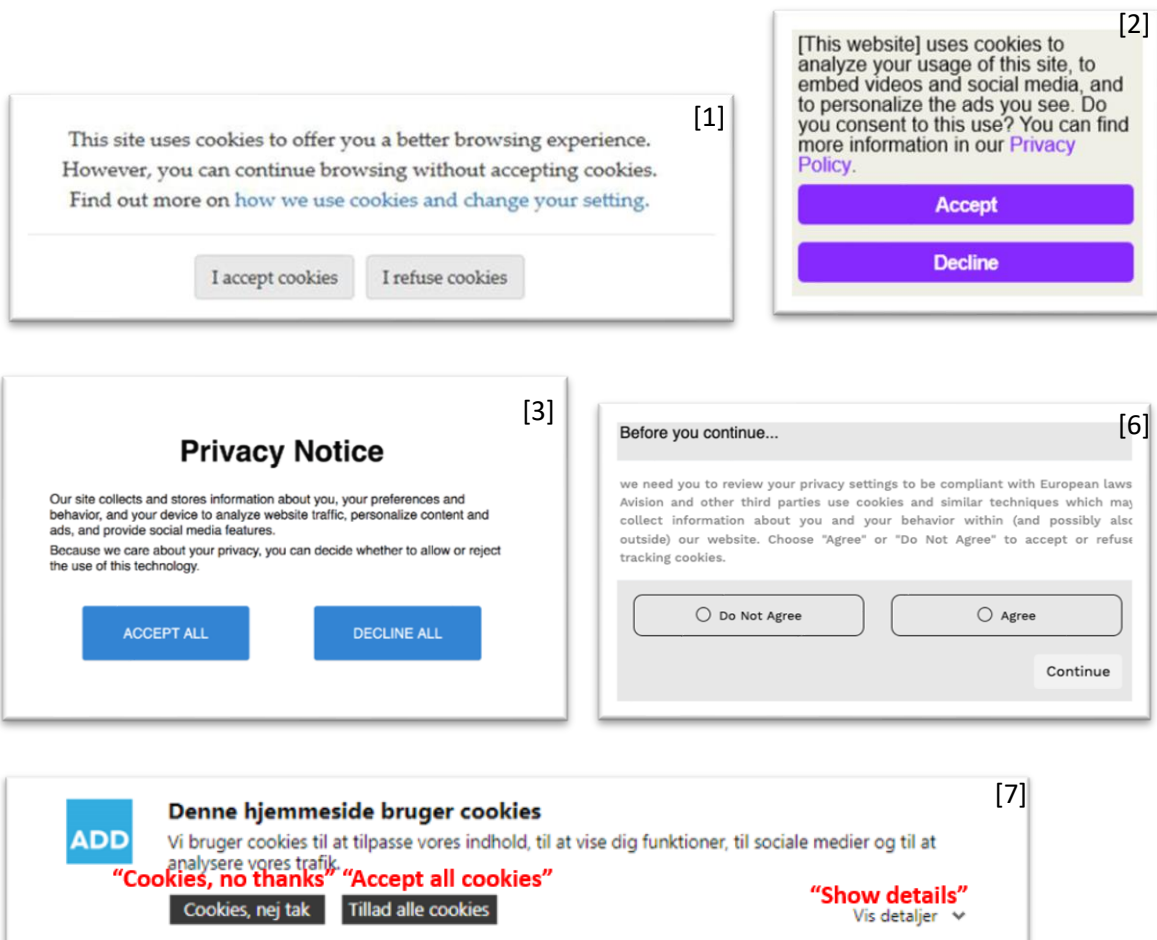
Article citation, title and authors	<i>Neutral:</i> banner with equally shown “accept” and “reject” buttons	<i>No reject:</i> Banner with no option to reject on the 1 st layer	<i>Highlighted accept:</i> accept button is more visible than “reject” button	Comment
[1] Testing the Effect of the Cookie Banners on Behaviour. Rene van Bavel, Nuria Rodríguez-Priego.	x			This article studies the impact of the informative text in the banner on the outcome of consent decisions.
[2] (Un)informed Consent: Studying GDPR Consent Notices in the Field. C Utz, M Degeling, S Fahl, F Schaub, T Holz.	x	x	x	This article analyzes the effect of removing reject from the 1 st layer, highlighting accept and presence of purposes and/or vendors.
[3] Dark Patterns after the GDPR: Scraping Consent Pop-ups and Demonstrating their Influence. Midas Nouwens, Ilaria Liccardi, Michael Veale, David Karger, and Lalana Kagal.	x	x		This paper evaluates the impact of removing reject from the 1 st layer, as well as presence of listed purposes and/or vendors on consent decisions.
[4] Multiple Purposes, Multiple Problems: A			x	This article analysis the effect of the

User Study of Consent Dialogs after GDPR. Dominique Machuletz and Rainer Böhme.				highlighted “Select all” button and presence of purposes on consent decisions.
[5] This Website Uses Nudging: MTurk Workers’ Behaviour on Cookie Consent Notices. Carlos Bermejo Fernandez, Dimitris Chatzopoulos, Dimitrios Papadopoulos and Pan Hui.		x		This articles evaluates the impact of the presence of purposes and nudging bar on banners where reject is accessible only on the 2nd layer.
[6] Dark and bright patterns in cookie consent requests. Paul Graßl, Hanna Schraffenberger, Frederik Zuiderveen Borgesius, and Moniek Buijzen.	x	x	x	This article evaluates the impact of dark (and opposite, bright) patterns expressed via highlighting accept (resp. reject) and removing reject (resp. accept) from the 1 st layer of the banner.
[7] Are you sure, you want a cookie? – The effects of choice architecture on users' decisions about sharing private online data. Bauer, J.M., Bergstrøm, R. and Foss-Madsen, R.	x		x	This paper evaluated the impact of hiding reject under the link inside the banner’s text and highlighting accept in bright green color at the same time.
[9] “Okay, whatever”: An Evaluation of Cookie Consent Interfaces Hana Habib, Megan Li, Ellie Young, Lorrie Cranor.		x		The article provides a comprehensive analysis of various design parameters, including blocking/non-blocking banner, present of reject on 1 st layer, layout of the main text, possibility to revoke consent, etc.

<p>[10] Factors that Influence Cookie Acceptance. Characteristics of Cookie Notices that Users Perceive to Affect Their Decisions. Julia Giese and Martin Stabauer</p>		x		<p>This paper evaluates the effect of removing reject from the 1st layer, and highlighting accept together with showing purposes on users decisions.</p>
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“Neutral” banner with identical “accept all” and “reject all” buttons

This *Neutral* banner interface where both “accept” and “reject” buttons are presented identically, is often considered the most neutral design of a banner and is used as “control experiment” in the studies against which other interfaces are evaluated. We show below the interfaces of “neutral” banners that have been tested in papers [1][2][3][6][7].



Banner text: “We use cookies to adapt our content, to show you functions, for social media and for analyzing our traffic”

Table below presents the acceptance rate in user that include a neutral banner in their experiments with users.

Article citation	Year	Sample size per cookie banner	Location of participants	Acceptance rate among users who interacted with the <i>Neutral</i> banner	Observations
[1]	2016	86	Spain	53%	Users were in a lab experiment.
[2]	2019	~1,700 mobile ~300 desktop	Germany	72% ⁷	Mobile users accept all cookies more often than desktop users on a real website.
[3]	2020	~40	USA	55%	US users were not habituated to click on “accept” on cookie banners in 2019.
[6]	2021	228 in dark patterns experiment, 255 in bright patterns experiment	UK	93.8% in dark patterns experiment, 53.2% in bright patterns experiment ⁸	Users that were continuously exposed to dark patterns, were very more likely to accept all cookies than those exposed to bright patterns.
[7] ⁹	2021	219	Denmark	71.7%	Users seem to be more accepting in real-world website.

All studies [1][2][3][7] report *quite a wide range of acceptance rate for neutral banners: between 53% and 72%*. Additionally, a study with dark and bright patterns [6] shows an interesting outcome: when users are continuously exposed to dark patterns (reject option is absent on first layer, accept is pre-selected or highlighted), users tend to accept consent more easily (acceptance rate 93.8%), however when users are exposed to reversed, bright patterns (accept option absent on the first layer, reject is pre-selected or highlighted), then users tend to be more reserved to accepting consent (acceptance rate 53.2%). The fact that users tend to accept consent more often on real websites than in controlled experiments demonstrates a similar effect: on real websites users have been exposed to dark patterns very often in the last years, and therefore experienced a “learning effect” or “habituation” to select the most visible, highlighted or predefined option to accept consent. This may indicate that *users are likely to accept consent more willingly if they have been previously exposed to “dark patterns”*.

Insights on behavior of users in neutral banners (“accept” and “reject” with identical design):

- On real websites, around **72% EU users tend to click “accept” on neutral banners [2][7]**. In controlled experiments with fewer users, the acceptance rate reported is lower suggesting that **users may accept consent more often in real website interactions**.
- Almost 94% users of those who are continuously exposed to dark patterns, accept all cookies, however only 53% users that are exposed to reversed, bright patterns, accept all cookies [6].

⁷ These numbers were obtained by normalizing accept and reject rate for “binary, non-nudging” banner in [2] over the overall interaction rate for mobile and desktop users.

⁸ Study [6] did not report the accept rate in the paper but provided the results of the statistical tests. On average and across all experimental settings, 93.8% users accepted cookies in dark patterns 53.2% of them accepted cookies in bright patterns.

⁹ The results presented here are computed from the Table A9 of the appendix of [7] found in “Extras” panel of the [online depository](#).

This may indicate that users are likely to accept consent more willingly if they have been previously exposed to “dark patterns”.

What users choose if there is no reject on first layer of the cookie banner?

Four studies [3][6][9][10] evaluated whether absence of “reject” option on the 1st layer of the banner impacts the users’ decision with respect to neutral banner. We call such banner design by *No reject* banners in our report. Refusing consent in these banners is possible on the second layer after clicking on “More info”, “Customize cookies”, “Manage options” or similar button. Figure below shows interfaces of the banners from these studies.

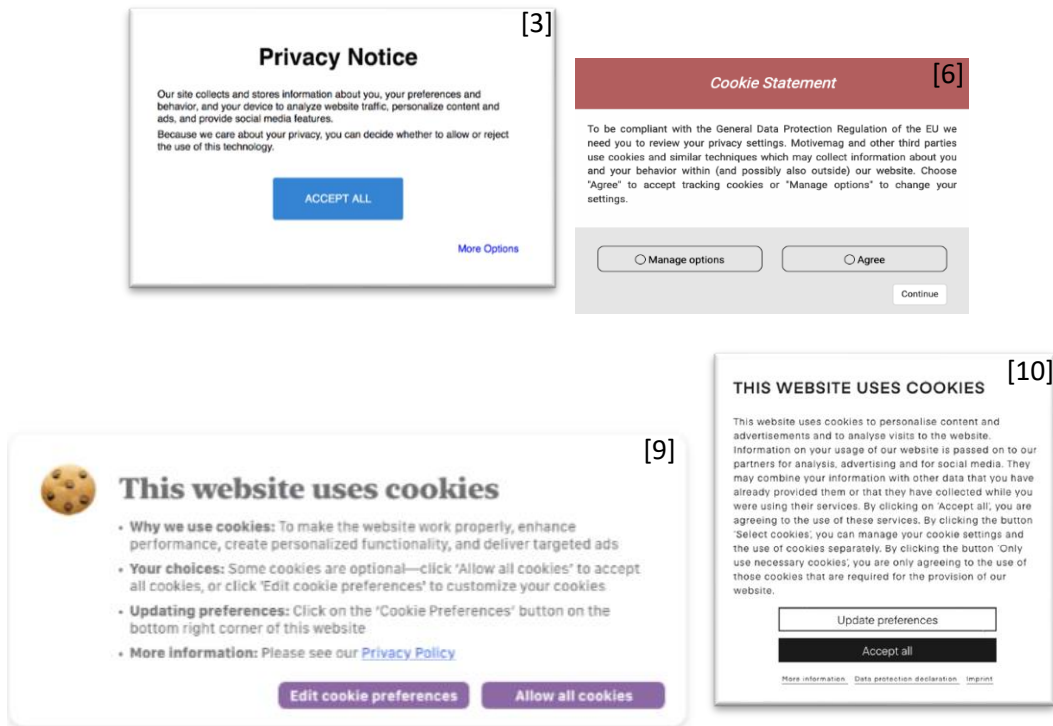


Table below presents the accept consent rates for the studies [3][5][6][9][10] as well as whether the behavior of users on such banners were statistically significantly different than their behavior on neutral banner with equally visible accept and reject buttons (according to the statistical test described in the study included in Table below). Here we have not reported on results from paper [7] with participants from Denmark because the authors studied several dark patterns in one banner interface (highlighting “accept” in green, size of “accept” is bigger than “reject”, “reject” is hidden as a link in the banner’s text), which is not possible to compare to other studies that evaluated each dark pattern in isolation.

Article citation	Year	Sample size per cookie banner	Location of participants	Acceptance rate among users who interacted with the <i>Neutral</i> banner	Acceptance rate among users who interacted with the <i>No reject</i> banner	Statistically significantly different between <i>Neutral</i> and <i>No reject</i>
[3]	2020	~40	USA	55%	77%	Yes, linear relationship between conditions with significant

						(p<0.001) slope coefficient
[6]	2021	228 in dark patterns experiment, 255 in bright patterns experiment	UK	93.8% in dark patterns experiment, 53.2% in bright patterns experiment ¹⁰	- ¹¹	No, for dark patterns Yes, for bright patterns Instead of classic significance testing, [6] relied on 95% credible intervals and used Bernulli distribution with consent decision as the dependent variable.
[9]	2022	92	USA	~60% ¹²	90% ¹³	Yes based on Pearson's chi-squared test with p<0.001
[10]	2022	~14,360 mobile ~8,890 desktop	Germany (45.9%), Austria (37.5%), Switzerland (9.6%), other countries	-	93.1% mobile 90.5% desktop	Yes based on Pearson's chi-squared test with p<0.001 ¹⁴

The most recent studies [9][10] report that *between 90% and 95.8% of users accept cookies in banners where no reject option is presented on the first layer*. If we compare accept rate to the neutral banner in the same study, the first study with 40 US users [3] has reported an increase in 22 percentage points with respect to neutral banners. Such increase is even bigger in the more recent study that reports 30% increase for US users [9].

Insights on banners with no explicit reject on the 1st layer, reject is possible on 2nd layer:

¹⁰ Study [6] did not report the accept rate in the paper but provided the results of the statistical tests. On average and across all experimental settings, 93.8% users accepted cookies in dark patterns 53.2% of them accepted cookies in bright patterns.

¹¹ Study [6] did not report the accept rate in the paper but provided the results of the statistical tests. On average and across all experimental settings, 93.8% users accepted cookies in dark patterns 53.2% of them accepted cookies in bright patterns.

¹² This number is obtained from Fig. 4 [9] since the percentage is not reported in the paper.

¹³ This number is obtained from Fig. 4 [9] since the percentage is not reported in the paper.

¹⁴ Note that authors of [10] compared *No reject* to a banner where reject option is present on the 1st layer, however accept option is visually highlighted. We call this design as "*Highlighted accept*" in this article.

- Between 77% and 95.8% of users accept cookies in banners where no reject option is presented on the 1st layer, but can reject on the 2nd layer of the banner [9][10].
- Latest study from 2022 [9] reports that removing explicit reject button from the first layer increases the probability of consent by 30 percentage points.
- Actions of users in banners with two identical “accept” and “reject” buttons statistically significantly differ from users’ actions on banners with no reject on the 1st layer [6][9].

Does highlighting “accept” button over “decline” button impact user’s decision?

Intuitively a situation when both “accept” and “refuse” buttons are present in a banner’s interface but “accept” is highlighted in a more visible color than “reject”, should impact the way the user makes their decision. We call such design *Highlighted accept* in this report.

Two studies [2][6] have analyzed the impact of highlighted “accept” button on user’s decision making and found different results – likely due to different samples of users, who are located in different countries and because experiments were conducted in different contexts. We have not reported on results from paper [7] with participants from Denmark because the authors studied several dark patterns in one banner interface (highlighting “accept” in green, size of “accept” is bigger than “refuse”, “refuse” is hidden as a link in the banner’s text), which is not possible to compare to other studies that evaluated each dark pattern in isolation. Below are interfaces of the banners from studies [2] and [6].

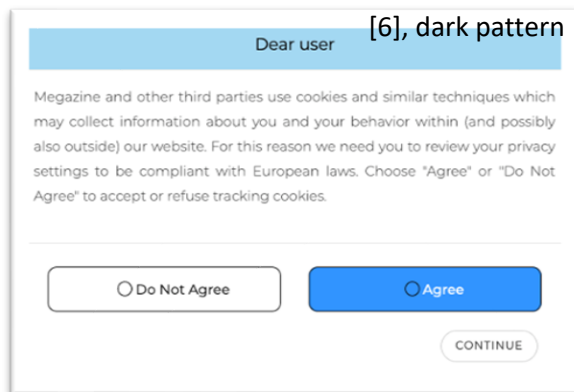
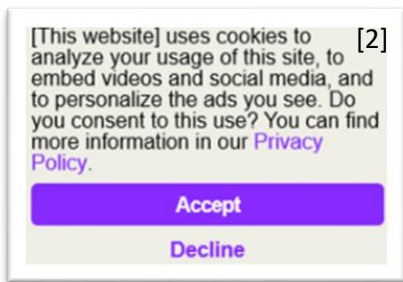


Table below shows acceptance rates in *Neutral* banner and in *Highlighted accept* banner from [2][6].

Article citation	Year	Sample size per banner	Location of cookie participants	Acceptance rate among users who interacted with the	Acceptance rate among users who interacted with the	Statistically significantly different between
				<i>Neutral</i>	<i>Highlighted accept</i>	<i>Neutral</i> and <i>Highlighted accept</i> banners

				<i>Neutral banner</i>	<i>accept banner</i>	
[2]	2019	~1,700 mobile ~300 desktop	Germany	72%	79%	No statistical tests were reported in this article.
[6]	2021	228 in dark patterns experiment 255 in bright patterns experiment	UK	93.8% in dark patterns experiment, 53.2% in bright patterns experiment ¹⁵	⁻¹⁶	No, neither for dark nor for bright patterns, [6] relied on 95% credible intervals and used Bernulli distribution with consent decision as the dependent variable.

The studies had participants from Germany [2] and the UK [6] and have found that *Highlighted accept banner does not have a substantial effect on the user’s consent decision* [2][6]. According to [2], 79% of users accept cookies in *Highlighted accept banner*, compared to 72% who accept all cookies on *Neutral banners*. Study [6] shows that either if “accept” button is highlighted, or if “refuse” is highlighted, this does not make a substantial effect of the user’s decision with respect to user’s decision on “*Neutral banner* within the same experiment.

Insights on banners with highlighted “accept” button:

- Only two user studies evaluated the impact of *Highlighted accept* on users’ decision making, concluding that **highlighted “accept” button in presence of “reject” button does not have a substantial effect on users’ consent decision.**
- Nevertheless, **this design seems to correspond to a “Look over there” dark pattern** identified in the latest version of the EDPB guidelines ([EDPB 2022](#)). Further studies are needed to evaluate the impact of *Highlighted accept*.

Are users interacting with the banner in order to dismiss it or are they afraid to reject?

Study [9] interviewed the US participants after they interacted with the banner and found that “About half of participants who selected “Allow all cookies” (50.2%) described that their goal was to dismiss the consent interface”. Therefore, even if the banner allows the users to browse the website, about half of the users that click “allow all cookies” do so to dismiss the banner.

Similarly, [10] stated the following after interviewing 627 German-speaking website visitors: “Quick dismissal of the cookie notice was also frequently mentioned as an external factor. In this context,

¹⁵ Study [6] did not report the accept rate in the paper but provided the results of the statistical tests. On average and across all experimental settings, 93.8% users accepted cookies in dark patterns 53.2% of them accepted cookies in bright patterns.

¹⁶ Study [6] did not report the accept rate in the paper but provided the results of the statistical tests. On average and across all experimental settings, 93.8% users accepted cookies in dark patterns 53.2% of them accepted cookies in bright patterns.

respondents were asked whether they clicked the most prominent button in a cookie notice in order to close it as quickly as possible. Just over half of the respondents (56.7%) said that they somewhat agreed or strongly agreed with this statement.”

Two studies analyzed whether participants are afraid to click “reject” in a cookie banner interface. Study [1] have hypothesized that “people may be accepting cookies because they simply do not know that they can continue browsing after they reject them”. The authors tested (a) a cookie banner without saying anything about the browsing, and (b) a cookie banner that said “you can continue browsing without accepting cookies”. The authors did not find any difference in the accept/reject consent rates for such banners. Moreover, they tested 4 other text messages with exactly the same design (and neutral buttons) and found no statistically significant difference in the consent rates. *This suggests that users tend to not read the text presented in the cookie banners.* This statement is supported by the claims of the users: according to study [10], 29% of users say they read the banner text occasionally, and only 7% said they always read it.

Study [2] made a user survey asking 45 participants what they think happens when they click “reject” while showing them the neutral banner with equally displayed “accept” and “reject” buttons. The authors found out that *48% of respondents would click “accept” because they are afraid the website or some parts of it may not work.*

Insights on motivation of users to interact with the cookie banners:

- 50.2% participants from those who clicked “accept” did so **to dismiss the banner** [9].
- 56.7% out of 627 participants clicked the most prominent button in a cookie banner **to close it as quickly as possible** [10].
- 48% participants would click “accept” because they are **afraid the website or some parts of it may not work** [2].
- Explaining users that they can continue browsing the website without accepting cookies does not make an impact on the consent rates, suggesting **that including text about the possibility to continue browsing is not efficient** [1].

Conclusion

In this report, we have analysed all existing literature across disciplines (computer science, social science, design and law) consisting in 10 academic papers to *inform policy makers, regulators and other interested parties of existing and ongoing research* about factual evidence on the impact of dark patterns on users decision-making in consent banners via user studies.

We have first identified the basic conditions for *ecological validity* of user studies on cookie banners and analysed the choices made in the design of user studies. As a result, we found that indeed *different conditions of the experiments often lead to different, incomparable results*. Therefore, the results of user studies should be considered with caution: studies differ in their results because of the conditions in which they were conducted. In particular, we have identified 5 conditions: sample size, location, audience, context and consent.

One possible barrier to rely on user studies in legal cases is that each website may have to be treated on a case-by-case basis. Therefore, ideally the consent banner analyzed in the case should be the one evaluated in the user study. One way to overcome this barrier is: first, to demonstrate the value of

existing user studies results, which we hopefully achieve in this article; second, for researchers to study the most common designs of consent banners thus ensuring a large coverage of websites.

Research community could provide immense help to the policy makers and regulators. So far, and to the best of our knowledge, user studies have been carried out with the goal to explore the design space of cookie banners and evaluate users' behavior on various banners' designs. While the goal of researchers is to carry out a global, large-scale, possibly cross-country study, the goal of regulators is different – that is, to perform a solid yet very targeted study for the audience of the regulated country and with the designs that reflect the needs and interests of the regulator.

One approach for the research community to help legal experts is to propose guidelines on how to conduct a methodologically valid user study. In our report, we have stated five basic conditions for the validity: for example, *Location* condition can ensure that the population in a given country are considered, where habits of people may be influenced by the guidelines of the national/state regulator. Yet we believe this report is only a first step, researchers could also carry out such user studies jointly to ensure that the needs of regulators in the choice of designs of banners are met.

To conclude, policy makers and regulators could benefit from common discussion on whether they could rely on user studies as evidence of dark patterns in their policy- and decision making, and identify conditions for such studies to be beneficial to rely on user studies as evidence for dark patterns.

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