

# Prospective Consent: The Effect of Framing on Cookie Consent Decisions

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## ABSTRACT

Prospect theory is a behavioral model of how people make decisions in the presence of risk; this work explores the application of prospect theory, particularly the *reference-dependence effect*, to user interactions with cookie banners. We identify two possible risks associated with cookies—the functional risk that denying cookies will degrade user experience and the privacy risk that accepting cookies will allow a website to access and sell personal information—and explore how the slant of a cookie consent banner (which risk it emphasizes) and the framing of a banner (whether it emphasizes the potential for gain or the potential for loss) impact user decisions. We conduct an empirical users study ( $n = 1557$ ) in which we observe how users interact with different cookie banner prompts. We find that for both possible slants, a negative framing is significantly more effective at nudging user decisions. We also find that the combination of slant and framing impact cookie opt-out rates by a factor of three. These results demonstrate the need for further consideration of the ethical implications of framing and nudging in the context of consent requests.

## CCS CONCEPTS

• **Security and privacy** → **Usability in security and privacy**;  
• **Human-centered computing** → **Empirical studies in HCI**;  
*HCI theory, concepts and models.*

## KEYWORDS

cookie consent, cookie banners, usable privacy, prospect theory

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## 1 INTRODUCTION

Recent privacy regulations such as the EU’s General Data Protection Regulation (GDPR) [38] and the California Consumer Privacy

Act (CCPA) [12] aim to enhance user privacy by empowering Internet users with control over their data. These regulations have given rise to ubiquitous consent interfaces such as *cookie banners*, which ask users to opt-in or opt-out of cookies. However, prior work has conclusively established that cookie banners fall short of ensuring that websites’ cookie practices comply with user preferences. Almost half of users express discomfort with standard cookie practices [48], but just 0.4% of users opt-out of cookies when presented with a common cookie banner design [53]. UI elements called dark patterns [9, 11, 15, 16, 20], which are common among cookie banners in the wild, further depress opt-out rates [53].

In this work, we consider how another element of cookie banners—the text used to frame the choices available to the user—impacts user interactions with cookie consent interfaces. We begin by identifying two possible risks associated with cookies: (1) the functional risk that denying cookies will degrade user experience and (2) the privacy risk that accepting cookies will allow a website to collect and profit from personal information. Drawing on prospect theory [25, 49–52], an empirical model of how people make decisions in the presence of risks, we consider two aspects of the banner text: (1) *slant*, that is whether the banner focuses on the functional risk of denying cookies (*positive slant*) or the privacy risk of accepting cookies (*negative slant*) and (2) *framing*, that is whether the text emphasizes the benefits of choosing the higher-utility option (*positive framing*) or whether it emphasizes the harms of choosing the lower-utility option (*negative framing*).

To understand the impact of these two textual aspects of cookie banners, we conducted an empirical user study with 1557 participants. Each participant visited an experimental aggregated news site after clicking on an advertisements displayed through Google Ads. Upon arriving on the site, each user was presented with a cookie banner containing one of five different text prompts. We found that for the conditions with a positive slant (i.e., those that emphasized the risk that denying cookies would degrade user experience), the negative framing resulted in significantly lower opt-out rates ( $p = .009$ ). For conditions with a negative slant (i.e., those that emphasized the risk that accepting cookies would degrade user privacy), the negative framing resulted in significantly lower opt-in rates ( $p = .013$ ). These results are consistent with prospect theory’s *reference-dependence effect*, an empirical pattern in how people make decisions in the presence of risk. Overall, the fraction of users who opted-out of cookies varied between conditions by up to a factor of three.

These results demonstrate that the language employed when prompting users to make decisions that impact their privacy, such as whether to opt-in or opt-out of cookies, can significantly impact users’ decisions. This provides further evidences that undermines the theory that interactive prompts such as cookie banners result

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in informed consent to data practices. It also casts light on the need for careful consideration among privacy experts, UI designers, and regulators about the ethical implications of leveraging psychological patterns in human decision making in the context of consent interfaces and about whether and how such language should be regulated to enhance privacy online.

## 2 BACKGROUND: PROSPECT THEORY

Prospect theory [25, 49–52]—first introduced in the 1970s as a critique of the then-dominant expected utility theory [19, 55]—is a descriptive model of decision making in the presence of risk. Expected utility theory—which asserts that a principal faced with a choice between two options will evaluate the expected utility of each outcome and then select the option with the higher expected utility—does not accurately predict human behavior observed in many experimental settings.

Prospect theory instead posits that decisions are comprised of two phases: an editing phase and an evaluation phase. In the editing phase, humans apply a set of simplifying heuristics to reduce the complexity of the decision problem. In the evaluation phase, probabilities and utilities are weighted by a decision weight  $w$  and a subjective value  $v$ , respectively. Humans are then presumed to rationally evaluate the options based on the weighted expected subjective value of the edited prospects.

The interactions between the editing phase and the weighting functions  $w$  and  $v$  result in several effects that have been empirically validated through a series of experimental studies. One notable effect, sometimes termed the *framing effect* or the *reference-dependence effect*, observes that people simplify decision problems by defining outcomes relative to a neutral baseline. Because people are loss averse, this implies that the framing of a decision problem—whether the higher-utility outcome is presented as a gain relative to the lower baseline (positive framing) or whether whether the lower-utility outcome is presented as a loss relative to the higher baseline (negative framing)—can effect which option people select. A negative framing will more effectively nudge people away from the lower-utility option.

More than 40 years later, prospect theory is still widely viewed as the best available model for how people make decisions in the presence of risk. It has been applied as a descriptive model to explain observed behavior in various different areas of economics including finance [6, 18, 33, 44], insurance [7, 24, 27, 47], savings [28], price setting [23], labor supply [13, 17], and betting markets [45]. Within the domain of computer science, prospect theory has been applied to explain decisions relating to investment in security [43, 54], adoption of two-factor authentication [39], disclosure of personal information [3, 4, 22], and password selection [31].

## 3 METHODOLOGY

To evaluate the impact of slant and framing on cookie consent decisions, we conducted an empirical user study with 1557 participants. Each participant visited an experimental website; upon arriving on the site, the user was presented with a cookie banner. Our website logged how each user interacted with the cookie banner.

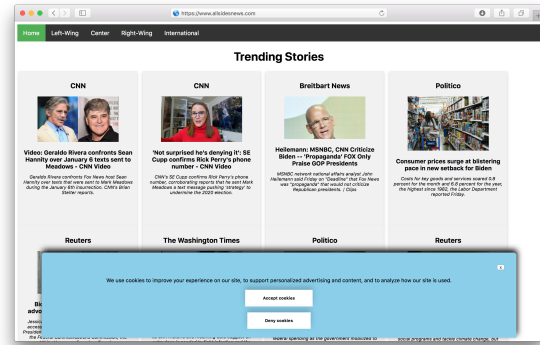


Figure 1: News aggregation site used in our user study.

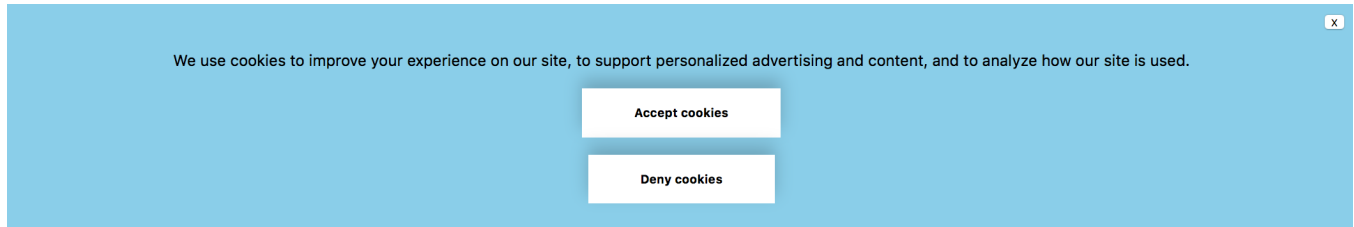
### 3.1 Experimental Setup

To conduct this study, we used an experimental aggregated news site. We chose this context because cookies on this site provide a credible privacy threat even for a brief, one-time visitor: a user's browsing pattern on such a site can expose sensitive information such as political beliefs and interests that are commonly sold to third-party aggregators. A screenshot of our website is shown in Figure 1.

When a user first arrived on the site, they were presented with a pop-up cookie banner. The text of the banner stated, "We use cookies to improve your experience on our site, to support personalized advertising and content, and to analyze how our site is used." The banner contained two prominent buttons below the text—one to accept cookies and one to deny cookies—as well as an "x" box in the top right-hand corner to dismiss the banner. The banner for the neutral condition is shown in Figure 2. The website logged how each user interacted with the banner.

The banner was non-blocking—users could ignore the banner and use the site, although some content was occluded—and the banner remained visible until the user clicked on one of the buttons or dismissed the banner. As with most real-world banners, the default behavior (i.e., whether cookies were "opt-in" or "opt-out" and what would happen if the user dismissed the banner) was not clearly specified by the interface. In fact, our site did not actually use any cookies for any users.

To understand the extent to which prospect theory—and specifically the reference-dependence effect—applies to cookie consent decisions, we introduced four experimental conditions that explore whether the reference-dependence effect applies to cookie consent decisions. More specifically, we evaluated how effective different framings—positive framing, which emphasizes the benefits of the higher-utility choice compared to a lower-utility baseline, versus negative framing, which emphasizes the losses incurred by the lower-utility choice compared to a higher-utility baseline—are at nudging users towards accepting cookies (in the positive slant conditions, which describe cookies as beneficial) and at nudging users away from accepting cookies (in the negative slant conditions, which describe cookies as harmful). These four conditions differ from the neutral condition only in the labels that appear on the two buttons in the banner (the accept cookies button and the deny



**Figure 2: The cookie banner for the neutral slant and neutral framing condition.**

Slant	Framing	Accept Cookies Label	Deny Cookies Label
Neutral	Neutral	Accept cookies	Deny cookies
Positive	Positive	Accept cookies to improve your experience on this site	Deny cookies
Positive	Negative	Accept cookies	Deny cookies and degrade your experience on this site
Negative	Positive	Accept cookies	Deny cookies to prevent this website and its partners from accessing or selling your personal information
Negative	Negative	Accept cookies to allow this website and its partners to access and sell your personal information	Deny cookies

**Table 1: A summary of the five different banner versions employed in our user study. Slant indicates to whether accepting cookies is presented as the higher-utility choice (positive slant) or lower-utility choice (negative slant). Framing corresponds to whether the button for the higher-utility choice emphasizes the benefits of that choice (positive framing) or whether the button for the lower-utility choice emphasizes the harms of that choice (negative framing).**



**Figure 3: The Google Advertisement displayed to users.**

cookies button); the precise labels for these buttons in each condition are provided in Table 1. Users were pseudorandomly assigned to a condition based on a hash of their IP address.

### 3.2 Participant Recruitment

To ensure ecological validity, we recruited study participants through a Google Ads campaign run between July 14-20, 2021. The ad was placed for search terms relating to news and was targeted at U.S. users through the Google Ads network with an average cost per click of 21 cents. A copy of the recruiting ad is shown in Figure 3.

Our cleaned dataset included log records from 1557 unique users who were assigned to one of our five conditions, with 290-337 users in each condition. 73.6% of users visited the site on a mobile browser, 7.5% on a tablet, and 18.8% on a desktop.

### 3.3 Ethical Considerations

To minimize the risk to our users, the only data collected were interactions with a publicly available site (e.g., how users interacted with the banner on the news site) for which users had no expectation

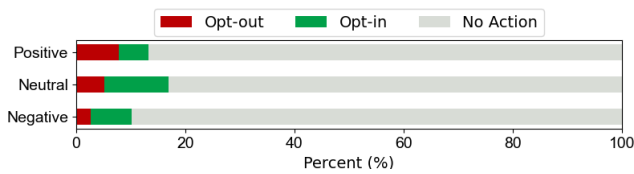
of privacy; no personally-identifiable information was collected. Log entries were associated with a unique identifier defined by a hash of the user’s IP address; no IP addresses or other identifiers were stored. Information collected was used only for research purposes. The privacy policy for our website also clearly stated that this was an academic study exploring how users interact with cookie banners, and that no personal information was collected or sold; the privacy policy also included a button that users could click to opt-out of the study and have their log entries deleted.

This research received an IRB exemption approval from the institutional ethics review board (IRB) at our institution.

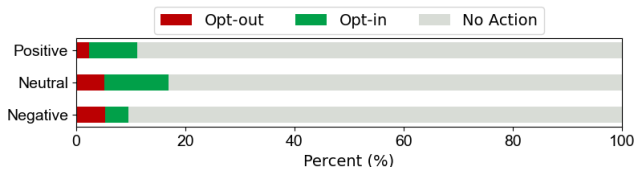
## 4 RESULTS

To evaluate the effect of framing on user interactions with cookie banners, we used Chi-squared contingency tests to test for significant differences between conditions.

Banners with a positive slant present users with a choice between accepting cookies—which are claimed to improve users’ experience on the site—and denying cookies and degrading the experience. We found that users who saw the banner with negative framing were significantly less likely to opt-out of cookies (and more likely to accept cookies) compared to users who saw the banner with positive framing ( $p = .009$ ). This is consistent with prior work apply prospect theory in other domains, which have found that negative framings are more effective than positive framings at nudging users away from “bad” decisions (in this case, nudging users away from opting-out of cookies). In the positive-framing



**Figure 4: The effect of framing on cookie banners with a positive slant, compared to a neutral baseline banner.**



**Figure 5: The effect of framing on cookie banners with a negative slant, compared to a neutral baseline banner.**

condition, 7.8% of users opted-out of cookies compared to just 2.6% in the negative-framing condition. These results are depicted in Figure 4.

Banners with a negative slant attempt to nudge users in the opposite direction; they present user with a choice between accepting cookies—which poses privacy risks by allowing a website to access and sell personal information—and denying cookies to prevent this harm. We found that users who saw the banner with negative framing were significantly less likely to accept cookies (and more likely to deny cookies) compared to users who saw the banner with positive framing ( $p = .013$ ). This is also consistent with prior work on prospect theory. In the positive-framing condition, 8.8% of users accepted cookies (and just 2.3% opted-out) whereas in the negative-framing condition only 4.3% of users accepted cookies (and 5.3% opted-out). These results are shown in Figure 5.

We also compared our four conditions with framing to a neutral baseline condition. In all cases, the conditions with framing and slant resulted in lower interaction rates than the neutral baseline condition, although the difference between the neutral condition and the condition with positive slant and positive framing was not statistically significant.

## 5 DISCUSSION

These results have real-world implications that should be incorporated into best practices and industry standards for cookie consent. They also shed light on directions for future work.

*Framing and Consent.* All five of our conditions presented users with a banner with the same text prompt and with two buttons: one that accepted cookies and one that denied cookies. However, the fraction of users who opted out of cookies varied between conditions by up to a factor of three: in the condition with positive slant and positive framing 7.8% of users opted out of cookies compared to just 2.3% in the condition with negative slant and positive framing. This large difference in how users interact with various banners (despite the identical outcomes underlying that decision) indicates that how users interact with cookie banners is swayed by

the framing of the decision and not just by the user’s preferences about how their data may be used. This in turn suggests that a user who clicks a button to allow cookies—or one that fails to click the button to deny cookies—might not actually be providing informed consent to the underlying data practices.

Future work will be required to more fully explore the interaction between framing and consent—does framing have less impact on users with strongly-held beliefs? how does framing interact with other forms of nudging (e.g., visual dark patterns)?—but future privacy regulations and industry standards should account for framing when defining best practices and setting minimum standards for informed consent.

*Ethical Implications of Framing.* From a privacy perspective, it is tempting to believe that banners with positive framing and positive slant enhance privacy because they significantly increase the rate at which users opt out of cookies compared to alternate banner designs. However, that is only the case if (1) we define privacy as compliance with societal-defined norms regarding data use—a view espoused by the philosophy of contextual integrity [34, 35]—and (2) we establish that those norms in our society preclude the use of non-necessary cookies in this context—as yet, an open question. Most privacy regulations and industry standards instead embrace the philosophy that Internet privacy is best met by empowering users with control over who has access to their personal information, a view that is grounded in Western legal theory [10]. From this perspective, even well-intended framing that exploits patterns in human decision-making to nudge users to opt-out of cookies should be considered a privacy violation if it overrides users’ abilities to make decisions that accurately reflect their data use preferences.

Further work will be required to determine which sorts of framing and slant (or lack thereof) result in users making decisions that best-align with their privacy preferences and to update regulations and standards to reflect these results.

*Non-interaction Decisions.* Most prior work on prospect theory tends to implicitly focus on decisions with two possible choices. However, users who interact with (non-blocking) cookie banners actually have three possible choices they can make: accept cookies, deny cookies, or neither. Users who opt not to interact with the banner, either by ignoring it or by dismissing it, have implicitly opted for that third choice. That third option is complicated by the fact that the outcome of choosing not interact with a banner varies based on local privacy regulations and individual company policies, and is thus unlikely to be well-understood by Internet users.

Our results suggest that the presence of this implicit third option has a significant effect on how framing influences patterns in user behavior. In the conditions with positive slant, negative framing decreased opt-out rates compared to both positive framing and to the neutral baseline condition, but it only increased opt-in rates compared to the positive framing; the negative framing condition actually decreased both opt-out and opt-in rates compared to the neutral baseline condition. In the conditions with negative slant, negative framing decreased opt-in rates compared to both positive framing and to the neutral baseline condition but it only increased opt-out rates compared to the positive framing; opt-out rates were statistically identical between the negative framing condition and the neutral baseline.

Further work will be required to develop a better understanding of user beliefs about default cookie behavior and to understand how factors such as slant and framing might influence user perceptions of this third option.

Our results provide strong preliminary evidence to support our hypothesis that prospect theory effects such as the reference-dependence effect can significantly influence how users interact with cookie banners and whether they consent to cookies. However, future work will be required to develop a more complete understanding of the relationship between prospect theory and cookie consent and to develop guidelines and regulations to ensure that these effects are used ethically in order to enhance user privacy online.

## 6 RELATED WORK

This work is the first to explore the reference-dependence effect, or prospect theory more generally, on user interactions with cookie banners. However, both prospect theory and cookie banners have been the focus of research independently.

### 6.1 Prospect Theory and User Interfaces

A small amount of work has looked at how well the reference-dependence effect, or prospect theory effects more generally, predict patterns in user interactions with user interfaces. Qu et al. [39] investigated the reference-dependence effect and the pseudocertainty effect in the context of two-factor authentication; they found that both effects explained whether or not users choose to enable two-factor authentication for a game in a laboratory setting. Ma et al. [31] explored the impact of the reference-dependence effect and the source-dependence effect on password selection; they found that an intervention could leverage the reference-dependence effect to nudge users to select significantly stronger passwords.

Earlier work has explored other connections between prospect theory and privacy. In 2007, Acquisti et al. posited that several prospect theory effects—notably ambiguity aversion—might significantly impact privacy decision making [2]. Follow-up work found that people were more willing to sell personal information than to buy back previously-disclosed information [3, 22], and that the framing of notice affected whether or not users disclosed personal information in a survey [4]. Choe et al. [14] also found that visual signals of an app’s trustworthiness were affected by framing, with positively framed signals proving more effective at influencing user opinions about the trustworthiness of an app. More recent work has looked at developing and validating a theory for how context and personality affect decisions about disclosing personal information [5] and at the mechanism-design problem of how to calibrate noise in privacy-preserving mechanisms [29, 30].

Prospect theory has also been applied to other security decisions, although only in limited domains. Verendel [54] developed a prospect theory model for decisions about buying versus skipping security protections (e.g., anti-virus software), although that work did not include any experimental validation. Schroeder [43] conducted a lab-based survey of IT officers in the U.S. military and found that prospect theory predicted hypothetical decisions about investment in information security. Sawicka and Gonzalez [41] explored the extent to which prospect theory can explain behavioral

dynamics in IT-based work environments; they found the model matched choices observed in a short experimental run, but that it was not likely to account accurately for behavior over longer time periods. Sanjab et al. [40] explored how the decision weight function and value function impact principals’ decisions in adversarial games in the context of attacks on Unmanned Aerial Vehicles (UAVs); they found that these subjective functions led to the adoption of riskier strategies which cause delays in delivery.

### 6.2 Cookie Banners and Nudging

Although this work is the first to apply prospect theory to cookie consent, interactions with cookie banners—and the impact of nudging and dark patterns [9, 11, 15, 20] on those interactions—have been extensively studied.

A large-scale experiment varying the position of GDPR cookie consent notices found banner location, visual nudging, and other dark patterns (e.g., defaults) significantly impacted how users interacted with cookie banners [53]. A manual analysis of 300 cookie banners from news websites found that two thirds demonstrated dark patterns such as nagging, obstruction, sneaking, interference, and obstruction [46]. Nouwens et al. [36] scraped cookie banner designs from consent management platforms (CMPs) that appeared on top-10,000 websites in the U.K.; they found that dark patterns and implied consent were ubiquitous and that common design elements significantly impacted user consent decisions. Gray et al. [21] performed an interaction criticism reading of three different types of consent banners and identified design choices that raise ethical concerns. Bermejo Fernandez et al. [8] found that nudging designs in cookie banners had a large impact on the decisions users make.

Nudging effects and dark patterns have also been observed and evaluated in other contexts, including ecommerce [32], social networks [26], and Do Not Sell interfaces [37]; they have been consistently found to impact user behavior.

In recognition of these effects, GDPR bans specific anti-privacy designs in cookie consent notices, such as pre-selected checkboxes. However, some privacy advocates have argued that nudging should be used to nudge users towards privacy-protecting choices [1, 42].

## 7 CONCLUSION

In this work, we explore the application of prospect theory, particularly the reference-dependence effect, to cookie consent. We identify two possible risks associated with cookies—the functional risk that denying cookies will degrade user experience and the privacy risk that accepting cookies will allow a website to collect and sell personal information—and explore how the slant of a cookie consent banner and the framing of a banner (whether it emphasizes the potential for gain or the potential for loss) impact user decisions. We find that for both possible slants, a negative framing is significantly more effective at nudging user decisions, and we find that the combination of slant and framing impact cookie opt-out rates by a factor of three. We also find that slant and framing significantly reduce interaction compared to a neutral baseline banner. These results demonstrate the need for further consideration of the ethical implications of framing consent requests and a more careful evaluation of the extent to which interactions with such interfaces constitute informed consent.



## REFERENCES

- [1] Alessandro Acquisti, Idris Adjerid, and Laura Brandimarte. 2013. Gone in 15 seconds: The limits of privacy transparency and control. *IEEE Security & Privacy* 11, 4 (2013), 72–74.
- [2] Alessandro Acquisti, Stefanos Gritzalis, Costos Lambrinouidakis, and Sabrina di Vimercati. 2007. *What can behavioral economics teach us about privacy?* Auerbach Publications.
- [3] Alessandro Acquisti, Leslie K John, and George Loewenstein. 2013. What is privacy worth? *The Journal of Legal Studies* 42, 2 (2013), 249–274.
- [4] Idris Adjerid, Alessandro Acquisti, Laura Brandimarte, and George Loewenstein. 2013. Sleights of privacy: Framing, disclosures, and the limits of transparency. In *Proceedings of the Ninth Symposium on Usable Privacy and Security*. 1–11.
- [5] Gaurav Bansal, Fatemeh Mariam Zahedi, and David Gefen. 2016. Do context and personality matter? Trust and privacy concerns in disclosing private information online. *Information & Management* 53, 1 (2016), 1–21.
- [6] Nicholas Barberis and Ming Huang. 2008. Stocks as lotteries: The implications of probability weighting for security prices. *American Economic Review* 98, 5 (2008), 2066–2100.
- [7] Levon Barseghyan, Francesca Molinari, Ted O'Donoghue, and Joshua C Teitelbaum. 2013. The nature of risk preferences: Evidence from insurance choices. *American Economic Review* 103, 6 (2013), 2499–2529.
- [8] Carlos Bermejo Fernandez, Dimitris Chatzopoulos, Dimitrios Papadopoulos, and Pan Hui. 2021. This Website Uses Nudging: MTurk Workers' Behaviour on Cookie Consent Notices. *Proceedings of the ACM on Human-Computer Interaction* 5, CSCW2 (2021), 1–22.
- [9] Christoph Bösch, Benjamin Erb, Frank Kargl, Henning Kopp, and Stefan Pfattheicher. 2016. Tales from the dark side: Privacy dark strategies and privacy dark patterns. *Proceedings on Privacy Enhancing Technologies* 2016, 4 (2016), 237–254.
- [10] Louis Brandeis and Samuel Warren. 1890. The right to privacy. *Harvard law review* 4, 5 (1890), 193–220.
- [11] Harry Brignull. 2019. Dark patterns. *Dark Patterns* (2019).
- [12] California. 2018. California Consumer Privacy Act (CCPA). Cal. Legis. Serv. Ch. 55 (A.B. 375).
- [13] Colin Camerer, Linda Babcock, George Loewenstein, and Richard Thaler. 1997. Labor supply of New York City cabdrivers: One day at a time. *The Quarterly Journal of Economics* 112, 2 (1997), 407–441.
- [14] Eun Kyoung Choe, Jaeyeon Jung, Bongshin Lee, and Kristie Fisher. 2013. Nudging people away from privacy-invasive mobile apps through visual framing. In *IFIP Conference on Human-Computer Interaction*. Springer, 74–91.
- [15] Gregory Conti and Edward Sobiesk. 2010. Malicious interface design: exploiting the user. In *Proceedings of the 19th International Conference on World Wide Web*. 271–280.
- [16] Norwegian Consumer Council. 2018. Deceived by design, How tech companies use dark patterns to discourage us from exercising our rights to privacy. *Norwegian Consumer Council Report* (2018).
- [17] Vincent P Crawford and Juanjuan Meng. 2011. New York City cab drivers' labor supply revisited: Reference-dependent preferences with rational-expectations targets for hours and income. *American Economic Review* 101, 5 (2011), 1912–32.
- [18] Stephen G Dimmock and Roy Kouwenberg. 2010. Loss-aversion and household portfolio choice. *Journal of Empirical Finance* 17, 3 (2010), 441–459.
- [19] Milton Friedman and Leonard J Savage. 1948. The utility analysis of choices involving risk. *Journal of political Economy* 56, 4 (1948), 279–304.
- [20] Colin M Gray, Yubo Kou, Bryan Battles, Joseph Hoggatt, and Austin L Toombs. 2018. The dark (patterns) side of UX design. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 1–14.
- [21] Colin M Gray, Cristiana Santos, Nataliia Bielova, Michael Toth, and Damian Clifford. 2021. Dark patterns and the legal requirements of consent banners: an interaction criticism perspective. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–18.
- [22] Jens Grossklags and Alessandro Acquisti. 2007. When 25 Cents is Too Much: An Experiment on Willingness-To-Sell and Willingness-To-Protect Personal Information. In *Workshop on the Economics of Information Security*.
- [23] Paul Heidhues and Botond Köszegi. 2014. Regular prices and sales. *Theoretical Economics* 9, 1 (2014), 217–251.
- [24] Wei-Yin Hu and Jason S Scott. 2007. Behavioral obstacles in the annuity market. *Financial Analysts Journal* 63, 6 (2007), 71–82.
- [25] Daniel Kahneman and Amos Tversky. 1979. Prospect Theory: An Analysis of Decision under Risk. *Econometrica* 47, 2 (1979), 263–292.
- [26] Bart Piet Knijnenburg and Alfred Kobsa. 2014. Increasing sharing tendency without reducing satisfaction: Finding the best privacy-settings user interface for social networks. In *Thirty Fifth International Conference on Information Systems*.
- [27] Botond Köszegi and Matthew Rabin. 2007. Reference-dependent risk attitudes. *American Economic Review* 97, 4 (2007), 1047–1073.
- [28] Botond Köszegi and Matthew Rabin. 2009. Reference-dependent consumption plans. *American Economic Review* 99, 3 (2009), 909–36.
- [29] Guocheng Liao, Xu Chen, and Jianwei Huang. 2017. Optimal privacy-preserving data collection: A prospect theory perspective. In *GLOBECOM 2017-2017 IEEE Global Communications Conference*. IEEE, 1–6.
- [30] Guocheng Liao, Xu Chen, and Jianwei Huang. 2019. Prospect theoretic analysis of privacy-preserving mechanism. *IEEE/ACM Transactions on Networking* 28, 1 (2019), 71–83.
- [31] Eryn Ma, Summer Hasama, Eshaan Lumba, and Eleanor Birrell. 2022. Prospects for Improving Password Selection. arXiv:2201.01350 [cs.CR]
- [32] Arunesh Mathur, Gunes Acar, Michael J Friedman, Elena Lucherini, Jonathan Mayer, Marshini Chetty, and Arvind Narayanan. 2019. Dark patterns at scale: Findings from a crawl of 11K shopping websites. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW (2019), 1–32.
- [33] Juanjuan Meng and Xi Weng. 2018. Can prospect theory explain the disposition effect? A new perspective on reference points. *Management Science* 64, 7 (2018), 3331–3351.
- [34] Helen Nissenbaum. 2004. Privacy as contextual integrity. *Wash. L. Rev.* 79 (2004), 119.
- [35] Helen Nissenbaum. 2009. *Privacy in context: Technology, policy, and the integrity of social life*. Stanford University Press.
- [36] Midas Nouwens, Ilaria Liccardi, Michael Veale, David Karger, and Lalana Kagal. 2020. Dark patterns after the GDPR: Scraping consent pop-ups and demonstrating their influence. In *Proceedings of the 2020 CHI conference on human factors in computing systems*. 1–13.
- [37] Sean O'Connor, Ryan Nurwono, Aden Siebel, and Eleanor Birrell. 2021. (Un)clear and (In)conspicuous: The right to opt-out of sale under CCPA. In *Proceedings of the 20th Workshop on Workshop on Privacy in the Electronic Society*. 59–72.
- [38] The European Parliament and the Council of the European Union. 2016. 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), L 119/1.
- [39] Leilei Qu, Cheng Wang, Ruojin Xiao, Jianwei Hou, Wenchang Shi, and Bin Liang. 2019. Towards better security decisions: Applying prospect theory to cyber-security. In *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–6.
- [40] Anibal Sanjab, Walid Saad, and Tamer Başar. 2017. Prospect theory for enhanced cyber-physical security of drone delivery systems: A network interdiction game. In *2017 IEEE international conference on communications (ICC)*. IEEE, 1–6.
- [41] Agata Sawicka and Jose J Gonzalez. 2003. Choice under risk in IT-environments according to cumulative prospect theory. In *21st International Conference of the System Dynamics Society, New York*.
- [42] Florian Schaub, Rebecca Balebako, Adam L Durity, and Lorrie Faith Cranor. 2015. A design space for effective privacy notices. In *Eleventh Symposium On Usable Privacy and Security*. 1–17.
- [43] Neil J Schroeder. 2005. *Using prospect theory to investigate decision-making bias within an information security context*. Technical Report. Air Force Institution of Technology Wright-Patterson School of Engineering and Management.
- [44] Hersh Shefrin and Meir Statman. 1985. The disposition to sell winners too early and ride losers too long: Theory and evidence. *The Journal of finance* 40, 3 (1985), 777–790.
- [45] Erik Snowberg and Justin Wolfers. 2010. Explaining the favorite–long shot bias: Is it risk-love or misperceptions? *Journal of Political Economy* 118, 4 (2010), 723–746.
- [46] Than Httut Soe, Oda Elise Nordberg, Frode Guribye, and Marija Slavkovic. 2020. Circumvention by design-dark patterns in cookie consent for online news outlets. In *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society*. 1–12.
- [47] Justin Sydnor. 2010. (Over) insuring modest risks. *American Economic Journal: Applied Economics* 2, 4 (2010), 177–99.
- [48] Jenny Tang, Hannah Shoemaker, Ada Lerner, and Eleanor Birrell. 2021. Defining Privacy: How Users Interpret Technical Terms in Privacy Policies. *Proc. Priv. Enhancing Technol.* 2021, 3 (2021), 70–94.
- [49] Amos Tversky and Daniel Kahneman. 1981. The framing of decisions and the psychology of choice. *science* 211, 4481 (1981), 453–458.
- [50] Amos Tversky and Daniel Kahneman. 1986. The framing of decisions and the evaluation of prospects. In *Studies in Logic and the Foundations of Mathematics*. Vol. 114. Elsevier, 503–520.
- [51] Amos Tversky and Daniel Kahneman. 1991. Loss aversion in riskless choice: A reference-dependent model. *The quarterly journal of economics* 106, 4 (1991), 1039–1061.
- [52] Amos Tversky and Daniel Kahneman. 1992. Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and uncertainty* 5, 4 (1992), 297–323.
- [53] Christine Utz, Martin Degeling, Sascha Fahl, Florian Schaub, and Thorsten Holz. 2019. (Un) informed consent: Studying GDPR consent notices in the field. In *Proceedings of the 2019 ACM SIGSAC conference on computer and communications security*. 973–990.
- [54] Vilhelm Verendel. 2008. *A prospect theory approach to security*. Citeseer.
- [55] John von Neumann and Oskar Morgenstern. 1944. *Theory of Games and Economic Behavior*. Princeton University Press.