Can browser choice screens be effective?

Experimental analysis of the impact of their design, content and placement

A report by

moz://a

Acknowledgements

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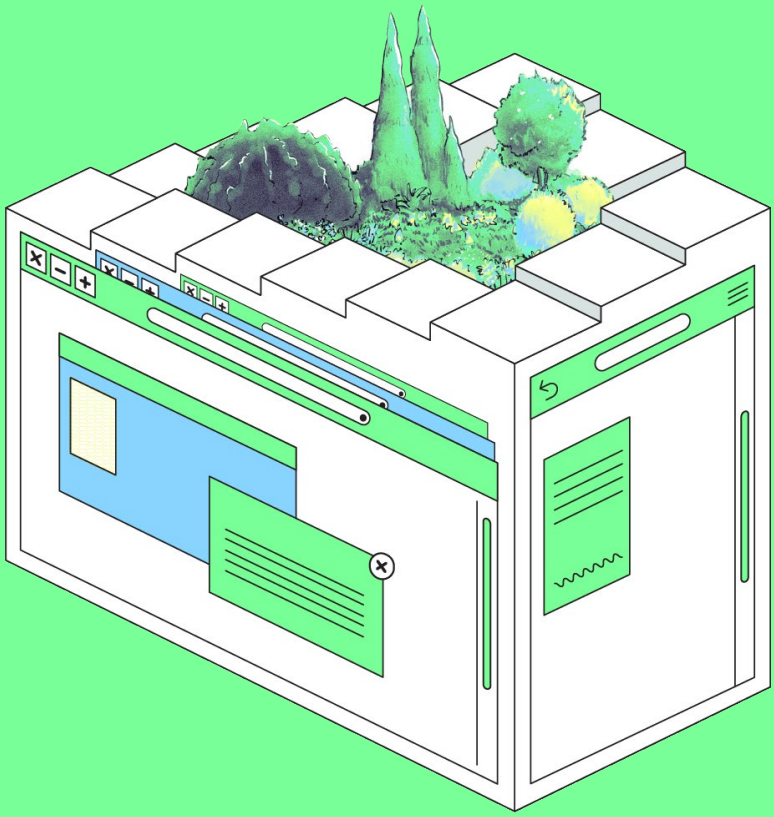
Special thanks to Stefan Hunt and Emily Chissell of Keystone Strategy for advice on the experimental design and behavioural theories that underpin this work.

This report was commissioned by Mozilla with the goal of exploring the potential impact of choice screens. The authors were compensated for their work on the report. The ability to publish was not tied to the results.

We would like to thank all of the people who gave their time to review the experiment and the report and offer valuable feedback, including, in particular, Mozilla colleagues and the following individuals from other organisations:

- Amelia Fletcher, ESRC Centre for Competition Policy at the University of East Anglia
- Andreas Maaløe Jespersen, the Danish Competition and Consumer Authority



Executive Summary

Operating systems and device manufacturers currently decide which web browsers are pre-installed and set as the default. Research shows that many people do not change this default - they may not realise there's a default browser or know the additional steps needed to change it. To improve competition, regulators around the globe are considering mandating the use of 'choice screens', which would prompt people to actively select their preferred default browser.

We undertook an experiment to test how different types of choice screen influence people's choices and levels of satisfaction. Our analysis provides insight into the impact of the design of choice screens and their potential to be effective.

In the experiment, people were asked to set up a highly realistic simulated mobile or desktop device (using either Android or Windows) and then navigate to the browser. We recruited 12,000 people from Germany, Spain and Poland. Some were not shown a choice screen and their default browser was pre-set. For the rest of the participants, we randomly presented a choice screen that varied along three dimensions: i) the level of information provided, ii) the number of browsers and iii) when the choice screen was shown:

- **The "low information" group** received minimal information (i.e., browser descriptions only accessible via a drop down) for 12 browsers with the choice screen shown during set-up, on first use of the device. The order of the browsers was randomised.
- **The "high information" group** was the same as above but received more information - an information screen, browser descriptions, star ratings and number of reviews.
- **The "fewer browsers" group** received high information, but only saw five browsers.
- **The "browser first use" group** saw high information and fewer browsers but the choice screen was shown when they first clicked on the pre-installed default browser.

There are many insights from the experiment about how to make browser choice screens most effective.

Five key take-aways are:

1) **Well-designed browser choice screens can impact people's decisions:** they lead people to choose a browser that they expect to remain with, increasing the selection of 'independent' browsers (i.e. not owned by the incumbent operating system or device manufacturer) compared to the control.
2) **The content and design of browser choice screens matter:** including more information and a wider range of browsers affects choice - leading to a small increase in people selecting independent browsers - while also increasing people's satisfaction. The order that browsers are presented also strongly affects choice.
3) **The point at which browser choice screens are shown also matters:** people who receive a choice screen after clicking on the pre-installed browser choose it as their default much more often than those who receive a choice screen during set-up.
4) **People report clear preferences about browser choice screens**: most prefer high information and more browsers, and want choice screens at device set-up.
5) **Choice screens improve satisfaction without significantly increasing burden:** they do not significantly increase the amount of time to set up a device, and people report higher satisfaction with the ease and set-up time, and their sense of control.

Overall, well-designed choice screens have benefits - giving people an active choice allows them to select their browser default more easily and increases contestability. Our analysis suggests having a browser choice screen aligns with people's preferences, increases satisfaction and does not have the downsides that some have been concerned about. But there are risks that choice screens could be poorly designed, in ways that would reduce their effectiveness - e.g. if the operating system or manufacturer lists their browser first.

The results also highlight the value of using experiments to inform the estimated effects and design details of regulatory interventions in digital markets. Experiments can also help to avoid unforeseen and unintended consequences to regulatory interventions.

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01.

Summary

Browser choice screens provide a way for people to select their preferred default and are required under the European Union's new Digital Markets Act (DMA). Other regulators around the globe are also considering browser choice screens as an intervention. This report sets out the results of a large-scale online experiment testing the effects of browser choice screens. The purpose is to estimate the impact of different design choices and provide evidence to help assess whether or not choice screens are effective.

Default browsers are currently pre-installed and pre-selected by the device manufacturer or by the developer of the operating system. A browser being the default means it will be used automatically (e.g. when clicking on a link in an email). Almost all Android devices have Google's Chrome pre-installed and either Chrome set as the default or Samsung Internet, which is the default on Samsung's devices. Apple's Safari is the pre-installed default on Apple's devices and Microsoft's Edge is the pre-installed default on Windows devices. We refer to this set of browsers as the 'incumbents'. There are a number of steps consumers need to take if they want to change their default and many people ultimately stick with the default browser chosen for them.

Behavioural literature recognises defaults are powerful mechanisms that influence people's choices and create 'stickiness' which favours the status-quo option. Defaults can be helpful when chosen to align with customer preferences, helping to save effort and time costs. However, in practice, some consumers will have a different preference than the pre-selected default and may want specific features (e.g. privacy) offered by other browsers, especially those that are 'independent' (i.e., not owned by an operating system or manufacturer). Moreover, default settings risk being used to steer people toward the incumbents' preferred browsers (i.e., their proprietary browsers) as opposed to people's preferred browsers.

Choice screens potentially provide a way for consumers to compare browsers and easily select their preferred default, even if it is not pre-installed. Choice screens can also make it easier for people to choose the default browser that they want, rather than it being chosen for them - giving people greater control over the browser they use. They could also help to increase competition between browsers, which would benefit the billions of people who use browsers daily to access the web.

But some have suggested that choice screens could be a burden, taking up people's time for little benefit. There are also concerns that the screens could be designed by incumbents in ways which steer consumers into making choices they may not otherwise have made - advantaging incumbents' browsers over others. Overall, policymakers need to weigh the benefits and costs of choice screens and, if minded to implement choice screens, consider which design details should be mandated. We directly investigate these issues.

What was the experiment?

The experiment explored the impact of differently designed choice screens on users' behaviours and attitudes by varying:

1. **the information provided**: more or less information (e.g. browser descriptions, star ratings, reviews);
2. **the number of options presented**: a larger or reduced set of browser options (12 or 5 browsers); and
3. **the placement of the choice screen**: presenting a choice screen when people first use their device (in this case, mid-way through the set-up process) or when they use their browser for the first time.

We created a highly realistic virtual environment to simulate setting up a new mobile and desktop device. The experiment replicates two devices/operating systems: setting up a Samsung mobile device running on Android and setting up an HP desktop using a Windows operating system. While the experiment focuses on two devices/operating systems, the aspects of the choice environment we investigate are relevant to browser choice screens on other types of devices and operating systems (importantly including Apple's iOS and macOS).

There were 12,000 people in the experiment — with samples of 4,000 adults from each of Germany, Spain and Poland. People were randomly allocated to one of five different groups for each of Android and Windows:

- **The control group (no choice screen)** did not receive a choice screen and their default browser was pre-set to Samsung Internet/Edge - reflecting the current use of pre-installation and default settings in browsers.
- **The "low information" group (Treatment group 1, or T1)** received a choice screen during the first use of a device (i.e., midway through set-up) that showed 12 browsers[1] with minimal information about them i.e., limited browser descriptions which people could only access if they clicked on a down arrow.
- **The "high information" group (T2)** received a choice screen during device set-up which included more information — an information screen explaining browsers and defaults, descriptions for all browsers with no clicks necessary, as well as the browsers' star ratings and number of reviews.
- **The "fewer browsers" group (T3)** received more information during device set-up as per above, but only saw five browsers (the top four in terms of market share and a rotating slot for the remaining eight browsers).
- **The "browser first use" group (T4)** saw the same choice screen as the previous group, but it was shown once people had completed device set-up and when they clicked on the pre-installed default browser (in this experiment, the pre-installed default was either Samsung Internet or Edge - in practice Chrome is also pre-installed on Android devices and for non-Samsung devices is normally the default).

The ordering in which the browsers were displayed on the choice screen was randomised in all of the treatments, enabling us to examine directly whether the order influences people's choices. Everyone was asked to set-up their device as they would in real-life and then asked to use their browser to complete a short task and quiz (using either their chosen browser or a pre-set browser). Once the virtual experiment had been completed, all participants were then asked about their browser usage, understanding of defaults, choice screen preferences and satisfaction on different aspects of the set-process (including the amount of time it took, their sense of control and the range of settings they could customise).

Key takeaways

Overall, we find that **a well-designed choice screen - with key information about each browser and a wide range of browsers - shown during set-up at first use of a device has benefits**: it enables people to select their default easily, increases browser contestability, aligns with people's preferences, increases satisfaction and does not have the downsides that some have been concerned about.

1 Browsers were primarily selected for each country and device on the basis of national marketshares for mobile and desktop using Statcounter.

There are five key takeaways:

1. Well-designed browser choice screens can impact people's decisions: they help people choose a browser that they expect to remain with:

- **Choice screens move people away from pre-installed default browsers.** Just over half of the control group expect to change the default browser that had been selected for them — suggesting that the pre-installed default may not serve the needs or preferences of many people. On the other hand, 98% of the people who select a browser through a choice screen expect to remain with it.

- **Browser choice screens increase contestability.** Serving a choice screen leads to an increase in the share that selected independent browsers relative to the control group. People in the treatment groups were 13% less likely to expect to use a browser from one of the incumbents (Samsung, Chrome, and Edge) than the control.

2. The content and design of choice screens matter: several factors impact choice, including information, the number of browsers, and the order browsers are displayed:

- **Providing information on each browser impacts choice.** Adding information (moving from T1 to T2) decreases the percent of participants who chose one of the incumbents, from 73% to 70%. When more information is available there's also a small increase in those who choose an independent browser.

- **Providing key information and more browsers to choose from increases satisfaction**. Participants who receive higher levels of information are more likely to state that they are satisfied with the amount of information they receive, with those in T2 most satisfied (rising from 56% for T1 to 64%).

- **The order that browsers are presented strongly affects choice.** Browsers that are lower positioned (randomised in this experiment) are chosen significantly less frequently - this is a particularly strong effect on Android (where browsers were positioned vertically). Moving from being ranked first to being fourth decreases the likelihood of people choosing that browser by several percentage points. Chrome shows the largest fall (7 percentage points), but the lowest relative drop (11% fall). Pre-set browsers (Samsung and Edge) have a high absolute fall (6 percentage points) and the highest relative drop (38% fall). Firefox and Opera are less impacted.

3. The point at which a choice screen is shown also matters:

- **People are significantly more likely to choose a pre-installed browser as their default when the choice screen is shown at first use of the browser.** In T4 people were required to click on the pre-installed browser before being shown the choice screen. This almost doubles the percentage of people who choose the operating system's pre-set browser (Samsung or Edge in our experiment), from 11% to 19%. This is particularly at the expense of Chrome, which sees its share fall. Though in practice Chrome also comes pre-installed on many devices and pre-set as the default on some.

4. People have clear stated preferences about choice screens: wanting more information, more browsers to choose from and shown at first use of a device during set-up:

- **People want the ability to select their default browsers**. The overwhelming majority (98%) prefer to be shown a choice screen.

- **Of these, many more people prefer the choice screen to be shown when they set up their device** (65%) compared to when they first use the pre-set browser (33%) - even those shown a screen at browser first use (T4) prefer to be shown it during set-up.

- **Most people prefer the screen with both greater amount of information and more browsers to choose from** (44%). This was significantly higher than screens with less information but with more browsers (20%) or more information but fewer browsers (26%).

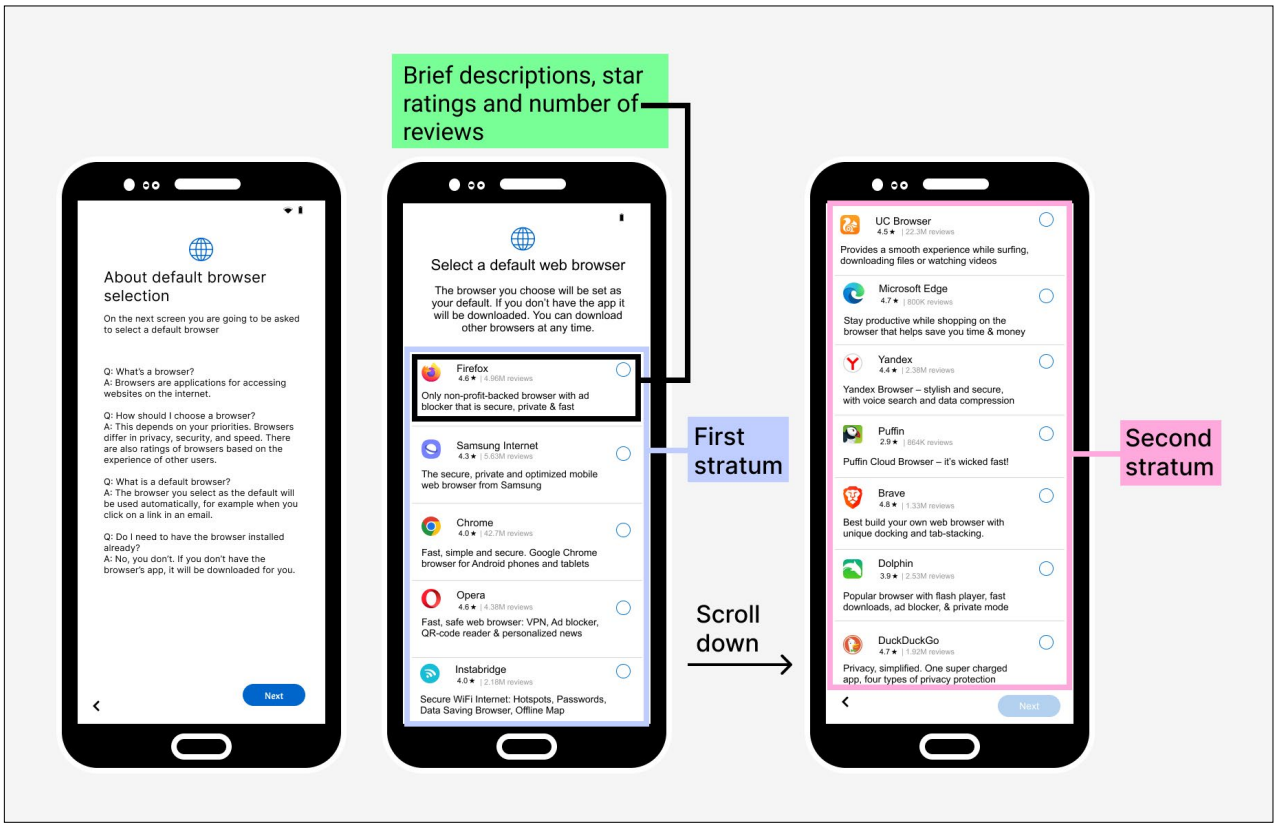
5. Browser choice screens improve satisfaction without significantly increasing burden:

- **Choice screens increase people's satisfaction.** Across a range of measures of satisfaction — from the ease of setting up the device, the amount of time to set up, to the range of settings they could customise — satisfaction increased. The increase is particularly high for satisfaction with 'the extent to which I felt in control', which increases by 12% (to 75%) for the treatment groups compared to the control.

- **Choice screens do not significantly increase time taken**. The increase in the time taken to complete the set-up of a device is small and is not statistically significant.

Taken together, these results provide robust evidence that the design of browser choice screens is critical. In particular we find that the choice screen with high information and more browsers — shown at first use of the device, during set-up — generates the highest satisfaction (on all metrics we asked about) and is the most preferred of the choice screens we tested. See Figure 1 below for the mobile version of this choice screen (the Windows version is similar). Given the large number of smartphone users, even small effect sizes on a can have meaningful effects at the market level.

Figure 1: Android choice screen for Treatment 2 - high information, more browsers



Notes: The order of the top five browsers by market share was randomised in the first stratum and the next seven browsers were randomised in the second stratum - the 12 browsers were displayed as one continuous scrollable list.

Lessons for regulators and market participants

This experiment provides a range of supportive evidence for the use of browser choice screens — but also illustrates that their precise design and when they are displayed affects their impact and the choices people make. It shows how critical it is for regulators to pay close attention to the detail of how and when these screens are introduced. There are risks that firms responsible for introducing choice screens (e.g. 'gatekeepers' under the DMA) could design them in ways which reduce their effectiveness (for example the Google 2019 browser choice screen has been shown to have negligible effects) or may even reinforce many of the concerns regulators are seeking to address. This would be detrimental to browser competition and would ultimately distort the choices made by consumers. It is therefore important that regulators understand, look out for and deter any ways consumers could be manipulated into choices they may not otherwise have made or that would not be in their best interests.

Although Mozilla does not have its own operating system and therefore cannot test interventions directly, we have been able to conduct realistic testing in this 'online' experiment. This demonstrates that such experiments can provide important evidence to understand how to make these types of changes most effective — in addition to live 'field' testing where that is possible. Accordingly, regulators can and should conduct online experiments such as this one to inform their interventions. Regulators should also instruct gatekeepers to conduct field experiments (closely supervised), benefitting from their scale, data and user access advantages to optimise regulation and enforcement. This experiment, and experience with using experiments more generally, shows that it is hard to foresee and easily predict the effects of interventions (e.g., we did not predict that a choice screen shown after clicking on a pre-installed browser would have such a different effect than one shown during device set-up). The process of having to create treatments and analyse trade-offs also forces a deep degree of engagement with the details of such interventions. Therefore running experiments can be very valuable before introducing regulatory changes, when possible.

However, Mozilla recognises that **choice screens will not necessarily be sufficient on their own to address competition concerns**. Given the maturity of the browser market, with long-held patterns of behaviour built up over time, even more active intervention will be needed. To improve competition for consumers, Mozilla considers there is a case for introducing measures that go beyond simply levelling the playing field. For example, in the case

of browser choice screens, regulators could mandate that browser incumbents[2] must not appear in the most prominent position, e.g., at the top of the list - whilst the placement of other browsers would otherwise be randomised and accessible, without any form of payment.[3] Beyond choice screens, there is also a case for developing new interventions which engage users more effectively, taking into account the range of academic research and business data available today.

It is important to set expectations over the scale and timeframe in which these types of interventions change market dynamics. As this experiment shows, many still chose the incumbent browsers — meaning market shares did not change hugely as a result. Even well-designed choice screens on their own will not fundamentally change the market structure and competition between browsers overnight. However Mozilla considers that when carefully designed, closely overseen by regulators, and included in all major operating systems, they are, at least, a step in the right direction.

Next steps

Mozilla looks forward to engaging with regulators, firms, academics, civil society and consumer organisations to discuss this experiment and explore its results. We hope this experiment will enable continued discussion and further experimental testing in this area by others, where to date little research has been undertaken. There are many other aspects that could usefully be explored further and tested, including for example how and when people might be asked again (after setting up a new device) about their choice of default browser or the impact of repeated and persistent prompts such as those from operating system providers, which could shift people back to incumbent browsers.

2 Browsers of operating system/device providers such as Google's Chrome, Microsoft's Edge, Apple's Safari, Samsung Internet and Amazon Silk.

3 The second iteration of Google's 2019 search engine choice screen used an auction system where other browsers had to bid to win a place on the screen, a process which has been widely criticised - leading to Google replacing the auction with free participation.

02.

Background

Browsers provide a key gateway for people to access the internet and for businesses to reach consumers. They are amongst the most important and widely used software applications — with billions of people using them daily to access news, entertainment, shopping, communication platforms, search and other activities. The open web plays a critical function in our society and browsers are the cornerstone.[4]

Despite their importance, the browser market has become highly concentrated and regulators have found that competition is severely constrained. Why does this matter? Many problems can arise in markets where there is not enough competition. In this case, people could end up using browsers that they would not otherwise select if given the choice; they may not be the right browsers for them; they may be forced to give up their privacy or agree to unwanted or unfair terms; they may not even realise which browser they are being automatically defaulted to; or, worse, their choice of browser might be overridden by the operating system provider.[5] Weak or restricted competition can not only reduce consumer access to independent browsers, but it also reduces the incentives for the incumbents to advance new innovations and make other improvements to their browser (e.g. increase its speed, offer new features, improve privacy properties or make security improvements). Many of these issues may not be immediately apparent but nonetheless impact people's experience of the internet.

Effective competition relies on the ability of consumers to choose freely from a range of products, including those provided by independent competitors. To achieve this, browsers like Mozilla's Firefox and many others, need a level playing field. But also, importantly, consumers benefit from being given greater visibility, choice and control in the browser they use.

4 https://www.mozilla.org/en-US/about/webvision
5 Mozilla, Five Walled Gardens: Why Browsers are Essential to the Internet and How Operating Systems Are Holding Them Back, page 8 Mozilla_Five-Walled-Gardens.pdf

Concerns about browser competition and consumer choice and control have been widely reported by regulators and governments globally[6], although to date they have not yet been addressed. However, in some jurisdictions that is about to change. A number of positive regulatory interventions could materially improve browser competition in those markets — if these changes are implemented in the right way. Most imminently, the EU's DMA (fully applicable in 2024) will impact browser competition in a number of different ways — from preventing gatekeeper tying and bundling, to ensuring browsers can be powered by different browser engines (something which is currently restricted on iOS), and requiring gatekeepers to mitigate the impact of operating system default settings.

This latter change is the focus of the research set out in this report, building on previous research Mozilla has undertaken[7] into the effects of 'online choice architecture' (i.e. the way design can shape how people interact and make decisions online[8]) in the context of browsers.

Article 6(3) of the DMA includes a specific provision which requires gatekeepers to facilitate consumer browser choice and, in effect, to show choice screens:

> *"The gatekeeper shall allow and technically enable end users to easily change default settings on the operating system, virtual assistant and web browser of the gatekeeper that direct or steer end users to products or services provided by the gatekeeper. That includes* ***prompting end users, at the moment of the end users' first use of an online search engine, virtual assistant or web browser of the gatekeeper listed in the designation decision pursuant to Article 3(9), to choose, from a list of the main available service providers****, the online search engine, virtual assistant or web browser to which the operating system of the gatekeeper directs or steers users by default…"* .[9]

These types of changes have also been considered by, among others, the UK's Competition and Markets Authority (CMA) in the UK and the Australian Competition and Consumer Com-

6 See for example CMA's Final Report into mobile ecosystems Final report (publishing.service.gov.uk), June 2022, Competition in the Mobile App Ecosystem | National Telecommunications and Information Administration (ntia.gov), February 2023, ACCC's digital Platform Services Inquiry Third Interim Report, Interim Report No.3 - search defaults and choice screens (accc.gov.au), September 2021 and the European Commission's DMA, Publications Office (europa.eu).

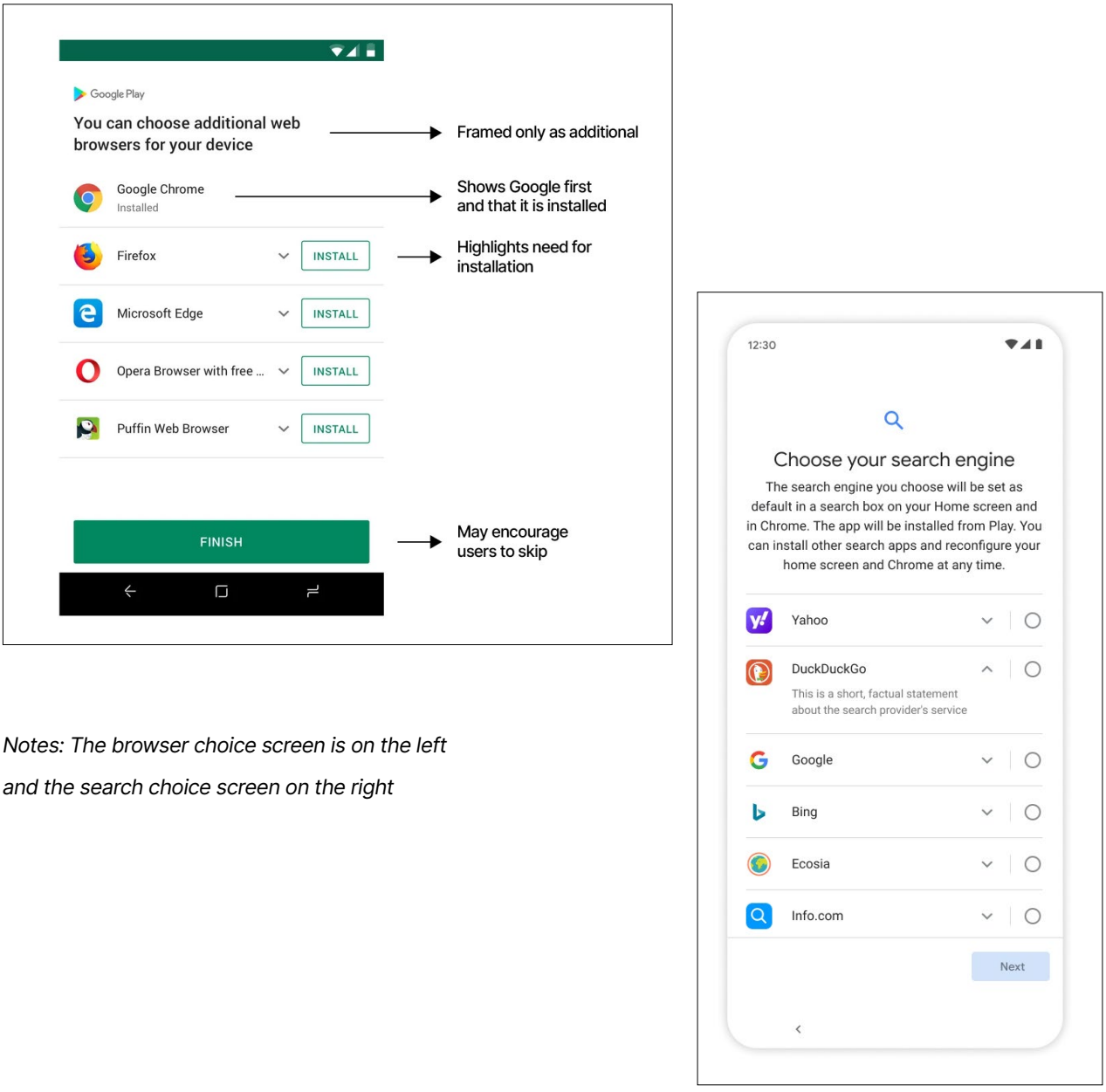
7 https://research.mozilla.org/browser-competition/remedyconcepts

8 Design and presentation of choices can affect consumers and shape markets in significant ways (intentionally or not, and with or without consumer awareness). It influences when, if and how people make decisions on their devices. Choice architecture can be used positively or negatively to deliberately encourage outcomes that are advantageous for firms, but do not necessarily align with people's preferences or needs.

9 Digital Markets Act, Publications Office (europa.eu), page 35

mission (ACCC) in Australia in previous reports, as well as by academics.[10] This is also not the first time that browser choice screens have been introduced. For example, they were introduced in a limited form as part of previous European Commission competition cases against Microsoft in 2009 and Google in 2018.[11] Figure 2 below illustrates the current two Google choice screens in relation to browsers and search engines.

Figure 2: Google's 2019 choice screens for browsers and search



Notes: The browser choice screen is on the left and the search choice screen on the right

10 For example, DMA_SwitchingToolsandChoiceScreens.pdf (cerre.eu), Amelia Fletcher, November 2022 and Choice Screen Auctions, Michael Ostrovsky, Stanford University and NBER, June 2023 csa.pdf (stanford.edu)

11 For an explanation of the current Google choice screens see here: Android Choice Screen and the previous Microsoft choice screen (known as the web browser ballot box - but now defunct) see here: BrowserChoice.eu - Wikipedia

There have been a number of criticisms raised about these designs, both from regulators and from other independent firms such as DuckDuckGo, as well as Mozilla.[12] Such concerns include:

- listing all the current pre-installed browsers at the top of the screen (including Chrome) - which could provide an advantage as it is the most visible;
- indicating which browsers need to be installed - which may put users off from selecting those;
- framing the selection as one in which users can choose *additional* web browsers to download - but does not set this as their default; and
- only presenting the choice screen when a user first enters the Play Store — which could interrupt the task being undertaken by the user at that time, leading to less engagement with the screen.

The CMA concluded that while choice screens can be useful in facilitating browser choice and reducing the importance of pre-installation and default settings, the choice architecture of Google's choice screen may limit its effectiveness.[13]

The relevant thinking from previous reports about choice screen design and lessons learned from these previous designs have been taken into account in this research. However, surprisingly, little robust publicly available wide-scale research has been undertaken to understand and inform how choice interventions should be introduced, how consumers will react and what consumers themselves want to see.

Indeed regulators and academics have highlighted a number of areas where further research on the design and impact of this form of choice screen would be beneficial (e.g. how many browsers should be displayed, in what order and with what information etc).[14] As was evident while developing this research, the details matter. Objective data-driven 'behavioural' evidence is critical to properly understand and predict how people will engage with choice screens. Without this evidence, there is a real risk that these types of interventions will be at best ineffective and, at worst, will help to reinforce the incumbent browsers.

12 For example, DuckDuckGo raised various concerns and proposed an alternative design Search Preference Menus: Improving Choice With Design (spreadprivacy.com). Criticisms have also been raised by the CMA Appendix G - Pre-installation default settings and choice architecture for mobile browsers (publishing.service.gov.uk) and the ACCC's September 2021 Interim Report into search defaults and choice screens – in particular chapter 4, section 4.1 and 4.2.

13 CMA's Final Report into mobile ecosystems Final report (publishing.service.gov.uk), June 2022, paragraph 5.100-5.101

14 For example the ACCC recommended further research and user testing to determine the optimal number of choices to be presented on choice screens, timing and frequency of its display, ACCC's September 2021 Interim Report Interim report No.3 (accc.gov.au), pages 112, 115 and 116.

Behavioural evidence more generally can provide unique insights into the design and impact of many consumer-facing interventions — and can play an important role more broadly in the implementation and monitoring of many DMA provisions[15] and digital competition and consumer changes under consideration by regulators. In practice many of these changes will depend on how consumers make choices and the way in which interfaces are designed by firms will be critical. Expert practitioners, academics and commentators all increasingly recognise the impact choice architecture plays in relation to competition, consumer and regulatory law and policy-making.

Many behavioural effects are recognised and well understood.[16] Setting an option as the default often has particularly powerful effects and leads people to be much more likely to remain with that option. Using defaults may not always be bad as they can in some cases save people time and effort - but they can also be harmful in other circumstances. The order that options are presented in a list, especially online and particularly on mobile devices, can have a large impact on choice. How options are presented (known as 'framing effects') can be important, as can the number of options that consumers must consider, with a concern that too many options can lead to paralysis and worse choices (known as 'choice overload'). All of these behavioural effects and many others (e.g., prompts and reminders, personalisation or popularity claims) could be relevant to designing choice screens for browsers. Original, experimental evidence is helpful in providing guidance on different designs.

Behavioural effects are not always used to help steer consumers towards the choices that are best for them. There is also a risk that behavioural techniques might be used by those that control the choice architecture to steer consumers in a specific direction of interest to the architect, which may not be in the interests of the consumer. Such steering (also known as 'deceptive design') can also have a strong impact on people's decision making.

15 See in particular Implementing the DMA: The Role of Behavioural Insights by Amelia Fletcher, Zita Vasas :: SSRN, DMA_SwitchingToolsandChoiceScreens.pdf (cerre.eu), and other behavioural papers such as Online Choice Architecture - How digital design can harm competition and consumers - discussion paper (publishing.service.gov.uk), CMA Discussion Paper, April 2022, Thaler, R. H., Sunstein, C. R., & Balz, J. P. (2013). Choice architecture. In The Behavioral Foundations of Public Policy (pp. 428-439). Princeton University Press; Johnson, E. (2022). The Elements of Choice: Why the Way We Decide Matters. Oneworld Publications.

16 See Online Choice Architecture - How digital design can harm competition and consumers - discussion paper (publishing.service.gov.uk), CMA Discussion Paper, April 2022 for an overview of different behavioural effects

What are the concerns with browser choice to date?

Many people do not currently 'actively' choose their browser. There are several aspects of the way in which the design and layout of people's devices (i.e. mobile phone, computer, tablet, etc.) reinforces the use of the current largest incumbent browsers (e.g. Chrome, Safari, Edge and Samsung[17]). Typically only one or two of these browsers come pre-installed on people's devices with one automatically set as the default. Many people stick with using a browser that is pre-installed and pre-set as their default browser.

For example, in the UK for Android users, Samsung Internet is pre-installed (alongside Chrome) and set as default on 58% of Android mobile devices, with roughly a quarter of Samsung users continuing with Samsung Internet as their default.[18] Almost all non-Samsung UK Android users have Chrome both pre-installed and set as the default - a result of agreements Google has with device manufacturers where it pays them to be pre-installed and placed in a prominent position. On iOS devices Apple's Safari is set as the default. Only a small proportion (around 10%) of users actively decide to install and use a different browser.[19] On desktop, for those using Windows operating systems, Edge is pre-installed and set automatically as the default. Some consumers may not understand what being set as default means, which browser has been set as their default or how they can change it. Regulators have also highlighted concerns about the complexity of the multi-stage process involved in changing the default browser.[20]

Pre-installation and default positions act as powerful mechanisms to direct people to using these browsers - and raise barriers for independent browsers to acquire new users and expand their market presence. Therefore Mozilla considers that regulatory interventions which tackle pre-installation and pre-set defaults could help to increase the number of people who consider or use different browsers and help make a step towards improving browser competition.

17 Market shares of browsers vary between countries and between operating systems - but these are typically the browsers with the largest market shares.

18 CMA Final report into mobile ecosystems, Appendix G - Pre-installation default settings and choice architecture for mobile browsers (publishing.service.gov.uk), paragraph 18

19 CMA Final report into mobile ecosystems, Appendix G - Pre-installation default settings and choice architecture for mobile browsers (publishing.service.gov.uk), paragraph 17

20 The CMA, for example, highlighted how changing the default browser settings can take around six steps on iPhones and around seven steps on Android devices. It concluded that 'the multiple steps and additional effort involved in this process could possibly dissuade users from changing default browser via device settings' and how limited technical abilities can be another deterrent - Appendix G - Pre-installation default settings and choice architecture for mobile browsers (publishing.service.gov.uk), paragraph 52.

The research set out in this report builds on previous Mozilla research — in particular previous research into browsers and operating systems as set out in the 'Five Walled Gardens' report[21] and more recently the in-depth qualitative research into browser choice design concepts[22] — exploring different ways to engage consumers in browser choices. This research paints a complex picture about people's perceptions and abilities to choose and change browsers. It also corroborates the findings of many regulators, that software can be designed in ways that strongly influence or even manipulate consumers, and that interventions reliant on consumer interaction need to be carefully designed and implemented with people's preferences and 'biases' in mind.[23]

Our research also illustrates that, while well-designed choice screens may be one tool to improve people's ability to actively choose and interact with their browser, the problem is undoubtedly more challenging. Mozilla recognises that re-engaging consumers in this area (particularly after such a long period) will be difficult and may well take time, though is not impossible. Beyond choice screens, it will also be important to consider further creative ways to engage with people to ensure they can meaningfully choose and control their software. The research set out in this report is a first important step on a longer journey to determine how and what other types of interventions can help to increase browser competition and re-empower consumers.

21 Mozilla 'Five Walled Gardens Report: Why Browsers are Essential to the Internet and How Operating Systems are Holding Them Back', September 2022 - Mozilla_Five-Walled-Gardens.pdf

22 Key findings included: 1) Timing and presentation can greatly influence people's likelihood of engagement with choice interventions. 2) When choice interventions highlight the pre-set browser, people are less likely to explore alternatives. 3) Choice interventions should enable people to make an informed choice by providing helpful information and context. See https://research.mozilla.org/browser-competition/remedyconcepts

23 The term 'bias' has been frequently used to date to describe behavioural effects, however such 'biases' may well be rational given the cost of complex decision-making for consumers - see Implementing the DMA: The Role of Behavioural Insights by Amelia Fletcher, Zita Vasas :: SSRN

03.

Outline of the experiment

We conducted the experiment within an online survey, which was delivered and coded using a survey software platform. Prior to launch, the survey underwent thorough quantitative and qualitative pilot testing to ensure that people understood the experiment and that the survey questions were clear, and we adjusted the survey accordingly.[24]

For the experiment, two panel providers helped us recruit 12,000 survey participants across Spain, Germany, and Poland. We received around 4,000 survey completes in each of these countries representing a broad range of age groups, regions, and a balance of genders.[25] The reason for analysing multiple countries was both to allow us to recruit enough participants and also to provide geographic variation within the EU — whose consumers will be affected by the new regulatory requirement. We aimed for the samples to be nationally representative but were not able to fully achieve this.[26] However, when reweighted to match national demographics, the results are similar to those presented in the main report without reweighting.

The survey was delivered in Spanish, German, or Polish and took approximately 16 minutes to complete on average. People were told that the survey was about better understanding how consumers use their smartphones and computers, and those who completed the survey received a payment equivalent to €2 on average.

24 The quantitative testing involved recruiting two waves of participants (1,000 and 500) to test the survey. After each wave, we recorded where people dropped out and any concerns they expressed, and adjusted the survey accordingly. The qualitative testing involved recruiting two waves of participants (20 and 10) to test the survey through unmoderated remote interviews. Participants were recorded speaking aloud about their experience as they completed the survey, providing us with in-depth feedback and allowing us to identify and address any concerns.

25 Please see Table 1.3 in Annex 1 for a full description of the demographic characteristics of the sample.

26 We recruited a large sample of people and the panel providers in some countries were unable to recruit-sufficient numbers of younger and older participants.

Upon entering the survey, people were asked to respond to five screening questions that captured information about their age, region of residence, gender, income, and education. Moreover, the survey automatically recorded the type of device that people were using to respond to the survey and screened out anyone who was not using a Windows computer or an Android smartphone. The goal was to ensure that the results of the experiment generalise as best as possible to people that use Windows/Android.

Next, we presented people with instructions explaining that they would be asked to set up a virtual device within the survey and that they could interact with the device in a realistic way. We highlighted that it was important to "pay as much attention, take as much time and exert as much effort as you would when setting up a new device in real life". We asked them to ensure that their "choices are reflective of what you would choose when setting up a new device for yourself". Then we explained that they would need to complete a task using the virtual device after completing the set-up process.

We also explained that people could interact with the device in a realistic way but that we had made some changes. Some buttons had to be disabled (e.g. transferring data from an old phone) and were greyed out, whenever they had to enter a password we would provide it to them (so we did not inadvertently receive potentially sensitive information), the terms and conditions that they would see would be non-binding and any options to change settings would not change the settings on their real device. These instructions assuaged initial concerns that some people expressed when we piloted the survey, but reassuringly this feedback also illustrated that the experiment looked highly realistic. After having read the instructions, people were asked to complete a comprehension test, which directly assessed whether they had understood the information that we presented to them. People could attempt to complete the comprehension test twice – those who failed the second time were screened out of the survey before they had entered the virtual device.[27] This comprehension check ensured that people taking the survey understood what was required of them and the implications of their choices in the experiment.

People who responded to the survey using a Windows computer were then taken to a setup journey for a Windows 11 HP desktop, and those who responded via an Android were taken to a setup journey for a Samsung Android 13 smartphone. The setup journeys were fully interactive and looked realistic — people could click different options and move back and forth between screens.[28] Please see Figures 1.1 and 1.2 in Annex 1 for the full Windows and Android journeys.

27 Those who failed the comprehension test could read the instructions again before re-attempting it.

28 Information was conveyed to people at some stages in the setup process through small pop-up boxes that were presented in the top left-hand side corner of the screen. The purpose of these boxes was, for example, to tell people which password to use when signing into their hypothetical Microsoft or Google accounts.

We automatically transitioned people to the 'home' screen of their device once they had completed the set-up process. Once on the home screen, we told people to click on the browser icon (which varied depending on their treatment group) and to navigate to a Wikipedia page containing geography trivia. Moreover, they were told that they should pay attention to the trivia as they would subsequently be asked to complete a quiz, and that those who performed well would be entered into a prize draw for €100.[29]

As people entered the setup journey, they were randomly allocated to five different experimental conditions. These conditions influenced the type of information that people were shown — and the decisions they were asked to make — as they set up their device. The five (equally sized) groups comprised one control group and four treatment groups.

The treatment groups differed on three dimensions:

- the amount of information provided (high or low);
- the number of browsers presented in the choice screen (12 or five); and
- when the choice screen was presented - on device first use (i.e., during set-up) or on the first use of the browser (i.e., after set-up when clicking on the pre-installed browser).

The experimental conditions are summarised in Table 1 below.

Table 1: Experimental conditions

Groups	Information	Number of browsers	Placement
Control Group	**N/A**	N/A	N/A
Treatment group 1	**Low:** Browser descriptions (revealed on clicking downwards arrow)	12	Device first use
Treatment group 2	**High:** Q&A screen, browser descriptions, star ratings, reviews	12	Device first use
Treatment group 3	**High:** Q&A screen, browser descriptions, star ratings, reviews	5	Device first use
Treatment group 4	**High:** Q&A screen, browser descriptions, star ratings, reviews	5	Browser first use

29 The motivation for including the trivia quiz was to create a state of mind among participants that more closely mirrors how people feel when they open a browser for the first time on their device. In reality, people are likely to have something in mind that they would like to do when they open their browser for the first time - the inclusion of the quiz is intended to replicate this feeling. It is important that participants' state of mind mirrors what it would be like when completing a similar task in real life, as this may influence how choice screens affect their decision making.

The groups are described below (all choice screens can be found in Figures 1.3 and 1.4, Annex 1).

The control group

These participants were not shown any choice screen and could not choose a default browser when setting up their device. This condition replicates the current status quo (i.e., people do not currently see a browser choice screen in real-life when setting up their device or when using their browser for the first time). They were assigned Microsoft Edge as their default browser if they set up a Windows device, or were assigned Samsung Internet as their default browser if they set up an Android device.

Treatment group 1 (low information, 12 browsers, displayed during device set-up)

Participants in this group were shown a browser choice screen midway through the device setup process.[30] The choice screen contained a list of the 12 most popular browsers in their country (i.e., in Spain, Germany, or Poland) for the device they were using (i.e., an Android smartphone or a Windows computer).[31] These browsers were placed in two strata: the five most popular browsers were in the top stratum (which occupied the top five spots in vertical descending order on the Android choice screen and the top horizontal row of the Windows choice screen and first left-hand slot on the second row)[32] and the remaining seven browsers were placed in the second stratum.

We randomised the order in which the browsers were presented within each stratum (as we did for the other treatments). Along with the name of each browser, people were shown the browsers' logos, and they could click on a small downwards-pointing arrow next to each browser to expand the content and reveal a brief description of that browser.[33] People could not continue to the next screen unless they chose a browser, and they could only select one. There was no indication of which browsers were pre-installed; instead people were informed that the chosen default browser would be downloaded for them if it was not

30 Careful consideration was given to what might be the most appropriate point to serve the browser choice screen. We considered that it would be most effective when served mid-way through the set up, before people might start to tire of the set-up process, and also not immediately after screens with prominent gatekeeper logos (such as the Google or Microsoft account screens).

31 These 12 browsers were selected based on desktop / mobile Statcounter shares for each country (using a 12-month average), but in the absence of share data, we then included browsers based on the number of Play Store downloads and where this was equal we based it on awareness rating data from ACCC/Mozilla research. Furthermore for desktop, we also only included browsers that have official Windows versions available for download. We recognise that Statcounter has limitations in accurately measuring browser market share and would recommend alternatives are considered for regulatory interventions.

32 The reason for this difference in design was due to the different size of the screens between a mobile device and the desktop. On desktop, we were unable to fit all five browsers on the top row without affecting their presentation, particularly in the treatments with more information displayed.

33 This description was taken from wording used to describe the browser in the Play Store.

already installed. Finally, people were also told that other browsers could be downloaded at any time. The choice screens shown to Windows and Android users assigned to Treatment group 1 are displayed below in Figures 3 and 4.

Figure 3: Windows choice screen for Treatment 1

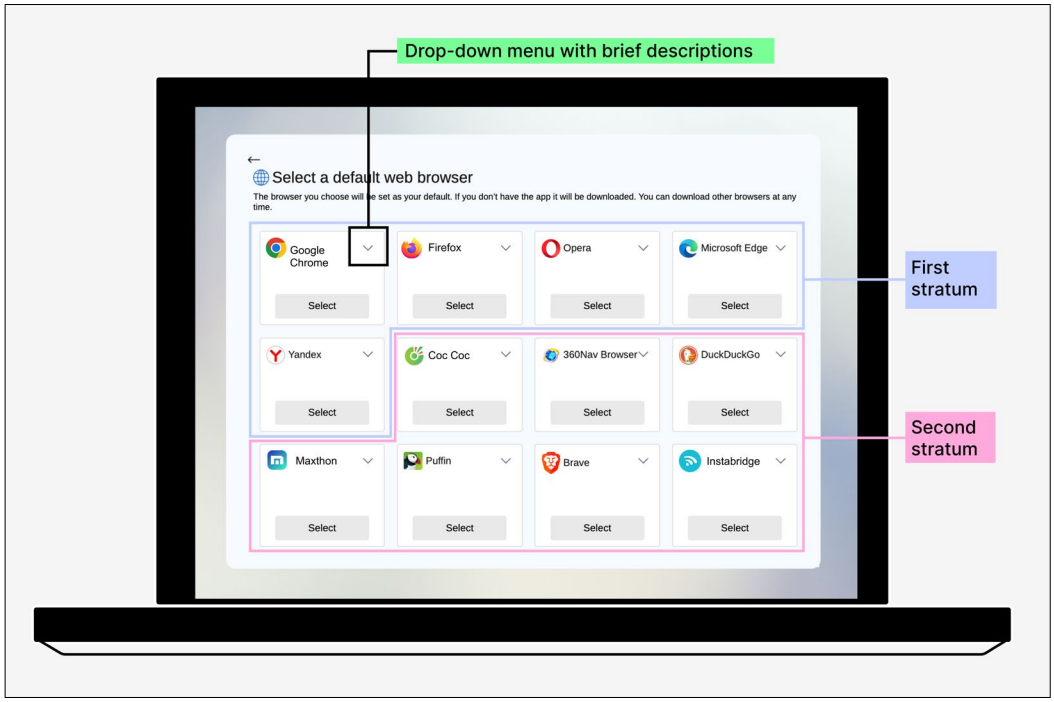
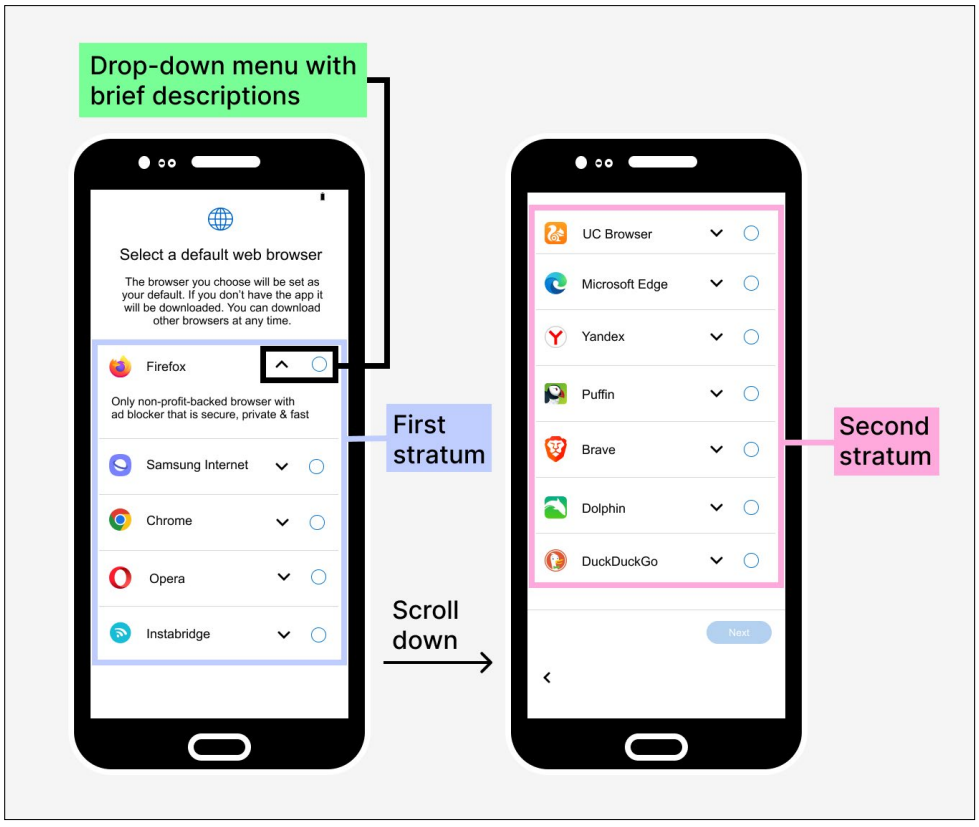


Figure 4: Android choice screen for Treatment 1



Treatment group 2 (high information, 12 browsers, displayed during device set-up)

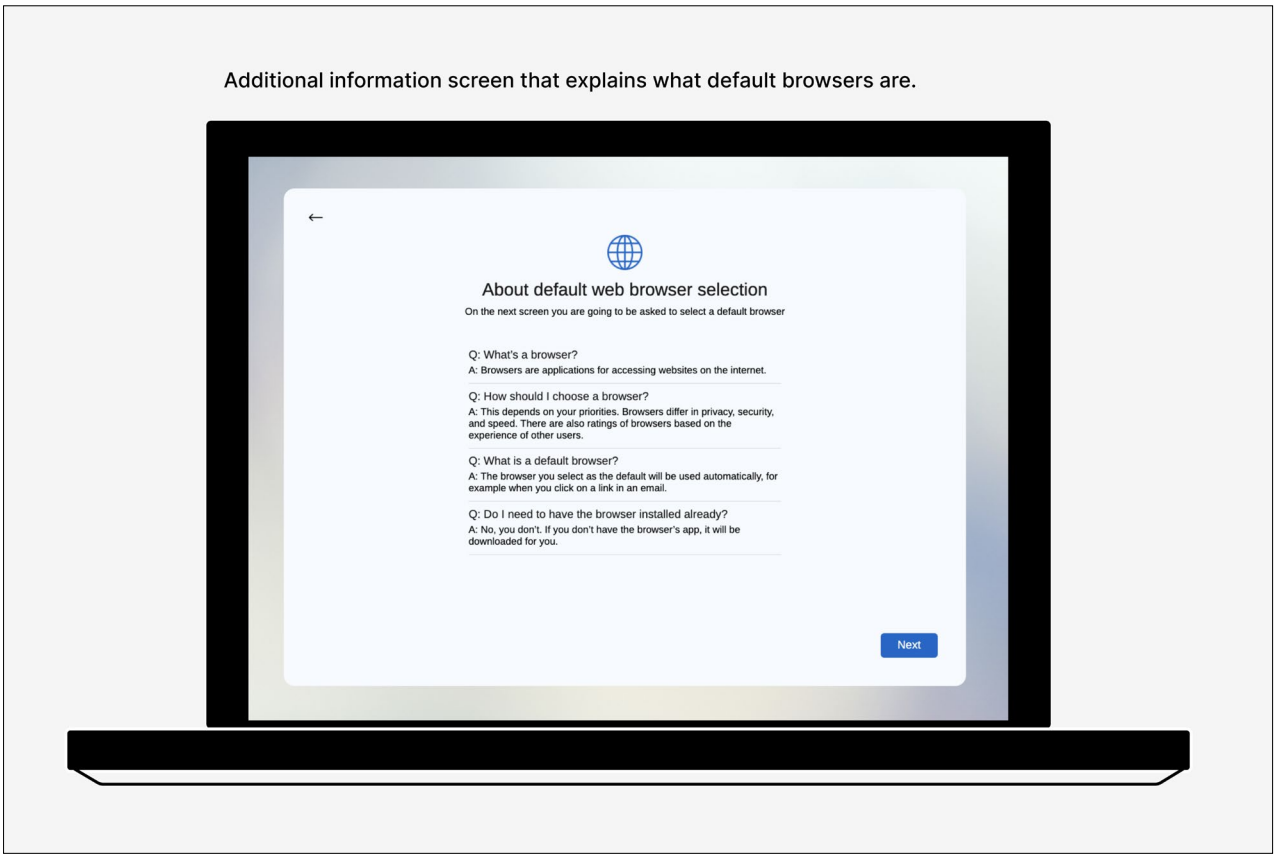
This group was shown the same choice screen as Treatment group 1, with two key differences. First, people were shown a 'Questions and Answers' (Q&A) information screen before being served the choice screen, which explained what a default browser is and what selecting a default browser entails.[34] Second, people did not need to click a downwards-facing arrow next to the browser to reveal the browser descriptions, which were displayed automatically; people were also shown the browsers' user ratings (in the form of a star rating on a scale from 1 to 5) as well as the number of user reviews that the browser had received.[35]

Figures 5 and 6 present the choice screens displayed to Windows and Android users assigned to Treatment group 2 - larger images are presented in the annex.

34 This information screen was designed to explain a number of key important concepts which many people lack understanding about, as seen in previous research, before asking people to make a selection. For example what a browser is, the types of differences between browsers, what happens when you select a default and the potential need to install the browser that was selected. On the main choice screen page we also added an additional reassurance that consumers could reverse their decision if needed.

35 The browser star ratings and number of reviews were taken from the Play Store.

Figure 5: Windows choice screen for Treatment 2



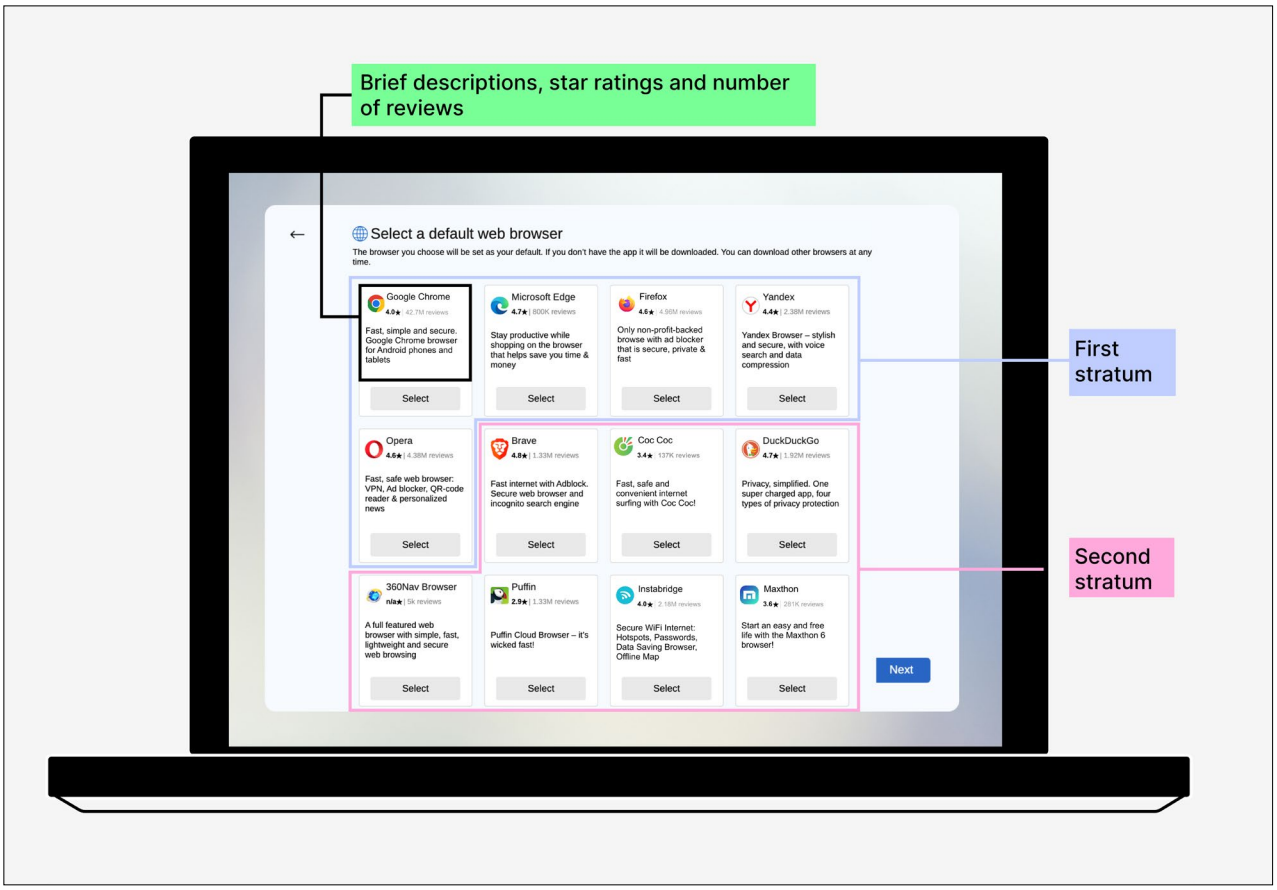
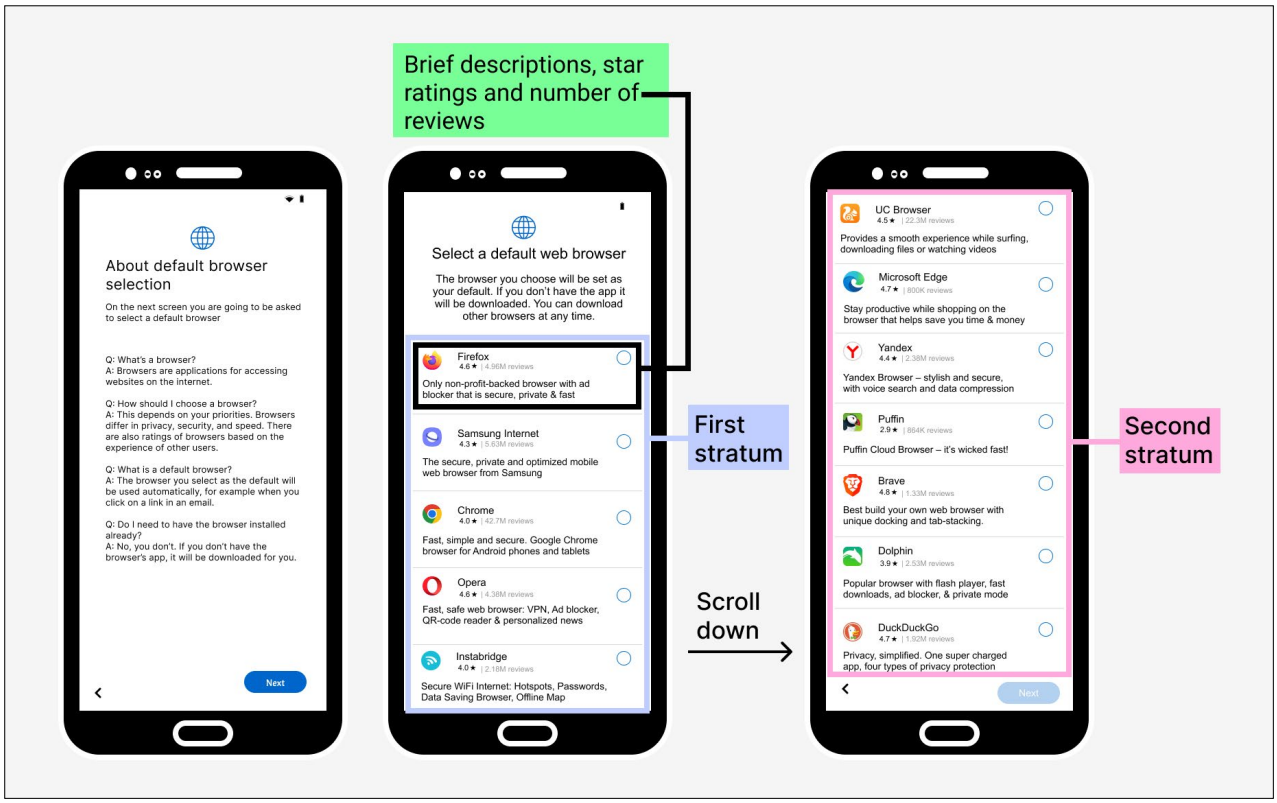


Figure 6: Android choice screen for Treatment 2

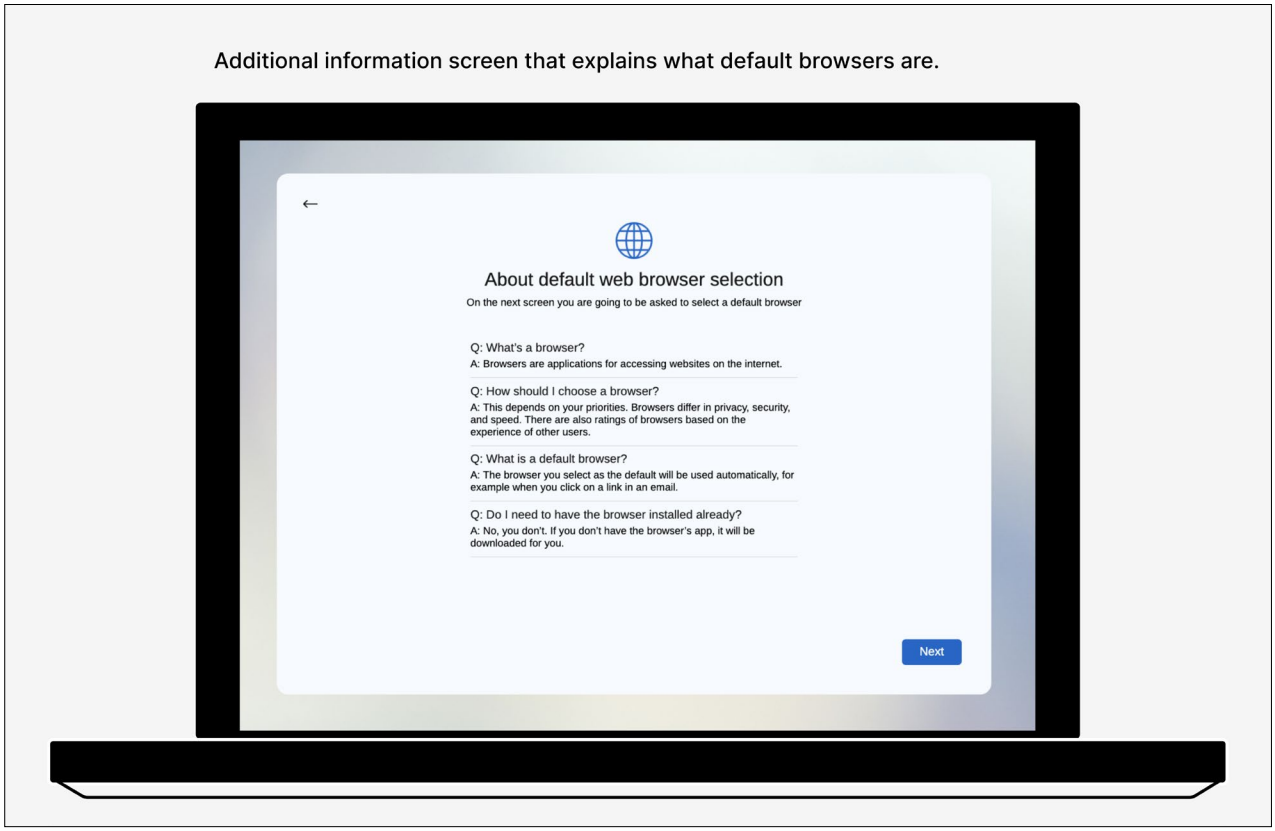


Treatment group 3 (high information, 5 browsers, displayed during device set-up)

People in this group were shown the same Q&A and choice screens as those in Treatment group 2, with the only difference being that they were presented with a list of five – rather than 12 – browsers. The five browsers that these people were shown were always the four most popular browsers for their device in their country, in addition to one randomly selected browser from the remaining list of the fifth to twelfth most popular browsers (i.e., browsers that were always displayed to those in Treatment groups 1 and 2). The order of the top four browsers was randomised, while the fifth (randomly selected) browser was always presented in fifth place.

Figures 7 and 8 present the choice screens displayed to Windows and Android users assigned to Treatment group 3.

Figure 7: Windows choice screen for Treatment 3



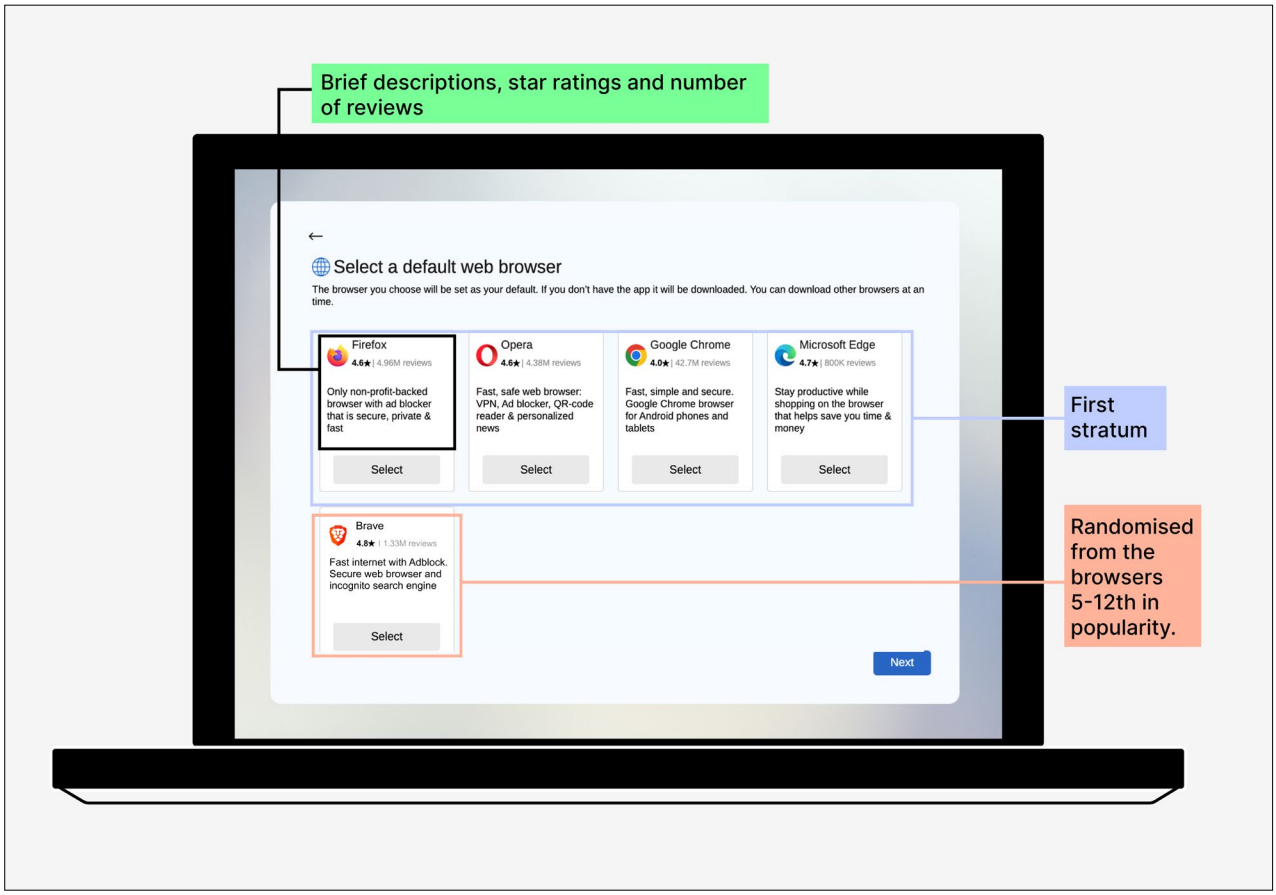
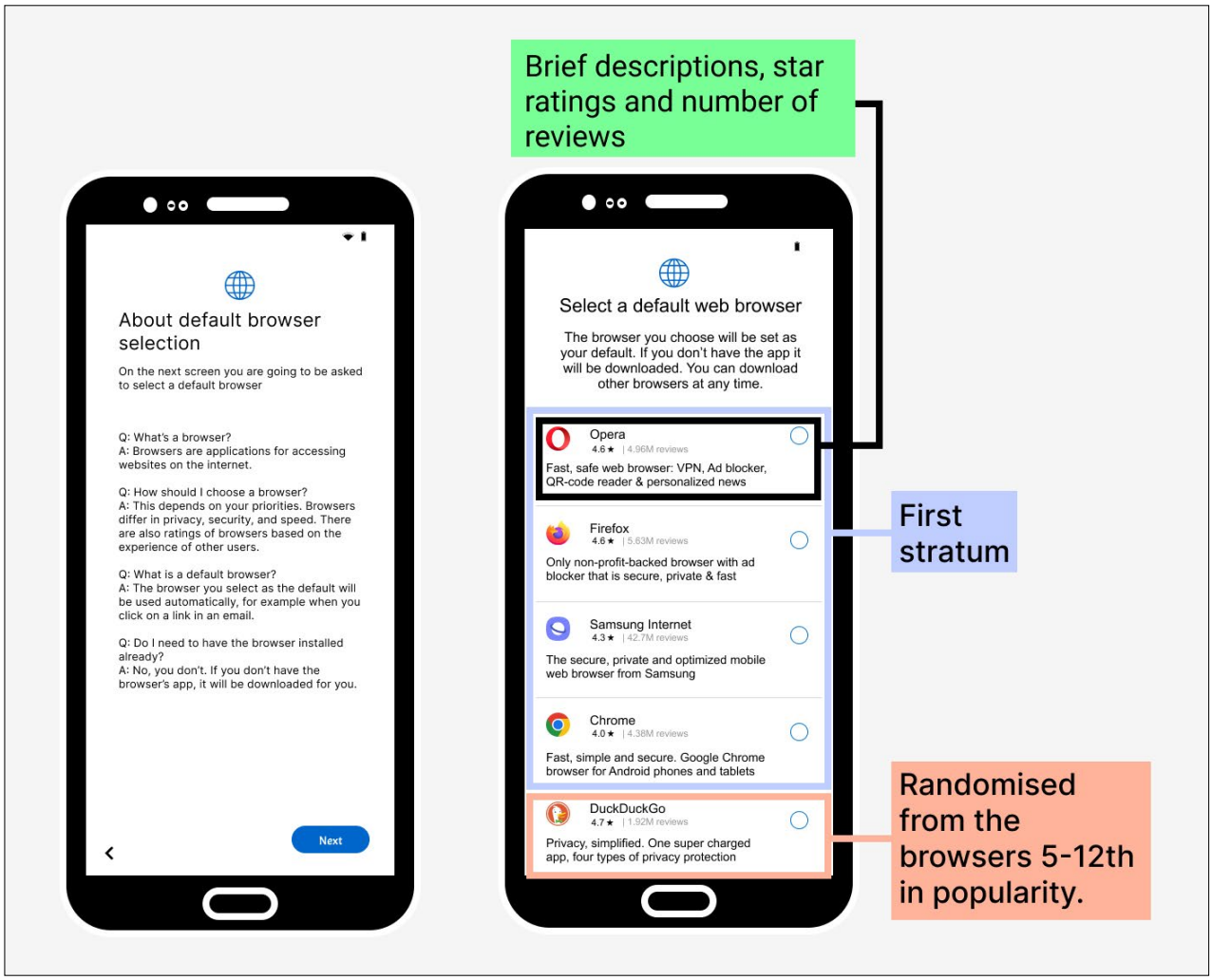


Figure 8: Android choice screen for Treatment 3



Treatment group 4 (high information, 5 browsers, displayed during first use of the browser)

People in Treatment group 4 were shown the exact same Q&A and choice screens as those in Treatment group 3. The only difference in the choice screens between the two groups was that those in Treatment group 4 were shown the screens after they had completed set up and when they clicked on the browser icon on their home screen, instead of being shown the screens while setting up their device. Because people in Treatment group 4 had not yet seen a choice screen, on the home page they were shown an icon for the pre-set default browser (i.e., Windows Edge or Samsung Internet). This differs from Treatment groups 1-3 who saw the browser that they had selected as their default on the home page.

These treatment groups were chosen in order to assess the impact of information on people's choices, how information interacts with the number of browsers people were shown, and the effects of showing the choice screen at different points. Previous studies have raised specific questions about what the 'ideal' number of browsers is for choice screens and how much information consumers should be given such that they make informed decisions without suffering from information overload. There are, however, other interesting aspects related to choice screens that we do not cover in this study, and which could be explored in future testing - for example the effect of indicating on the choice screen that some browsers were already installed and showing the choice screen at other points (e.g. first use of the app store on a device). Ultimately due to time and resource constraints and the sample size needed to conduct our analysis with sufficient statistical power, we were able to test four treatment groups.

One key benefit of conducting the experiment within an online survey — rather than in the field — is that we could ask people follow-up questions once they had completed the set-up process. More specifically, we asked people questions to assess:

- their degree of satisfaction with the setup process;
- the types of browsers they were familiar with and would consider using as their default browser; and
- the browser they would expect to have as their default if they continued using the device for another six months.

In addition, we asked people questions specifically about the browser choice screen:

- when (if at all) they would like to be shown a choice screen for default browsers; and
- when they would like this screen to be displayed (during device set-up, when the browser is used for the first time, or at some other point).

Finally, we asked a series of questions about their browser usage and defaults:

- the browsers people have used in the past;
- their prior familiarity with the concept of a 'default browser'; and
- whether they knew how to switch their default browser.

Please see Annex 3 for the survey questionnaire.[36]

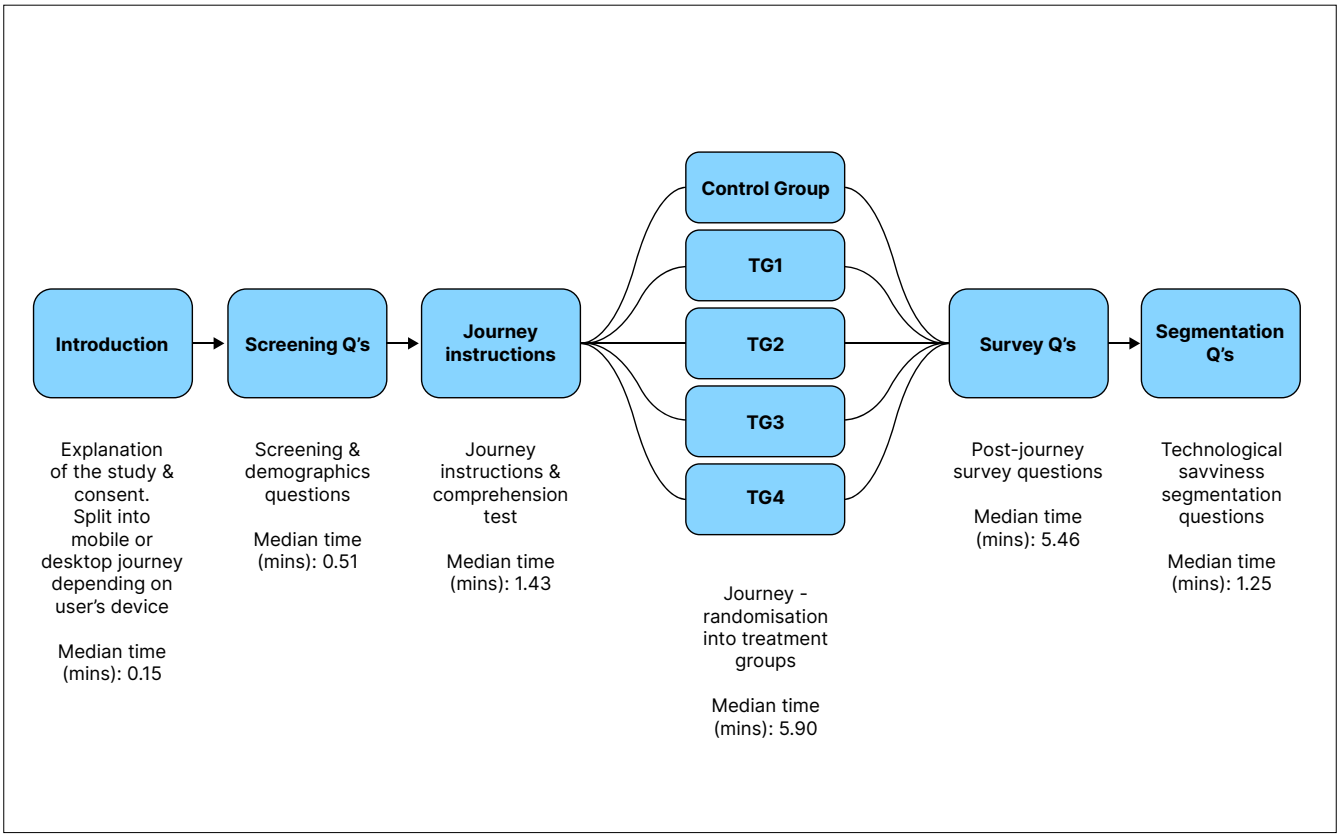
In addition, we passively recorded different types of data as people completed the survey. For example, we recorded the type of device and browser that people used to complete the survey. We also recorded how long people spent on each part of the survey and set-up

36 Responses to survey questions were incentivised (i.e., people were entered into prize draws if they responded correctly) where possible to improve the quality of the data.

journey, and what they clicked on when they were setting up their device (e.g., if they chose to connect to the Wi-Fi network we provided or not).

The survey flow, and the time that it took for people to complete each component of the survey, is displayed in Figure 9 below.

Figure 9: Survey flow



Notes: This figure shows the different stages of the survey and presents the median time spent on each stage.

04.

Results from the experiment

This section presents the findings from the experiment.[37] Accompanying tables and figures are set out fully in Annex 2. Throughout this section we, for example, use 'T1' as shorthand for "Treatment group 1". Throughout, when we refer to 'pre-set' browsers we mean Samsung Internet if the person was setting up a Samsung Android device, and Microsoft Edge if setting up a Windows HP device (as these are the pre-set default browsers that people using these devices are automatically given when they set these types of devices up in real life). As noted previously, Chrome is generally pre-installed on Android devices and set as default on some non-Samsung devices.

Choice screens lead people to select a default browser they expect to remain with

We first look at whether being shown a choice screen has any benefits compared with not being shown a choice screen at all.

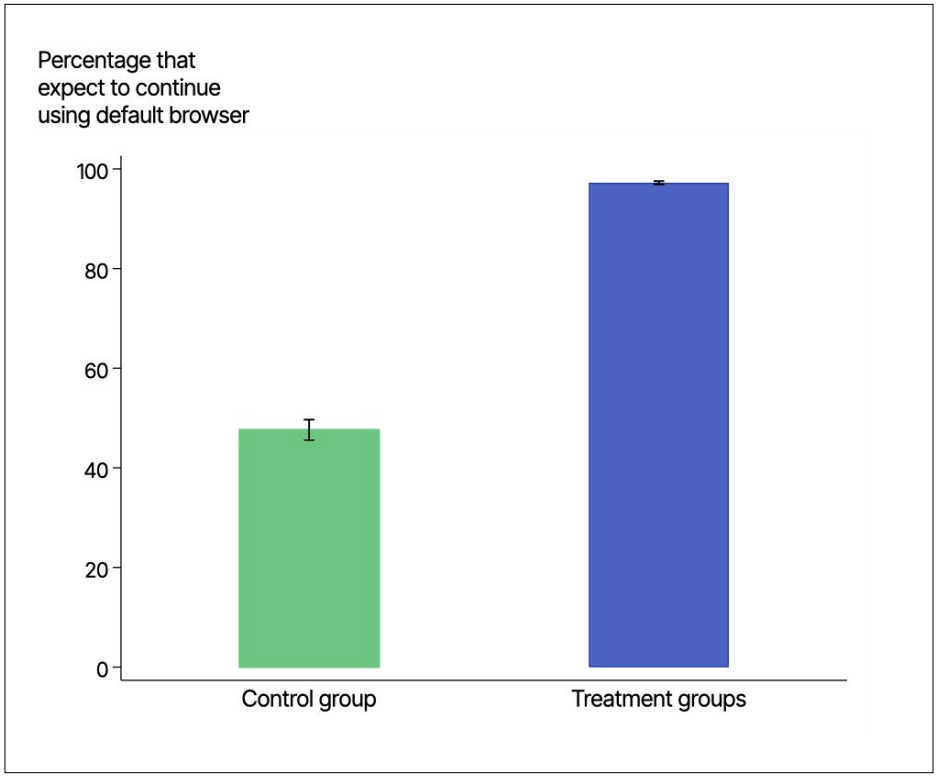
We test this by seeing if being served a choice screen influences people's expectations regarding whether they would continue using their default browser if they continue using the device for six months, comparing the control group to the treatment groups (i.e those who did not receive a choice screen against those who did). For the treatment groups the default is the browser they chose in the choice screen and for the control group this is the pre-set

37 The experiment and the main analyses were pre-registered with the American Economic Association: https://www.socialscienceregistry.org/trials/11870

default (Samsung Internet/Edge). For those that say they do not expect to continue using the browser as their default, we asked them which browser they would switch to, as well as how confident they were that they would do so. The purpose of asking these questions is to provide evidence to indicate whether defaults and choice screens are likely to have ongoing effects on choice and to see if choice screens enable better matching of the browser that people say they would continue to use, compared to the pre-set default given to people.

The results are set out in Figure 10 below which compares the percentage of people who expect to continue using their default browser after six months for those in the control group in comparison with those in all of the treatment groups.

Figure 10: Percentage who expect to continue using their default for 6 months



Notes: This figure presents the percentage who answered 'yes' to a question in the survey regarding whether they would keep the default browser they chose (or were provided with in the control group) after six months if they were still using the same device. The figure presents the share that expects to continue using their default browser from the control group and from all four treatment groups. The black vertical lines on top of the bars show the 95% confidence interval. It is based on the total number of observations: 12,060.

Over 98% of people assigned to the treatment groups expected to remain with the browser that they chose as they set up their device.[38] Whereas **just over half of people in the control group (51%) expected to switch away from the pre-set default** browser after 6 months.

Another way to interpret these results is that 49% of the control group expected to stay with the default that had been pre-set for them; even though the majority of those people (approximately 80%), if they actively made a choice, would not select that browser.

Moreover, around 29% of those in the control group who said they would switch browsers stated that they are uncomfortable switching the default, while 19% of those in the control group who said they expected to switch the default were not confident that they would actually end up making the switch away from the pre-set browser. This shows that of those in the control who would want to switch their default browser, a sizeable proportion would either be uncomfortable doing so or were not confident they would do so.

Taken together, these results suggest that well-designed choice screens are an effective way to match people with the default browser that they intend to use in the longer-term — especially for those who do not know how to or may otherwise struggle to switch default browser. Furthermore, it suggests that the pre-installed default may not serve the needs or preferences of many people.

Our results show that the 51% in the control group who expect to switch away from the pre-set browser (Samsung Internet/Edge) they were given, have very similar preferences over browsers to the 87% in the treatment groups who actively choose a browser that is not Samsung Internet or Edge (e.g., around 60% choosing Chrome). This means that the increase in the share of Samsung Internet/Edge seen in the control group, corresponds to a decrease in the share of all other browsers, including independent browsers. **People in the treatment groups (who received choice screens) were 13% less likely to expect to be using an incumbent browser after 6 months than the control.**

It is perhaps surprising that we find such large differences between the treatment and the control groups, as one might expect people to exhibit some degree of optimism bias (i.e., a tendency to believe that they would switch, even though they may not have the time or capacity to do so in real life). But clearly there will be a variety of factors that influence how people answer this question.

38 Those in T4 were about twice as likely to say that they would switch away from the browser they chose than those in T1-3, suggesting that this treatment matched some people with browsers that they did not actually want to use.

The fact that a large percentage of people expect to continue using the pre-set default browser reflects what we know about real markets. For example, approximately 90% Apple phone users use Safari and approximately 25% of Samsung phone users use Samsung Internet.[39]

Overall, the finding of large default effects in browsers is in line with a wide range of other research that suggests that defaults can have sizable, persistent effects.[40] People have limited attention and may not change their default, they are impacted by status quo effects and more. And existing evidence also shows that default effects (and pre-installation) strongly affect browser choice.[41]

While it was not part of our experiment, we would expect that pre-installed browsers (installed on devices but not pre-set as the default - such as Chrome on Samsung devices), would also have their shares artificially inflated because they are more readily accessible than other browsers.

People served a choice screen are more likely to select a default browser that they expect to remain with than people who were given a pre-set default

- **Over 98% of people in the treatment groups expected to remain with the browser that they chose** - showing that well-designed choice screens enable people to select their preferred long-term browser.
- **Around half of people in the control group expected to switch away from the pre-set default browser** - showing that for many people the pre-set browser may not be the browser they would choose.

39 CMA Final report into mobile ecosystems, Appendix G - Pre-installation default settings and choice architecture for mobile browsers (publishing.service.gov.uk), paragraphs 17 and 18

40 For example see Jachimowicz, J. M., Duncan, S., Weber, E. U., & Johnson, E. J. (2019). When and why defaults influence decisions: A meta-analysis of default effects. Behavioral Public Policy, 3, 159–186. http://doi.org/10.1017/bpp.2018.43

41 CMA's Final Report into mobile ecosystems, Final report (publishing.service.gov.uk), June 2022.

Content and placement influence choice of default browser

We begin by examining whether each of the differently designed choice screens that people were shown during set-up and at first browser use, influence their selection of default browsers. These analyses necessarily do not include comparisons with those in the control group, as they were unable to choose a default browser. Therefore all the analyses in this subsection compare the results across different treatment groups only.

Our analysis as set out in Table 2 below, shows that Chrome was the most popular browser across all treatment groups, with around 62% of people choosing Chrome in T1 (low information group).[42] Firefox was the second most popular browser, with 20% of people in T1 selecting it as their default. The third-most popular option - with 11% choosing it in T1 - was one of the pre-set default browsers (i.e., Edge if on Windows and Samsung Internet if on Android). Finally in T1, around 3.2% chose Opera, 1.4% selected Brave and 1.3% selected DuckDuckGo, while the remaining browsers were each selected by less than 1% of respondents in this group.

When testing whether the entire distribution of browsers chosen by people differs by treatment group, we find **statistically significant differences between all treatment conditions** ($p < 0.001$), with the exception of T1 relative to T2 (high information group) (the p-value of this test is 0.22). This shows that the design of choice screens matter, as they influence users' choices.

Table 2 summarises the effects of treatment assignment on the default browser that people chose. Each row represents the share of people that chose a particular browser in the respective treatment conditions. The final row indicates whether there is a statistically significant difference in the share that picked a particular browser across all treatment groups.[43]

42 The default browsers that people chose (aggregated across device and country) can be found in Table 2.1 in Annex 2.

43 This is an F-test which tests the null hypotheses that the share that chose a given browser is the same in all treatment conditions, and p-values below 0.05 are typically considered significant, meaning that there are significant differences across the treatment groups for all browsers except Firefox.

Table 2: Browser choice by treatment condition

Browser chosen	T1: Low info/ 12 browsers/ set-up	T2: High info/ 12 browsers/ set-up	T3: High info/ 5 browsers/ set-up	T4: High info/ 5 browsers/ first browser use	P-value
Pre-set browser (Samsung Internet /Windows Edge)	11%	11%	11%	19%	0.000
Chrome	62%	59%	60%	54%	0.000
Firefox	20%	20%	22%	20%	0.298
Opera	3.2%	4.4%	5.1%	4.9%	0.005
5th place browser	0.3%	0.2%	0.1%	0.0%	0.036
Bottom 7 browser	4.6%	5.3%	1.6%	1%	0.000
Observations	2372	2447	2371	2325	

Notes: This table presents the share of people that chose different browsers in treatment groups 1-4 in columns 2-5. Column 5 presents the p-value from an F-test of joint orthogonality across all four treatment groups (i.e., testing whether the share that chose a particular browser differs across groups) for a particular browser. Choosing a pre-set browser is defined as choosing Samsung Internet if the respondent used Android, or Microsoft Edge if the respondent used Windows. The 5th place browser is defined as the respondent choosing the browser that had the 5th largest market share in their country and for their device. Choosing a bottom 7 browser is defined as choosing one of the browsers with the 6th to 12th largest market share in the respondent's country and for their specific device.

We now compare the results of T1 (low information) with T2 (high information). Relative to T1, **those in T2 were 1.2 percentage points more likely to choose Opera (p = 0.028), 0.7 percentage points more likely to choose Brave (p = 0.066), 2.6 percentage points less likely to choose Google Chrome (p = 0.070),** while other browsers were chosen at a similar rate. Presenting an extra Q&A screen ahead of the choice screen, along with additional information (such as star ratings) on the choice screen itself, decreased the share that chose a browser from a gatekeeper (Chrome, Samsung Internet or Edge) from 72.9% to 70.1%. Or another way to look at it is that **T2 increased the share who chose a highly rated browser (Opera or Brave, with ratings of 4.6 and 4.8 respectively) at the expense of a lower rated browser (Chrome, with a rating of 4.0)**, while not otherwise significantly affecting people's choices. Indeed, when conducting regression analyses, we find evi-

dence suggesting that those in T2, on average, chose a browser with a 0.0171 higher rating than those in T1 ($p < 0.1$).[44]

When comparing the results of T2 to T3 (fewer browsers), we find that those assigned to T3 were significantly less likely than those in T2 to choose one of the eight browsers with lower market share. This is unsurprising as those in T3 were shown these browsers far less frequently - those in T3 only saw five browsers, of which only one was a browser with lower market share selected at random, with the other four being Chrome, Samsung Internet/ Edge, Firefox, and Opera. We do not otherwise find any meaningful differences between those in T2 and T3.

People assigned to T4 (i.e. T3 but displayed at first use of the browser) made drastically different choices from those assigned to any other treatment condition**.** For example, they were 6.1 percentage points less likely to choose Chrome than those allocated to T3 ($p < 0.001$) — in this experiment Samsung Internet/Edge (rather than Chrome) were the pre-set default browser on our Android/Windows experiments for T4. **Those in T4 were also around 8.2 percentage points more likely to choose the pre-set browser, than those in T3 ($p < 0.001$), which represents a 73% increase in the share who chose the pre-set browser.** It therefore appears that showing the choice screen when the browser is used for the first time - as opposed to during device set up - shifts users from Chrome to the pre-set browser. One explanation for this effect is that people in T4 had to click on the icon for the pre-set browser when opening their browser for the first time (i.e. just before being presented with a choice screen to select their default browser), while people in other treatment groups were not similarly 'nudged' (they selected their default browser earlier in the set-up process before any pre-set default browser logo was shown).

Next, we analyse people's choices disaggregated by device and country.[45] There are large differences in the share who chose different browsers across device and country. For example, while 69% of people who used a Windows device in Spain chose Chrome, only 39% of people who used a Windows device in Germany did the same. **While there is some variation between countries and devices in terms of the magnitudes of the differences between treatment conditions, we generally find that the effects go in the same direction** across all sub-populations. For example, Windows users in Germany assigned T1 are 2.1 percentage points more likely to choose Chrome than those assigned to T2; similarly, Windows users in Poland assigned to T1 are 3.7 percentage points more likely to choose Chrome than those assigned to T2.

44 See Table 19 in Annex 2. Note that the effect of being assigned to T2 on the rating of the chosen browser is averaged over the entire sample, while the treatment only shifted the choices of a few percent of people. Thus, those who changed their default browser as a result of being assigned to T2, on average, experienced a far greater increase in the star rating of their chosen browser.

45 These results are presented in Tables 2.3 to 2.8 in Annex 2.

In addition to examining how the treatments influence choices for different devices in different countries, we study how choices vary by other characteristics of people. More specifically, we look at browser choices for the following subsets of people:

- those who had never changed their default browser before;
- those who had changed their default browser before;
- those who had never downloaded and installed a browser before;
- those who had downloaded and installed a browser before; and
- those who said that they were "very uncomfortable" or "somewhat uncomfortable" when answering a question about their ability to change their default browser before taking the survey.

Much like when we disaggregate the results by device and country, we also find qualitatively similar treatment effects across these groups.[46]

Finally, we conducted several robustness checks in order to study the validity of the results presented above. More specifically, we re-ran the analyses excluding those who claimed that the effort they exerted during the device set-up process was unreflective of the amount of time they would have spent in real life; those who failed an attention check; and those who failed the pre-set-up comprehension test the first time they attempted it. These tests show that the findings do not qualitatively (or significantly) change as a result of excluding potentially inattentive people. We also compared treatment effects on browser choice for those who took below or above the median time to complete the part of the set-up that came before they were randomised into treatment groups, and do not find that treatment effects differ in a meaningful way across these groups, suggesting that our results generalise to those who spend more or less time on the set-up process (and perhaps pay more or less attention).[47] [48]

46 These tests can be found in Tables 2.9 to 2.13 in Annex 2.
47 These tests can be found in Tables 2.14 to 2.17 in Annex 2.
48 Additional analyses show that people in T1-3 were - relative to the control group - about 75 percentage points more likely to state that they chose the same browser that they would have chosen for their actual device in real life. Those in T4 were 70 percentage points more likely to state the same than those in the control group. Moreover, while we do not find meaningful differences in the share that chose the same browser that they use on their current real-life device between T1-3, we find that a lower share chose a browser they already have/use in T4 (about 60% chose a browser that they currently have/use across the treatment groups).

The content and placement of choice screens influence people's choices

- **The treatment groups affect consumer choice differently.** There are significant differences between all treatment conditions ($p < 0.001$), with the exception of T1 relative to T2 - showing the design of each influenced choice.
- **Those in T2 were more likely to choose Opera and Brave** (1.2 percentage points and 0.7 percentage points respectively) than T1 - both are highly rated browsers. The share that chose an incumbent also decreases from T1 to T2 (from 73% to 70%). Greater information appeared to have an impact on browser choice.
- **Those in T4 were much more likely to choose the pre-set browser** (Samsung/Edge) than in T3 (73% increase) - showing that serving a choice screen at browser first use results in many more people picking the pre-set browser they had just clicked on.

The order of browsers affects choice of default browser

In addition to varying the content and placement of choice screens, we also randomised the order in which browsers were presented in the choice screens (please see the description of the treatment conditions in the section 'Overview of the experiment' which explains how this was randomised). This allows us to test if there were any ordering effects, i.e. whether there are any differences in the likelihood of being selected when the browsers were displayed in first, second, third or fourth position on the screens.

All people who were assigned to a treatment condition were shown Chrome, Samsung Internet/Edge, Firefox, and Opera on the first page of the choice screen, but the order of these browsers was always randomised. Those in T1/T2 also saw a fifth browser from the top five (randomised). Whereas those allocated to T3 and T4 were shown a fifth randomly selected browser from the list of eight browsers with lower market share - and this fifth browser was

always shown after the aforementioned four browsers. Those allocated to T1 and T2 were also shown seven other browsers with lower market share (with a total of 12 browsers) further down on the choice screen, the order of which we also internally randomised.[49]

To study the effect of ordering on browser choice, we initially limit our attention to the four top browsers (i.e. Chrome, Samsung Internet/Edge, Firefox, and Opera) and measure the effects of these browsers being placed first, second, third, or fourth on the likelihood that they were chosen. This analysis allows us to use a sample of people drawn from all four treatment conditions.[50]

Almost two-thirds (around 63%) of people chose Chrome when it was presented at the top of the screen. There was a small (1.3 percentage point) negative albeit statistically insignificant effect of Chrome being placed second on the share that chose the browser. However, **the share that chose Chrome went down by 4.7 percentage points ($p < 0.01$) when it was placed third relative to when it was placed first, and the share went down by an even more significant drop of 7.1 percentage points ($p < 0.01$) when it was placed fourth** (relative to first).

There are also sizeable ordering effects for the pre-set browser. About 17% of people chose a pre-set default browser (Samsung/Edge) when it was ranked first. However, when it was ranked second, the share that picked this type of browser went down by 4.0 percentage points ($p < 0.01$). The share that picked a pre-set browser went down even further when it was ranked third (a drop of 5.3 percentage points, $p < 0.01$) or fourth (6.3 percentage points, $p < 0.01$).

Next, we examine the effects of ordering on **Firefox and Opera, where the share decreased but not by as much**. Around 23% of people chose Firefox when it was ranked first. We find that the share that chose Firefox went down by 3.3 percentage points when it was ranked second ($p < 0.01$) relative to first, 3.3 percentage points ($p < 0.01$) when it was ranked third relative to first, and 3.8 percentage points ($p < 0.01$) when it was ranked fourth relative to being ranked first. Finally, we find that around 5.2% of people chose Opera when it was placed at the top of the choice screen. The share that picked this browser did not significantly change when it was ranked second or third, but we find that people were around 1.3 percentage points less likely to choose Opera when it was ranked fourth relative to first ($p < 0.05$).

Rather than looking at the absolute percentage point fall in people choosing a particular browser, we can consider the relative percentage drop in the share that picked a browser

49 Those in T1 and T2 were also presented with one more browser that was placed in the top 5 stratum (i.e., a browser that was randomly placed first , second, third, fourth, or fifth). This browser was always the 5th most popular browser for their device in the country that they were in.

50 The results are presented in Table 2.23 in Annex 2.

when it was fourth relative to when it was first. Comparing being ranked first to being ranked fourth, **while the absolute drop was highest for Chrome, the relative drop (a 11% reduction) was the lowest. This compares to relative drops for Samsung Internet/Edge, Opera and Firefox of 38%, 26% and 16% respectively**. In other words, Samsung Internet and Edge suffer the largest relative reductions in choice as a result of moving down the rankings.

To summarise, we saw that people were less likely to choose Chrome when it was ranked third or fourth. They were also far less likely to choose Samsung Internet or Edge when they were ranked third or fourth. While the absolute fall is particularly large for Chrome, the relative drop is not as large. The share that chose the pre-set browser went down significantly for each one-rank drop. Notably the relative drop is also particularly large for pre-set browsers, with over a third fewer choosing these browsers when they are ranked fourth relative to first. The share that chose Firefox went down by about as much when it was placed second, third, or fourth relative to first - what seems to matter here is primarily the fact that it was not ranked first. The absolute fall and relative drop for Firefox are both medium-sized. Opera, being much smaller in share, has a smaller absolute fall but its relative drop is, however, medium-sized.[51]

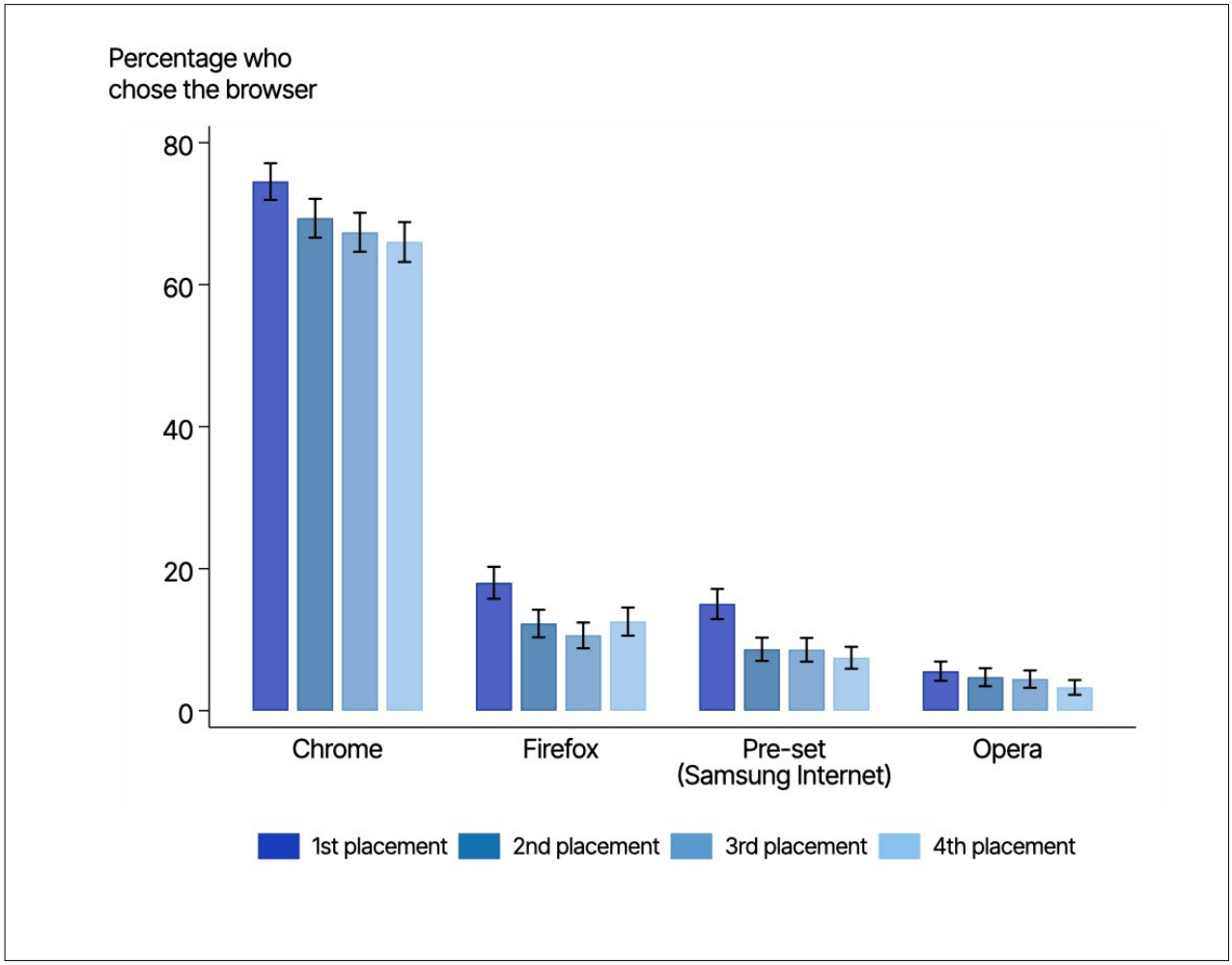
We also looked at whether there were any differences in the ordering effects if examining the Android and Windows results separately - where the design of the choice screens differed. In the Android choice screens browsers were displayed vertically beneath one another in a list-format (with the first five on the front screen and the next seven displayed if you scrolled down the screen). Whereas in the Windows screens, the browsers were presented in horizontal rows - T1 and T2 saw three rows of four browsers, and T3 and T4 saw one row of four browsers with one browser in the row beneath. See Figures 3-8 above for illustrations of how the choice screens looked for these devices.

We wanted to explore whether the order of the browsers matters more for Android than Windows, as moving a browser from first to fourth involves the browser being placed further down on the screen, while moving the browser from first to fourth in the Windows screens involves moving the browser from the left to the right-hand-side on the same row. The results of this analysis are set out in Figures 11-12 below and reveal that this is indeed the case.[52]

51 We also study the effects of ordering for browsers in the top five for people allocated to treatments 1 and 2, and the effect of ordering for browsers in the bottom 7 (again for treatments 1 and 2). These results are presented in Tables 2.24 and 2.25 in Annex 2. These analyses, amongst other things, suggest that ordering also matters for browsers placed in the bottom seven (e.g., it is generally better for the browser to be sixth than seventh). Finally, we re-ran the same analysis but using people's expected choice of default browser after six months as our outcome (see Tables 2.28 and 2.29 in Annex 2). These analyses produce qualitatively (and quantitatively) similar effects as those conducted with data on the default browser chosen during set-up.

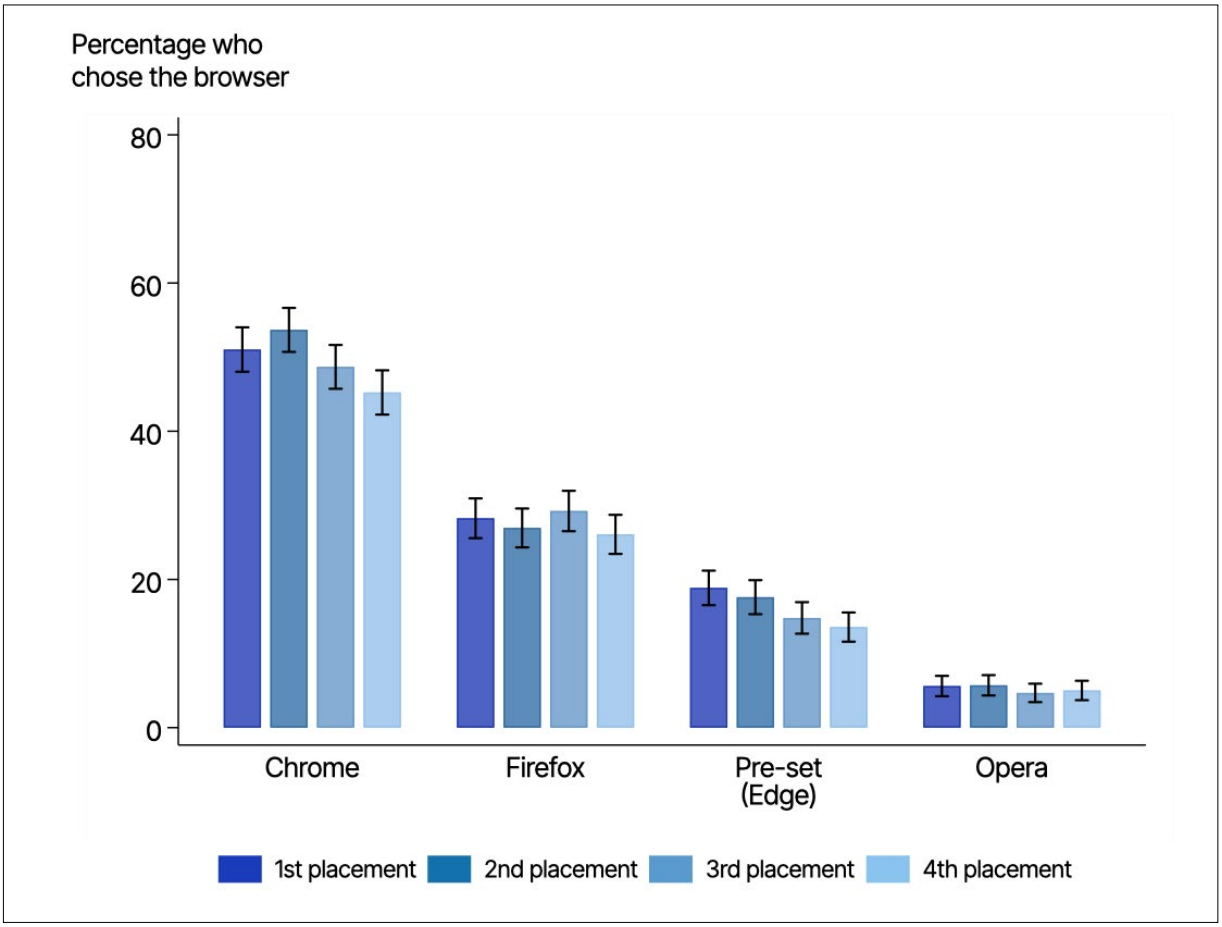
52 These results are also presented in Tables 2.26 and 2.27 in Annex 2.

Figure 11: The effect of order on browser choice for Android users



Notes: This figure presents the percentage who chose a particular browser when that browser was ranked first, second, third or fourth on the choice screen. The black vertical lines on top of the bars show the 95% confidence interval. This figure only includes people that saw the respective browsers listed in the top 4 on their choice screen from treatment groups 1-4 for Android users.

Figure 12: The effect of order on browser choice for Windows users



Notes: This figure presents the percentage who chose a particular browser when that browser was ranked first, second, third or fourth on the choice screen. The black vertical lines on top of the bars show the 95% confidence interval. This figure only includes people that saw the respective browsers listed in the top 4 on their choice screen from treatment groups 1-4 for Windows users.

On Android, the figures above broadly show the share of each browser being selected dropping as the browser is moved down from first through to fourth (with the exception of Firefox in the fourth position). Samsung Internet shows a particularly strong fall, from 15% when ranked first to 7.5% when ranked fourth, a relative drop of 50%, i.e., halving its market share.

By contrast, for Windows the results are much more mixed. For example, the results show that being placed first to fourth has no significant effect on the share of Windows users that chose Firefox or Opera but it does for Android users. The share of Windows users that chose Chrome only significantly decreased when Chrome was placed fourth (i.e in the far right position on the screen) relative to when it was placed first. The effects of ordering are much lower for Edge on Windows than Samsung Internet on Android. Edge falls from 19%

when ranked first to 14% when ranked fourth, a relative drop of 28%. In summary, while browsers suffer more from being moved down a vertical list, we also find some impact from being moved from left to right in a horizontal list - but this effect is smaller.

The ordering of browsers on the choice screen strongly affect the choices that people make, particularly comparing the first and the fourth position

- **Browsers positioned from first to fourth decreases likelihood of people picking that browser by several percentage points** - showing the importance of being positioned in the first top slot on the screen
- **The absolute drop was highest for Chrome (7.1 percentage points from first to fourth)** but its relative drop was the lowest (falling by 11%). Whereas **the pre-set browsers Samsung Internet/Edge had an absolute drop of 6 percentage points from first to fourth, but had the highest relative drop (falling by 38%)** - showing that pre-set browsers suffered most from the ordering effects.
- **Independent browsers Firefox and Opera also fell when moving from first to fourth but not by as much** (3.8 and 1.3 percentage points) and relative drops of 16% and 26% - showing they are less affected by ordering than the incumbents.
- **The ordering effects are stronger on Android than on Windows** e.g. the share of users that chose Chrome only significantly decreased on Windows when it was placed fourth (far right) relative to other positions and there were no significant effects for Firefox or Opera - showing that the order matters more when a list is displayed vertically than horizontally.

People want informative choice screens with more browsers during device set-up

After having set up their virtual devices, all people were asked when they think default browser choice screens should be displayed (if at all) and what type of default choice screen they prefer.[53]

53 Table 2.32 in Annex 2 presents people's responses to these questions, in addition to differences in responses between the control and treatment groups.

Rather than describe the different types of choice screens, we simply showed people the three different choice screens (i.e. less information, more information, fewer browsers), in order to obtain a more accurate measurement of participants' preferences. Aggregated results across the entire sample are presented in Table 3.

Table 3: People's preferences regarding the placement and type of choice screen

Preferences	Share of people
When should the choice screen be presented?	
Choice screen at set-up	65%
Choice screen at first browser use	33%
Choice screen at other time	1%
No choice screen at all	2%
What type of choice screen should be presented?	
Choice screen with 12 browsers/low information	20%
Choice screen with 12 browsers/high information	44%
Choice screen with 5 browsers/high information	26%
Any type of choice screen	10%

Notes: This table presents people's preferences regarding when choice screens should be presented and what information they should contain. It is based on observations from all participants (control and all treatment conditions) i.e, 12,060.

First, we find that the vast majority of people want to be presented with a choice screen. For example, **97-98% of those allocated to either the control group or the treatment groups want to be shown a choice screen**.

Second, the **majority of people - across all conditions - want the choice screen to be presented during device set-up** as opposed to when the browser is used for the first time or at some other point. Moreover, those who were shown a choice screen (T1-4) were more likely to want the choice screen to be presented during device set-up (including those in T4, who

saw the choice screen when they used their browser for the first time) than those who were not. While 53% in the control group wanted the choice screen to be placed during set-up, 68% of people in T1 wanted the choice screen to be placed during set-up ($p < 0.01$).

Third, **the most popular type of choice screen was the one presented to people in T2 (i.e., a screen with 12 browsers and high information) which 44% of all participants preferred**. 36% of people in the control group preferred this option, while between 43% (T3) and 47% (T2) preferred this option in the treatment groups. The second-most popular choice screen option was the one presented to those allocated to T3 (i.e., five browsers with high information) - with 26% preferring this screen.

Participants want a choice screen with high information, more browsers and served during device set-up

- **The majority of people prefer to be shown a choice screen (97-98%)**
- **Out of all the choice screens, the most popular was the screen with high information and 12 browsers (44%)** compared to the next most popular high information/less browsers (26%) - showing people like receiving more information about the browsers and a greater range of browsers.

Choice screens increase satisfaction (some more than others)

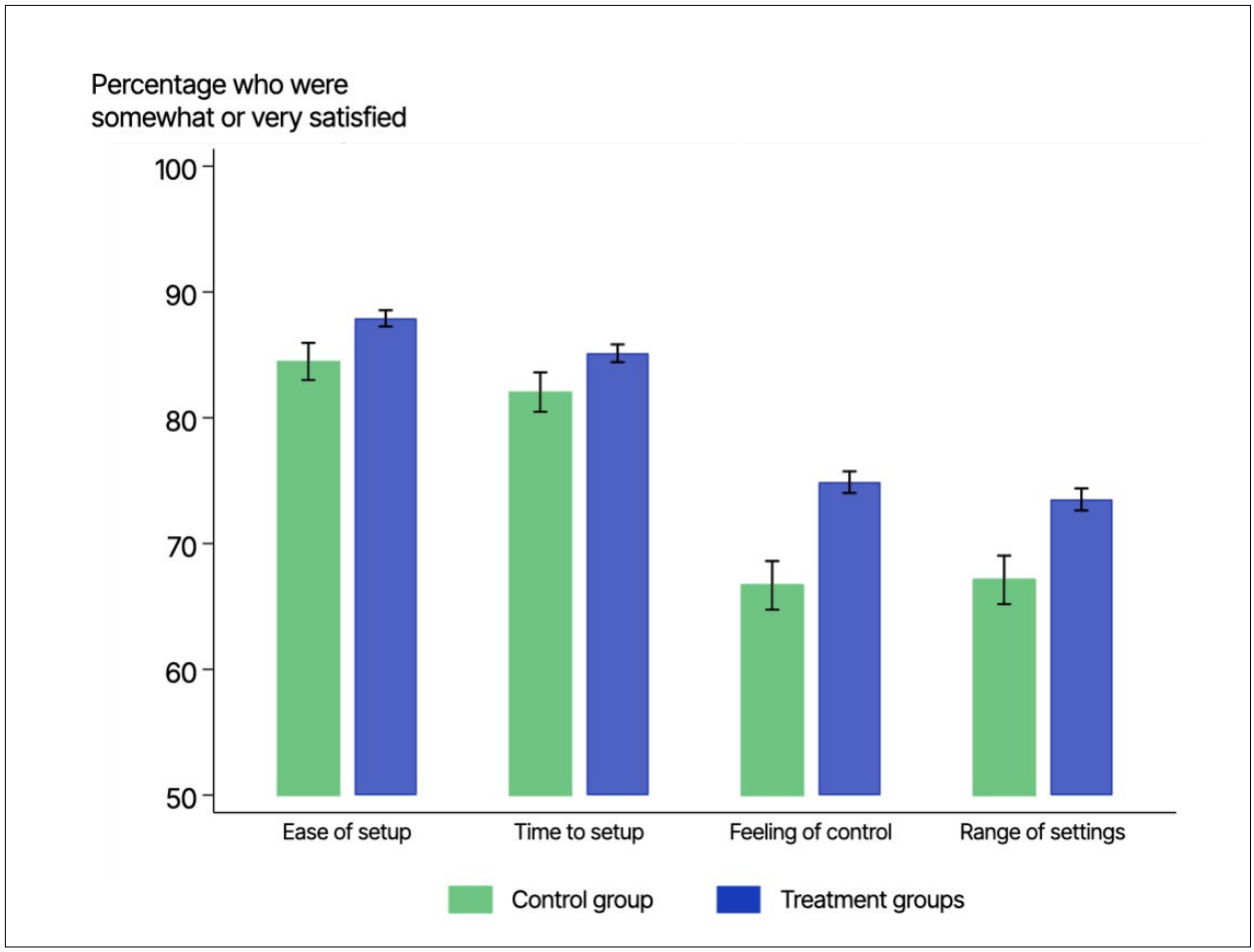
After setting up their device, we asked people how satisfied they were with different aspects of the set-up process. Those in the treatment groups were also asked how satisfied they were with the browser choice screen.

We first examine the effects of treatment assignment (relative to the control group) on satisfaction with the overall set-up process. This analysis shows that **participants in the treatment groups (i.e. those shown a choice screen) were, overall, more likely to be satisfied with every aspect of the set-up process that we measured - than those in the control group**. More specifically, people who were shown a choice screen were, relative to those who were not, significantly more likely to be satisfied with the 'ease of setting up the device',

'the amount of time it took to set up the device', 'the extent to which I felt in control', and 'the range of settings I could customise'.[54]

Comparisons between the treatment and control groups are presented in Figure 13 below. **The increase is particularly high for satisfaction with 'the extent to which I felt in control', which increases by 12% (from 67% to 75%).**

Figure 13: User satisfaction for participants in the control and treatment groups



Notes: This figure presents the percentage in the control and treatment groups who reported being 'Somewhat satisfied' or 'Very satisfied' with different aspects of the set-up process. The black vertical lines on top of the bars show the 95% confidence interval. Observations = 12,060.

54 Table 2.30 in Annex 2 presents the effects of treatment assignment (relative to the control group) on satisfaction with the overall set-up process.

When comparing the level of satisfaction with the choice screens across different treatment conditions, we find that those allocated to the **high information treatments (T2, T3 and T4) were most likely to state that they were satisfied with the amount of information provided about browsers, with T2 having the highest satisfaction level (64% versus 56% for T1,** $p < 0.001$). We did not find meaningful differences in the share who were satisfied with the number of browsers they were shown across treatment conditions. We did, however, find that those allocated to T3 and T4 (with fewer browsers) were significantly less likely than those in T1 to be satisfied with the amount of time it took to choose a browser.[55] This might be because people who saw fewer browsers felt they got less value from the process of selecting a browser.

People shown a choice screen were more satisfied with different aspects of set-up

- **Across a range of measures satisfaction is notably higher** (i.e., ease of setting up device, amount of time to set up and range of settings they could customise) than the control group, particularly sense of control (up by 12% to nearly 75%)
- **High information treatments had higher levels of satisfaction with the amount of information** provided than other treatments - with T2 the highest at 64% in comparison to 56% for T1

55 This analysis can be found in Table 2.31 in Annex 2.

Choice screens do not significantly increase device set-up time

On average, people in the control group and T4 spent approximately 10 minutes setting up their virtual device (those in T4 were not shown a choice screen during the set-up process). Surprisingly, people allocated to T1 and T2, who were shown more browsers, spent less time on the set-up process than those in who were shown fewer browsers (i.e. those in T3 and T4). Moreover, **those in T1 and T2 spent less time setting up their device than those in the control group** (these differences were, however, not statistically significant). In other words, we cannot reject the null hypothesis that choice screens do not increase the time people spend setting up their device.

Turning our attention to the amount of time people actually spent on the choice screens, we find that those in T1 (low information) spent around 12.6 seconds choosing their default browser. Those allocated to T2 or T3 (high information) spent around twice as much time as those in T1 ($p < 0.01$). A closer examination reveals that those allocated to T2 and T3 spent around half of this time on the Q&A screen, and half on the actual choice screen. In other words, **those in T2 and T3 spent about as much time on the actual choice screen as those in T1**.[56]

We do not find that serving a choice screen during set-up significantly increases the time it takes people to set up their device. People spent a similar amount on the choice screen across the different treatments.

56 See Table 2.35 in Annex 2.

Choice screens do not substantially increase awareness of independent browsers

Prior to asking people any other questions about browsers, we recorded whether they had heard about different browser options.[57]

We find that in the control group 97% of people say they have heard of Chrome, 93% have heard of Firefox, 84% have heard of Edge, and 72% have heard of Opera. Moreover, 27% of people in the same group have heard of Samsung Internet, 22% for DuckDuckGo, 13% for Brave, and 10% have heard of Tor. Between 0% and 7% of people had heard of the remaining browsers.

As expected, we find that being assigned to one of the treatments influences whether people have heard of different browser options. For example, **those who were shown a browser choice screen were between 3.8 (T1) and 6.6 (T3) percentage points more likely to have heard of Opera than those in the control group**. People who were allocated to T1 or T2 were also more likely to have heard of some of the independent browsers (which those in T1 and T2 were always shown, but which were not always displayed to those in T3 and T4). Finally, on average, those in the control condition had heard of 4.4 of the browser options that we asked them about, and **those in T2 and T3 had on average heard of 0.11 more browsers than those in the control group** ($p < 0.05$) - this is equivalent to a 3% increase in the number of browsers of which people are aware.

This suggests that choice screens have little impact on people's awareness of independent browsers.

57 These results are shown in Table 2.33 in Annex 2.

Choice screens influence the browsers people would consider as their default

People were asked which browsers they would *consider* using as a default browser in the future and could select any from the list of browsers provided. The purpose of this question was to determine whether being served a choice screen not only impacted the default browser being selected, but also impacted the types of browser that people might consider using as their default.

On average, those assigned to the control group said that they would consider using 1.75 of the browser options that we presented them with.[58] Further, those in the treatment groups, on average, stated that they would consider using around 0.2 fewer browsers than those in the control group ($p < 0.01$).

However, some of the choice screens simultaneously made people significantly more likely to say that they would consider using an independent browser (i.e. a browser that is not Chrome, Samsung Internet, or Edge). **Those in T1 and T2 were respectively 4.4 and 4.9 percentage points more likely ($p < 0.01$) to state that they would consider using independent browsers as their default**, compared to 62% of people in the control group. Those allocated to T3 or T4 were not significantly more likely to consider an independent browser than those in the control group. We might expect this result as those in T1/T2 were shown more independent browsers on their screens (12 in total) than those in T3/T4 which were only shown five browsers.

This suggests that choice screens showing more browsers increase the likelihood that people would consider using an independent browser as their default, whereas that is not the case for choice screens only showing five browsers.

58 See Table 2.34 in Annex 2.

Choice screens influence the information people use when choosing default browser

People who were allocated to one of the treatment conditions were asked about the factors that they took into consideration when choosing a browser. This allows us to test if the choice screen design impacted the type of factors people rely on in choosing a browser.

We find that some aspects of design appear to influence the factors people said influenced their choice of default browser. For example, 24% of those allocated to T1 (low information) said they took the descriptions of the browsers into account when selecting a browser, while **those allocated to T2-T4 (high information) were more likely to use the browser descriptions - between 4.2 (T3) and 5.8 (T4) percentage points** ($p < 0.01$) than T1.[59] It is perhaps unsurprising that those allocated to T2-T4 were more likely to rely on the descriptions, as those in T1 had to click on buttons next to the browser names in order to access these descriptions.

Further, **those in T3 (fewer browsers) were significantly less likely to state that they relied on logos than those in T1, and those allocated to T4 were significantly less likely to state that they relied on information they already knew** - or their prior awareness of the browser's brand - than those in T1. The effect sizes are all similar and small, from 2.7 to 2.9 percentage points. This might imply that if you have fewer browsers, people may not need to rely as much on heuristics such as logo recognition, though the pattern is not as clear as it is for browser descriptions.

Our results suggest that some elements of design may have an influence on the factors people rely on in choosing a default browser, such asbrowser descriptions and logos.

59 Their responses to these questions - and comparisons between treatment conditions - are presented in Tables 2.37 and 2.38 in Annex 2.

People lack good understanding of browsers and defaults, even after choice screens

We asked people what they think happens after they choose a default browser. **Only about half (52%) of people understand that their default browser is opened when they, for example, click on a link in an email or document**.[60] This share did not significantly vary across treatment groups, which is surprising as the Q&A screen (displayed to T2-4) explicitly states this is what happens when they select a default browser. Moreover, 6% of people incorrectly believe that they are *only* able to use their default browser (i.e., that all other browsers would be disabled). Even more significantly, **over half (53%) also erroneously believed that their default browser would automatically be pinned to their taskbar.** Previous research suggests this is a common misconception - and the impact of not being pinned to the taskbar, in terms of how this impacts people's usage of browsers, is an area where we consider further research could be undertaken.

People were also asked about the actions they completed when they set up their device.[61] Around 33% of people in the control group thought that they chose a default search engine during the experiment and around 40% of people in the same group thought they had selected a default browser (even though they did neither of these things). Moreover, while the share who (correctly) thought they selected a default browser rose to around 94% across the treatment groups, the share who (incorrectly) thought that they selected a default search engine also rose — to around 74%. In other words, people who selected a default browser were also more likely to think that they selected a default search engine.

It appears that Q&A screens like the one we tested in this experiment do not adequately educate people on this topic. This does not necessarily mean there is no value in providing such information to users so that they could make more informed choices and understand the implications of those choices. But this will be challenging and we find that information screens tied to choice screens alone may not be sufficient.

These results suggest that there is considerable confusion about what default browsers actually do and how default browsers differ from default search engines - e.g only around half knew that a default browser generally opens when clicking on a link in an email or document.

60 See Table 2.36 in Annex 2.
61 See Table 2.39 in Annex 2.

Our results provide good estimates for the impact of implementing choice screens

In this section, we address several questions around internal and external validity to provide insight into whether we would expect choice screens to have similar effects if they were implemented in practice.

First, we consider the 'ecological validity' of the device/desktop environments. By design, the device set-up environment used within the experiment closely follows the set-up process people would go through when setting up their phones or computers in practice. The goal was to have a similar process to the greatest extent possible - with the same look and feel, including exactly replicating details such as the fonts or logos used.[62] We also presented people with clear instructions, and screened out people who did not successfully complete a comprehension test.

Second, despite the fact that the process closely matches what someone would do in a standard phone or computer set-up process, it is possible that people who completed the experiment may not be similarly motivated when setting up their device as they would have in the real world. To assess this possible concern, we ask people whether the amount of effort they exerted when setting up the virtual device was reflective of the effort they would exert when setting up a similar device in real life. We find that a majority of people (84%) stated that their behaviour was reflective of what they would have done in real life. Moreover, to ensure that people who answered no to this question were not unduly influencing the results, we re-ran the main analyses (i.e. the effects of choice screens on the default browser that people chose) excluding these people, and find consistent effects.[63] In addition, we also re-ran our analyses with people who seemed more or less attentive,[64] and do not find that attentiveness predicts the effects of the choice screens.

62 A small number of aspects of the journeys were simplified or removed, as their inclusion risked either generating high drop-out rates or leading to overly long completion times. Please see Annex 1 for an overview of the screens and paths included in the Android and Windows journeys.

63 It is clear that many people paid attention when setting up their device, as over 91% of people in the treatment groups correctly recalled which browser they chose when they set up the virtual device.

64 We measured this in terms of whether they took an above or below median time completing the portion of the set-up journey that occurs before treatment assignment

A third consideration is the composition of our sample of people.[65] We note that a significant number of people dropped out while completing the survey, and many were screened out after failing the comprehension test twice.[66] Moreover, participants of survey panels might differ from the general population. While it is hard to rule out differences in terms of unobservables, the people in our experiment represented a broad range of age groups, regions, and were balanced on gender. We also collected data on a range of other variables, such as income, education, and the browsers that people currently use. While our sample does not fully match the populations in these countries, we conducted reweighted analyses based on education, region, browser use, and age. The reweighted analyses do not meaningfully differ to those presented in the main report.[67] Furthermore, for this type of research, where we are analysing differences in treatment effects due to choice architecture, we would not expect treatment effects to vary based on small changes in demographics.

Finally, we explore the internal validity of the experiment. The main threat to the internal validity of the type of experiment that we conducted is differential attrition between experimental groups.[68] We find that there are small significant differences in the share that dropped out of the experiment between those in the control condition and those in T2 and T3. More specifically, those in T2 and T3 were about 3 percentage points less likely to drop out of the experiment than those in the control group. Those allocated to T2 and T3 were also about 2.5 percentage points more likely to drop out than those in T4. There is no significant difference in dropouts between T1 and the control, T2, T3 or T4. However, as the balance tables show (Annex 1, Table 1.7), there are no significant differences in the characteristics of participants who completed the experiment and were allocated to the different experimental conditions, which suggests that differential attrition is unlikely to affect the validity of our results.[69] Nonetheless, even if there is differential attrition on unobservable variables, we can conclude that these effects would not affect the conclusions presented above because the differences in dropouts between T2/3 and T4/the control are small and

65 Recruitment was conducted by Bilendi (for the German and Spanish samples, and for some of the Polish sample) and Panelbase (for most of the Polish sample). Panel providers are commonly used when recruiting people for peer reviewed academic studies. See, for example, the paper titled "Beyond the Turk: Alternative platforms for crowdsourcing behavioral research".

66 Dropouts may threaten the external validity of the results if those who dropped out would have reacted differently than those who completed the survey in response to being shown a choice screen. However, as our analyses show, we do not find that the effects of choice screens differ meaningfully for those who pay more or less attention and across other variables. Therefore it is unlikely that the dropouts substantially influence the generalisability of the results. See Tables 1.4-1.6 in Annex 1 for more information about dropouts.

67 The reweighted analyses can be found in Tables 2.42-2.45 of Annex 2.

68 This type of differential attrition is only problematic if dropouts are non-random. For example, if 5% drop out in one group and 10% in the other group, the results remain valid as long as the dropouts are a random subset of those who were assigned to the respective experimental groups.

69 Differential attrition is only an issue for internal validity if there is attrition from different types of participants attrite in the experimental groups, and different drop-out rates across experimental groups are not in and of themselves sufficient to threaten internal validity.

the differences in outcomes between these groups are large.[70] [71] Furthermore, the only main result that has a small effect is between T1 and T2 (in relation to independent browsers), but there is no significant differential attrition between T1 and T2. Therefore having considered internal and external validity, we conclude that our main results are robust.

70 These dropouts only affect how we might interpret differences between the control/T4 and T2/3 – other comparisons do not suffer from differential dropouts.

71 For example, those in T2/3 were about 38 percentage points less likely to choose a pre-set browser after 6 months than those in the control, so even if all of the extra drop-outs in the control would have switched if they stayed in the experiment, the effect would not be reduced in a meaningful way. Similarly, those in T4 were about 8.9 percentage points more likely to choose a pre-set browser during the set-up journey than those in T2/3 – so even if all of the differential dropouts in T4 had stayed in the experiment and selected another browser, we would still have a meaningful and significant difference between the groups. Furthermore, our other main results relating to ordering, satisfaction and preferences are also large and so would not be substantially affected by differential attrition.

05.

Conclusion

This research provides important evidence regarding the effects of browser choice screens, how to best design such choice screens, and when they should be displayed to people - insights that we consider can help guide regulators and policy-makers. Further, the findings presented in this report are not only applicable to browser choice screens. Several insights apply more broadly in terms of helping regulators understand how online choice architecture affects consumer decision-making and could also enable people to have greater control within the digital environments they navigate, as well as providing insights about the value and process of running experiments.

As noted at the start of this report, a number of regulators have considered whether there should be rules that mandate the use of choice screens. Most notably, there is an explicit requirement under the DMA for choice screens for browsers (as well as search engines and virtual assistants) to be introduced in the EU by gatekeepers. However there is little detail in the law on what such choice screens should look like and when precisely they should be served - for example, at 'first use' could be interpreted in multiple ways. There is also very limited specific evidence to help understand how to make these types of intervention most effective; surprisingly little publicly available testing has been done in this area before. While regulators could draw on general behavioural principles, there are many which could potentially be applicable and it is not generally possible to know in advance which will be important in any specific setting. Context-specific, original evidence (of the sort provided in this experiment) is needed to make sure this type of intervention is most effective and does not impose unnecessary burdens on people.

Choice screens impact decision-making and people have clear preferences for them

First, the results of this experiment suggest that **well-designed browser choice screens can impact the choices people make**. We find that they better match consumers with the default browser that they want and help to increase browser contestability, which could impact competition. For example, many in the control group say they would want to switch away from the pre-installed default browser (but some of which do not know how) - while those given the opportunity to choose their browser via the choice screen expect to remain with it. They are **overwhelmingly supported by people** - 98% of people stated that they wanted to be shown a choice screen, with most preferring the screen with more information and greater number of browsers. In addition, those who were shown a choice screen reported being more satisfied with various aspects including their level of control when setting up the device, the time taken to set up the device, and their ability to customise their device settings.

Second, the **design and content of choice screens matter.** For example, we find strong evidence, as might be expected, that the **order in which browsers are shown** impacts consumer choices - with the first position being the best and lower ranked slots being worse. The pre-installed default browsers, which in this experiment were Samsung Internet/Edge, are particularly sensitive to ordering effects. The effects are also stronger on Android where there is a vertical list than on Windows with a horizontal list. Further, **giving more information**, such as details about the browsers' user ratings and the number of reviews, also affected the choices people made. Finally, increasing the set of browsers displayed makes people more likely to pick independent browsers - though the majority still pick the most used or pre-set browsers (i.e., Chrome, Edge and Samsung Internet).

Third, the **point at which a choice screen is shown also affects people's choices**. The results suggest that choice screens are **more effective when shown during set-up** on first use of a device rather than browser first use - and many people prefer the former. There was a significant increase in how many people chose the pre-installed default browser (i.e., Samsung Internet or Edge - which was the browser they had just clicked on) when the choice screen was displayed at browser first use. To simplify our experiment, the only pre-set and pre-installed browsers were Samsung and Edge, however in practice most Android devices also have Chrome pre-installed and for non-Samsung phones, it is often the pre-set default. Therefore in real life similar benefits could also arise for Chrome as for the pre-set default browsers in this experiment.

No major downsides of browser choice screens

Some may worry that browser choice screens place significant burdens on consumers by creating an unwanted distraction or by taking up too much of their time. In practice, however, we find that **choice screens did not significantly increase the time that people took** when setting up their device during the experiment. Moreover, those shown a browser choice screen reported being even **more satisfied with the ease of setting up their device**.

In fact people generally preferred being given a chance to choose their browser, particularly during device set-up. This is an intuitive result. When first setting up a device, people are already making choices about how they want that device set up. This is not the case when first entering a browser, as many people will be actively using the browser for a reason (such as buying or searching for something), and so may be less keen to be asked at that point to spend time choosing their default browser and may not make as much of a considered choice as they would otherwise have done. This supports findings from Mozilla's previous research which suggest that remedies which interrupted the user in the middle of a task were less likely to be effective.

Overall, we find that a well-designed choice screen has benefits: it enables people to select their default easily, increases browser contestability, aligns with people's preferences, and increases satisfaction without the downsides that some have been concerned about.

These results provide other learnings about browsers

There are other more general learnings from the experiment beyond browser choice screens, for example more findings about browser usage and understanding.

Even after providing additional explanation about browsers, what defaults are and what becoming the default means (through an explanation screen), many common misperceptions remain. People in the experiment were still confused about what exactly a browser is and what it does, confusing browsers with search engines (almost three quarters of people who chose a browser thought they had also chosen a search engine). Many are also confused about defaults. Interestingly, more than half (53%) thought that choosing a default browser would pin it to the taskbar on their PC or to the favourites bar on their Android

phone - a common placement for the incumbent pre-installed browser - but many would be surprised to find out is not always the case. This reinforces the importance of giving clear explanations - such that people understand the choice they are being asked to make and to facilitate easier active selection of a default browser. It also raises questions about what being a default should mean in practice - for example there may be a case for regulators to require that the selected default browser is pinned to the taskbar/dock automatically, in line with many people's expectations. There may also be other expectations people have of their default browser which we have not tested in this experiment but which are not universally applied by operating systems.

Previous research has found similar misconceptions, showing that the level of misunderstanding about browsers and defaults is very high. Our results show that even providing additional information at the time when people choose their default browser will not necessarily immediately counter this. It does not mean that providing additional information to try to explain choices is not worthwhile - in fact people shown the Q&A screen spent similar time on it as the choice screen itself (on average spending 15 seconds). However, it may take some time to improve people's understanding and there may also be more creative ways to achieve this.

Despite getting basic questions about browsers wrong, many people claim they are familiar with the idea of defaults and that they are comfortable downloading browsers and changing the default browser. And the majority claimed that they had previously done both of these (62-74%).[72]

Although not directly explored in this experiment, Mozilla considers that **well-designed nudges for people to review their default browser choice would also be beneficial.** While this experiment does not provide evidence on how frequently to provide these nudges or indeed how to specifically design these, some of the design learnings can be applied. Given the information and choice overload that many experience and that people's preferences are likely to be relatively stable, intuitively there are likely to be risks in over-prompting and doing so in a way that gets in the way of what consumers are seeking to do at that point in time. Potentially prompting people once, six months or a year after device set-up, might strike the right balance. Alternatively there could also be benefits in giving people a repeated nudge, possibly annually, whilst ensuring this is not overly burdensome or more likely, risks simply being dismissed by consumers. Given the long-held advantages that incumbent browsers have, regulators could also consider deploying such nudges only to people using those browsers.

72 See Table 1.3D in Annex 1.

New research is needed to explore how and when to review people's default browser choice, particularly as a person receiving a prompt while they are going about their daily activities, and how they interact with this prompt, is different to the scenario of setting up a device in this experiment. Building on this experiment, if a clear natural review point can be established - akin to device set-up, such as a major operating system update - that might be a good opportunity to re-display a choice screen.

The research highlights broader regulatory lessons

In addition to wider learnings about browsers, this experiment highlights several broader takeaways for regulators, particularly about running experiments or reviewing experimental evidence (their own or from others). Experiments can provide crucial information for prospectively learning about and evaluating the effectiveness of different interventions in digital markets, especially when it can be hard to get other forms of rigorous evidence.

- **Detailed testing of regulatory interventions is feasible.** Running online experiments can take time and is detailed work that requires considerable effort (e.g., they require considering every aspect of the design, and deciding on different treatments and crafting survey questions). It was time-consuming to create replicas of Android and Windows set-up processes that were highly realistic and based on design were virtually indistinguishable from the real set-up processes. It also took time to consider the full range of possible treatments to test and decide on the final treatments (e.g., where to place the choice screen, how exactly it should look, what information should be included and getting that information). But doing this work is easily achievable in a timescale that fits with most regulatory processes. From the beginning of our project through to publication took a little under six months and doing a similar project again would likely be quicker.

- **Online experiments can provide valuable insights.** There are considerable benefits from running experiments in highly realistic settings with the inclusion of detailed questionnaires. There can be a high degree of external validity (i.e.,the research produces results that are similar to what will happen when the policy would be enacted) while also providing the opportunity to include many useful, diagnostic questions in the survey components, such as asking people about their satisfaction with elements of their experience or their stated preferences about choice screens. The mere pro-

cess of having to create treatments and analyse trade-offs forces a degree of thinking about the detail of interventions that is much deeper than in normal regulatory processes. These benefits can be complementary to those of field experiments (e.g., A/B testing, where the policy is tested directly with people in real life), which can also be very valuable.

- **It is hard to foresee and easily predict the effects of interventions.** Based on the significant experience from those involved in this research, experiments almost always provide surprising effects. This is also true of the present experiment where there were a number of surprises (for example, we did not predict that T4 would lead to an increase in choice of the pre-installed browser in the choice screen). If policies that produce surprise testing results were rolled out in real life, without testing, there could well be unforeseen and unintended consequences. This shows how important it is to run experiments, where possible, before introducing changes.

- **The longer term effects are not fully known.** This experiment primarily has short-run outcome measures (with the exception of the question covering people's expectations about their choice of default browser in six months' time) and does not follow up with people over time. Thus, we do not know how consumers will continue to interact with browser choice screens - and the potential interaction with any other regulatory interventions in the market for browsers - in the longer-term. It will therefore be important to closely monitor the impact and engagement with these forms of interventions when they are implemented.

- **Simple reporting statistics are unlikely to tell the full story.** Monitoring the market over time and only relying on high-level measures, such as switching statistics, would not give a sufficiently detailed view on whether - and how - these types of interventions are having an impact. Market players and regulatory agencies will need to capture a much broader set of measures, ideally including detailed, granular data from individual people on their perceptions of the market and their experiences.

06.

Next steps

We are engaging with interested regulators, firms, academics, civil society and consumer organisations to discuss the results of this experiment, the implications for browser choice screens and the broader learnings.

Mozilla is a non-for-profit and open source organisation that encourages open discussion and data sharing to test thinking and develop policy globally. We are publishing this report in the spirit of encouraging further analysis, testing and debate. This will enable continued discussion and further experimental testing in this area by others.

While our experiment reveals many important insights, there are many other aspects in relation to browser choice screens that could usefully be explored further and tested. This not only includes further variations of the design of the browser choice screen that we were unable to test, but other areas beyond an initial choice screen. For example, how and when people might be asked again about their choice of default browser, where there is clearly a careful balance to be struck - and also the impact of repeated prompts such as those from operating system providers, which could shift people back to incumbent browsers. We would be happy to discuss such ideas for future research with other interested parties who may wish to build on our work and continue to improve global understanding - including testing in different jurisdictions.

Ultimately Mozilla considers that a range of interventions, including well-designed choice screens, will be needed to address browser competition concerns and empower consumers. Careful monitoring and regular reviews, including engagement with third parties, will be necessary to assess the impact of these types of interventions to ensure that they are having the desired effect and not, for example, being undermined by negative choice architecture.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