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Perceived autonomy in the age of personalized search:

Evaluating the impact of the GDPR in search engines

Timmerman, H.M. (3093662)

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Supervisor: Dr. Shenja van der Graaf

Second supervisor: Dr. R.P.A. Loohuis

Abstract

In an era where personalized algorithms shape online information access, safeguarding user autonomy has become increasingly vital. This study explores whether the General Data Protection Regulation (GDPR) is associated with higher levels of perceived autonomy in the context of search engines. Drawing on Self-Determination Theory (SDT), autonomy is conceptualized as a multidimensional construct comprising personalization control, algorithmic transparency, and search result diversity. A quantitative survey (N = 349) among Dutch users revealed that while the GDPR is associated with greater perceived diversity in search results, its perceived impact on transparency and control is limited. Digital skills emerged as the strongest predictor of autonomy: individuals with higher digital literacy felt more capable of managing privacy settings and understanding algorithmic processes. A comparison between general and GDPR-specific perceptions showed that users attribute improved diversity to GDPR, but not improved control or transparency. This study contributes to a more nuanced understanding of digital autonomy by bridging psychological and regulatory perspectives. It highlights that legal frameworks like the GDPR, though essential, are not sufficient on their own. Real user empowerment depends on individuals' ability to understand and act upon their digital rights. To close the gap between legal protection and lived experience, clearer regulatory communication and targeted public education are needed.

Keywords: Perceived autonomy, Search engines, Algorithmic transparency, Personalization control, GDPR, Digital skills, Self-Determination Theory

Table of contents

Introduction

The rapid advancement of digital technology has made search engines essential for information retrieval, decision-making, and online navigation. With billions of searches conducted daily, platforms like Google actively shape user experiences through algorithmic customization (Taylor, 2020). While the algorithms are supposed to optimize efficiency, they are "black box" mechanisms processing vast amounts of user data in ways not necessarily apparent to consumers (Wedel & Kannan, 2016; Pollack, 2016). As a result, concerns have emerged regarding the degree of consumer control within algorithms like search engines. Particularly, whether consumers have control within their digital world or are covertly influenced by algorithmic mechanisms (Van de Waerdt, 2020; Dogruel et al., 2022).

In response to these concerns, the European Union introduced the General Data Protection Regulation (GDPR) in 2018 to enhance transparency, strengthen user control, and promote responsible data handling (Goddard, 2017). GDPR requires organizations to disclose their data collection and processing activities while granting users explicit rights over their personal information. In the context of search engines, key provisions include the Right of Access (Article 15), allowing users to request data collected about them, the Right to Erasure (Article 17), enabling individuals to request removal from search engine databases, and the Obligation for Transparency (Articles 12–14), which mandates clear communication on data collection and processing (Gumzej, 2021). While GDPR has improved transparency and privacy awareness (Marikyan et al., 2024; Fox et al., 2022), its impact on consumer empowerment remains debated. Persistent issues such as information asymmetry and complex privacy policies may hinder users' ability to exercise their rights effectively (Sealey, 2020; Charif et al., 2020). Although the GDPR formally enhances users' rights, it remains unclear whether these rights translate into an actual sense of autonomy in practice.

Drawing from Self-Determination Theory (SDT) (Ryan & Deci, 2000), this study views perceived autonomy as a psychological construct grounded in users' sense of control, informed choice, and freedom from covert influence. In the context of search engines, consumer autonomy in search engines refers to the extent to which users can actively control and understand their digital experiences rather than being passively influenced by algorithmic decisions (Sankaran et al., 2021). When these dimensions are meaningfully supported, users are more likely to experience a sense of digital autonomy aligned with the core tenets of SDT. Conversely, a lack of transparency, control, or search result diversity may inhibit this sense of agency. This may leave users feeling manipulated, rather than empowered in their online interactions with search engines.

While previous research has explored the GDPR's influence on privacy concerns (Goddard, 2017) and regulatory efforts to improve algorithmic transparency (Fassiaux, 2023), little is known about how users perceive their autonomy within algorithmically driven environments such as search engines. Existing literature has largely emphasized legal compliance and platform-level design, overlooking the psychological dimension of perceived autonomy (Zaeem & Barber, 2020; Goddard, 2017; Fox et al., 2022). This study addresses that gap by examining whether users perceive greater autonomy, operationalized through personalization control, algorithmic transparency, and search result diversity. Given the central role of search engines in shaping information access and decision-making, understanding GDPR's impact on perceived autonomy is key to evaluating its effectiveness.

This study investigates the influence of GDPR regulations on perceived consumer autonomy within search engines by assessing transparency, control, and diversity. Additionally, it examines how digital skills, GDPR understanding, and GDPR knowledge influence user perceptions of autonomy in search engines.

The central research question is:

"To what extent do GDPR regulations influence perceived consumer autonomy in search engines, and how do digital skills shape this relationship?"

By focusing on personalization control, algorithmic transparency, and search results diversity, this research bridges gaps between legal frameworks, algorithmic governance, and user agency. This offers policy recommendations for improving digital literacy and regulatory communication. If findings confirm that higher digital literacy enhances perceived autonomy, this supports the need for public education initiatives on GDPR rights and digital privacy (Lukic et al., 2024). Additionally, if users with low GDPR literacy feel less in control, this suggests that communication strategies need to be improved to better inform consumers of their rights (Fassiaux, 2023).

The findings will benefit policymakers seeking to refine GDPR implementation and search engine providers looking to design more transparent and user-friendly privacy controls. Moreover, this study contributes to the broader discourse on digital privacy, algorithmic governance, and consumer rights, emphasizing that regulatory frameworks alone are insufficient. Users must also have the knowledge and capabilities to navigate and exercise their digital rights effectively (Helberger, 2021).

The remainder of this thesis is structured as follows: Chapter 2 outlines the theoretical framework, introducing key concepts such as perceived autonomy, personalization control, algorithmic transparency, and information diversity. Chapter 3 presents the conceptual model and outlines the research hypotheses. Chapter 4 details the methodology, including the research design, participant recruitment, measurement instruments, and data analysis procedures. Chapter 5 reports the main findings from the survey, followed by Chapter 6, which discusses the implications of the results, reflects on the study's limitations, and offers directions for future research. Finally, Chapter 7 concludes the thesis with a summary of the key findings and their relevance for policy, practice, and future academic inquiry.

Theoretical framework

Perceived online autonomy

In this study, perceived online autonomy refers to users' ability to make independent and informed decisions when interacting with search engines, particularly regarding personalization, transparency, and search result diversity. Autonomy in digital environments is essential, as it aligns with fundamental psychological needs for control, competence, and self-determination, which are critical for well-being and motivation (Deci & Ryan, 2012). According to Self-Determination Theory, autonomy is the ability to act with free will, and digital environments should support this by enabling meaningful user control. However, as Wertenbroch et al. (2020) argue, perceived autonomy does not necessarily translate into actual autonomy. Users may believe they control their search experiences, while algorithms constrain their actions without their conscious awareness. Sankaran et al. (2021) further emphasize that providing users with transparency and control can foster a greater sense of perceived autonomy in AI-driven environments. Similarly, Kleanthous and Siklafidis (2023) highlight that users often remain unaware of how personalization algorithms shape the content they encounter, underscoring the importance of transparency in fostering a genuine sense of autonomy.

When users feel in control of their online interactions, they are more likely to trust platforms, engage meaningfully with content, and make informed decisions (Kesan et al., 2015). However, when this control is undermined, it can trigger psychological reactance, leading to decreased trust and engagement (Brehm & Brehm, 2013). A key challenge in search engines is the "gap in transparency," as users often lack knowledge about how personalization functions limit their ability to assess the extent of their control (Galindo & Garcia-Marco, 2017). In this context, perceived control is closely tied to users' ability to manage their data, with greater control over data collection and usage enhancing their sense of agency while reducing privacy concerns (Acquisti et al., 2015). Algorithmic transparency further shapes autonomy by helping users understand and critically evaluate how search results are ranked and personalized. Research suggests that when users receive clear explanations of algorithmic decision-making, their perception of autonomy increases (Sankaran et al., 2021; Dogruel et al., 2022). Conversely, opaque personalization processes can create a sense of algorithmic dependency, leaving users feeling manipulated rather than empowered (Mik, 2016). This transparency-autonomy link is particularly relevant in the context of GDPR, which promotes greater user awareness but does not necessarily ensure a

functional understanding of data practices, leaving users with formal rights but limited practical agency (Pollack, 2016).

In line with existing research, this study operationalizes perceived autonomy through three key dimensions: personalization control, algorithmic transparency, and search result diversity (Pentina et al., 2016; Martin & Murphy, 2017; Helberger, 2021). Personalization control helps with the customization of user experience, while transparency establishes trust through the clarification of data practice. However, as Wertenbroch et al. (2020) note, recommendation algorithms and microtargeting mechanisms may reduce actual autonomy by affirming users' past habits and limiting exposure to alternative options. Meanwhile, search result diversity enhances informed choice by exposing users to a broad range of perspectives, a factor crucial in counteracting "filter bubbles" and algorithmic biases (Helberger, 2011; Pariser, 2011).

A lack of transparency and control can lead users to feel vulnerable and uncertain about how algorithms shape their experiences, ultimately diminishing trust and satisfaction with the platform. Galindo and Garcia-Marco (2017) argue that search engines inherently undermine users' autonomy through organizing the accessibility of information in a way that prioritizes commercial or algorithmic efficiency over individual empowerment. Therefore, making the data practice and operations of personalization open is critical towards making users feel in control and thus experience autonomy.

Search result diversity plays an important role in shaping perceived autonomy by ensuring users are exposed to a broad range of perspectives rather than being limited to algorithmically curated content. Helberger (2011) argues that diverse information empowers users to form well-rounded opinions. However, search engines' content curation practices can narrow informational exposure, influencing public discourse and limiting decision-making capacity (Van Couvering, 2007). A study by Wertenbroch et al. (2020) suggests that many users remain unaware of the extent to which personalization shapes their autonomy. Since users are frequently guided toward content that aligns with their past interactions rather than being exposed to alternative viewpoints. This phenomenon, often referred to as "filter bubbles," restricts user agency by reinforcing existing biases and reducing perceived control (Pariser, 2011). Empirical research by Helberger (2021) provides further evidence for this effect, demonstrating that Google News search results are significantly personalized based on users' browsing history. This demonstrates how algorithmic personalization can limit exposure to diverse perspectives, potentially undermining autonomy. Prior research indicates

that when users encounter diverse sources, they report a greater sense of autonomy and confidence in their ability to critically engage with content (Steiner et al., 2022).

However, personalization mechanisms typically prioritize relevance over diversity, potentially undermining these benefits (Bozdag, 2013). Given that GDPR emphasizes transparency and user control, this study examines whether its regulatory framework mitigates personalization biases and enhances exposure to diverse perspectives, ultimately fostering a more autonomous online experience. This study examines perceived autonomy in search engines by exploring the collective influence of personalization control, algorithmic transparency, and search result diversity on users' sense of autonomy.

While perceived autonomy helps us understand how users experience search engines, these experiences do not develop in isolation. They are shaped by the wider digital environment, including laws and regulations that aim to protect users. In recent years, several policies have been introduced to improve privacy, transparency, and control in online spaces. The next section gives an overview of the most important of these policies and how they relate to autonomy.

Privacy policies

The establishment of regulatory frameworks, particularly the General Data Protection Regulation (GDPR), the Digital Services Act (DSA), and the Digital Markets Act (DMA), have significantly affected the everyday activities of search engines concerning consumer autonomy (Fabbri, 2023; Wulf & Seizov, 2024). These regulations jointly aim to improve privacy, transparency, and competitiveness within digital markets. The DSA aims to enhance transparency and accountability on digital platforms to foster safer online environments, whereas the DMA addresses dominant "gatekeeper" platforms to promote equitable competition. The GDPR, implemented in May 2018, most directly impacts consumers by instituting stringent data privacy regulations and standardizing them throughout the EU. The GDPR gives individuals enhanced authority over their personal data, frequently termed "the Magna Carta of data protection" (Gal & Aviv, 2020).

Among these policies, the GDPR is the most relevant to individuals as it directly empowers them to control their data. The GDPR emphasizes principles of openness, control, and data minimization, leading search engines to implement tools that provide users with enhanced knowledge and control over the utilization of their data. While the GDPR is intended to improve user autonomy, its actual impact remains uncertain. Research suggests that while privacy policies have become more transparent, their complexity still poses

challenges for users, often creating an illusion of control rather than meaningful autonomy (Marikyan et al., 2024).

Additionally, the introduction of GDPR has led to unintended consequences, particularly in terms of search friction. Zhao et al. (2021) found that post-GDPR, users had to perform more searches and navigate additional pages to find relevant information, increasing the effort required to obtain desired results. Rather than streamlining autonomy, these barriers may limit users' ability to interact freely within digital spaces. The elements of transparency, control, and diversity are essential for understanding the influence of these restrictions on user autonomy. Transparency helps consumers understand how their data is used, control allows users to actively manage their data, and diversity offers a variety of perspectives to prevent restricted exposure from customizing. Collectively, these factors are crucial for developing a sense of autonomy, since they correspond with the self-determination theory's focus on offering users information and agency.

For instance, Google has enhanced and instituted tools such as "Why this ad?" and Ad Settings, enabling consumers to understand and manage the personalization of advertisements, thus conforming to the GDPR's requirements for transparency and control. Furthermore, functionalities such as auto-delete facilitate the GDPR's objective of data minimization by enabling users to regulate the duration of their data storage. These measurements illustrate the adaptation of search engines to regulatory mandates, facilitating a balance in power dynamics between consumers and data controllers.

This study aims to assess whether these policies have genuinely enhanced user autonomy or merely reshaped how it is experienced. By evaluating transparency, control, and diversity, we seek to determine whether GDPR empowers users in practice or if its regulatory approach has unintentionally introduced new obstacles.

Personalization control

Control over personalization is a crucial element of consumer autonomy in digital contexts. The ability to regulate the collection and utilization of personal data empowers consumers, enabling them to make informed decisions that align with their tastes and values. Hutmacher & Appel (2023) found that personalization can either increase or decrease user autonomy, depending upon the degree of control and transparency given to users. Their psychological model indicates that although personalization can reduce choice overload, insufficient explicit user engagement in personalization processes might engender feelings of manipulation, resulting in decreased autonomy.

Recent research supports this viewpoint, indicating that customers who perceive enhanced control over personalization settings are more inclined to interact actively with digital platforms. This active involvement frequently results in an increased feeling of empowerment, subsequently enhancing overall consumer autonomy. McBurney et al. (2009) contend that permitting users to openly change their personalized choices, as compared to relying on implicit AI-driven alterations, enhances their perceived control. Their findings indicate that when personalization techniques incorporate transparency tools and user-adjustable options, consumers have a greater sense of ownership over their digital experience.

However, despite the existence of these personalization choices, an important gap remains between the potential for control and the actual user experience. Kesan et al. (2015) indicate that a significant number of customers perceive not being in control over their personal data, as more than 80% of survey participants reported regret after disclosing personal information online. Additionally, Sieger & Detjen (2021) discovered that although consumers appreciate control, their experience of it is frequently limited by non-transparent system behaviors. Their research indicated that personalized options are insufficient without supporting clear, actionable feedback regarding the impact of personalization settings on outcomes.

Transparency is a crucial element in closing this gap. Lambillotte et al. (2022) discovered that perceived control mediates the association between transparency and privacy worries, indicating that when customers comprehend the utilization of their data for personalization, they express decreased privacy issues and an enhanced feeling of agency. Their findings indicate that personalized systems must incorporate real-time elucidations about the generation of recommendations and enable consumers to effortlessly adjust these settings.

The significance of feedback systems in improving personalization control is paramount. Gillespie (2014) contends that permitting customers to offer input on the relevancy and customization of their search results not only empowers users but also enhances the responsiveness of personalization algorithms to individual preferences. Pinxteren (2019) demonstrates that users who perceive more control over their information are more inclined to trust and participate with personalized offerings. He also observes that excessive personalization may result in privacy issues when customers perceive a lack of control over what is done with their data (Pinxteren, 2019).

Despite these prospective advantages, consumer perceptions of control in online settings remain unclear. A survey by Deloitte (2018) revealed that slightly more than half of

respondents believed the GDPR had moderately enhanced their control over personal data, while a considerable number did not observe a major change. The Eurobarometer survey by the European Commission (2019) indicated that perceptions of control over personal data have remained consistent over the years, implying that many consumers do not perceive a significant change in their ability to manage personalization settings. This corresponds with recent research indicating that, despite GDPR's objective to improve user control, individuals frequently perceive themselves as susceptible and influenced by 'dark patterns' in consent forms, which compromise authentic informed consent and reduce the perception of control (Marikyan et al., 2024).

Based on these facts, it is reasonable to propose that the perceived control over personalization in search engines significantly affects perceived customer autonomy. Consequently, the following hypothesis is suggested:

H1: Perceived control over personalization in search engines is positively related to consumers' perceived online autonomy.

Algorithmic transparency

Transparency is essential for consumer autonomy, especially in digital contexts where search engines persistently gather and analyze personal data. In this context, transparency indicates the clarity and openness with which search engines express their algorithmic processes to users. Informing users about the methods of gathering data, analyzing it, and utilization in shaping search results enables them to make more informed decisions, thereby enhancing their sense of control and autonomy (Tufekci, 2015).

Algorithmic transparency serves as both a technical requirement and a crucial element in protecting consumer autonomy against algorithmic manipulation. Research indicates that search engines and online platforms employ personalization algorithms that can subtly influence consumer behavior, frequently reducing autonomy instead of enhancing it. This occurs via "search engine bias" and content filtering mechanisms that restrict the diversity of perspectives available to users (Mik, 2016).

Platforms enhance user experience by transparently communicating the reasons for data usage and personalization, thereby reducing the information gap and encouraging trust (Ackermann et al., 2021). Algorithmic transparency is frequently constrained by corporate interests and regulatory obstacles. Research shows that although policymakers in Europe and

North America promote transparency, major technology companies intentionally avoid complete disclosure to preserve their competitive advantage (Pollack, 2016).

Sankaran et al. (2021) indicate that offering users explanations regarding the reasoning behind specific choices or recommendations improves their perception of autonomy. The study indicates that participants provided with explanations experienced greater autonomy and reduced reactivity to AI-driven recommendations, implying that transparent and accessible explanations can enhance users' sense of agency significantly. This is consistent with research indicating that increased algorithmic transparency fosters consumer trust and decision-making in digital marketplaces, especially when explanations of personalization processes are offered (Guo et al., 2024).

Clear explanations of algorithmic processes enhance users' understanding and engagement with search engines. According to Martin and Murphy (2017), this transparency allows users to evaluate the advantages and disadvantages linked to their online activities. Recent research indicates that transparency policies in online platforms enhance consumer trust and affect choice behavior. Disclosure of the methodologies behind search rankings and personalized results enhances users' perceptions of fairness and autonomy (Veltri et al., 2020).

Algorithmic transparency is crucial; however, the specific effects on consumer autonomy in search engines are not well understood. Research conducted after the implementation of GDPR, including studies by Deloitte (2018) and the European Commission (2019), indicates varied results concerning consumer perceptions of transparency. Regulatory frameworks such as the GDPR have enhanced specific transparency measures; however, research indicates that algorithmic decision-making continues to be mainly unclear. AI-driven personalization frequently maintains hidden biases and restricts consumer autonomy (Gramegna, 2018).

This study posits that algorithmic transparency in data collection and usage improves consumers' perceived autonomy in the context of search engine utilization. Consequently, the following hypothesis is proposed:

H2: Higher levels of algorithmic transparency directly increase perceived online autonomy.

Information diversity

Search result diversity indicates the variety and balance of perspectives present in search engine outcomes. Diversity is crucial in preventing the creation of echo chambers, wherein users are exposed merely to information that confirms their preexisting beliefs, consequently

constraining understanding and reducing autonomy (Bozdag, 2013). Search engines improve the exploration of diverse viewpoints, which is essential for developing comprehensive opinions and making informed decisions. However, research indicates that search engines do not consistently provide diverse search results, as filtering and ranking algorithms significantly affect the information users obtain (Steiner et al., 2022).

Diversity in search results is significant not only for individual choice but also for public discourse and democratic values. Van Couvering (2007) highlights the significance of search engines in influencing public opinion by enabling access to a variety of perspectives, enabling users to critically evaluate content and cultivate an improved comprehension of complicated issues. In addition, recent research indicates that the diversity of search results has a direct impact on political awareness and engagement. A content analysis of political search queries indicates that certain search engines offer a moderate degree of diversity, whereas others considerably restrict access to alternative viewpoints, thereby reinforcing ideological biases (Steiner et al., 2022). This is especially troubling in the realm of elections and political decision-making, as search engines serve as significant gatekeepers of information.

While these benefits exist, personalization algorithms frequently emphasize content that corresponds with users' historical behaviors and preferences, potentially diminishing diversity (Mik, 2016). Research comparing major search engines indicates that personalization leads to "filter bubbles" by disproportionately highlighting familiar content. For instance, Google exhibited a personalization rate of approximately 37%, while DuckDuckGo, which prioritizes privacy, demonstrated a lower rate of 20% (Akbar et al., 2022). This indicates that although personalization enhances relevance, it may simultaneously constrain users' exposure to varied perspectives, thereby limiting autonomy.

Han et al. (2021) similarly found that users frequently prioritize relevance over diversity in search results, resulting in a trade-off between personalized convenience and exposure to new perspectives. Liu and Han (2022) proposed the concept of "diversity acceptance," indicating that users' readiness to interact with diverse search results is significantly influenced by the context of their queries. An adaptive ranking system was proposed in which search engines dynamically adjust diversity according to individual user preferences and search topics (Liu & Han, 2022).

Empirical findings demonstrate significant variations in search result diversity across different search engines and topics. A comparative study of Google, Bing, and Ask revealed that Ask yielded a greater diversity of search results among the top three entries, whereas

Google exhibited a tendency to prioritize a more limited range of sources, favoring prominent websites and authoritative domains (Wu et al., 2019). This highlights issues related to algorithmic bias in content curation, especially as users tend to consider the initial results as the most reliable sources of information.

Search engines must balance personalization with diversity to address these issues, enabling users to explore various information sources while considering individual preferences (Evans et al., 2023). This study posits that increased diversity in search results will enhance consumers' perceived autonomy, given the importance of search result diversity in promoting a comprehensive online experience:

H3: Higher diversity in search results enhances perceived online autonomy.

Digital skills

Digital skills are essential for navigating online environments. They range from basic abilities, such as using devices and software, to more advanced competencies like critical information evaluation and strategic internet use (van Deursen et al., 2014). Basic skills allow users to interact with digital platforms such as search engines to search for information. Advanced skills, such as algorithmic literacy and the ability to assess online information, help them engage more critically (Zhu, 2024; Lee et al., 2017).

However, digital skills involve more than technical proficiency. They also determine how well users can interpret and use transparency and control mechanisms in search engines. Individuals with higher digital skills are better at adjusting personalization settings and recognizing biases in search results than those with low digital skills (van Deursen et al., 2016). In contrast, individuals with lower digital skills may struggle to understand and apply privacy controls, leading to a weaker sense of autonomy (Lorenz-Spreen et al., 2020).

Self-efficacy in digital skills also plays a role. Users with higher confidence in their digital abilities tend to manage their personal data and search preferences more effectively (Chen, Li, & Fu, 2024). Those with lower digital skills, however, are more vulnerable to misleading information. They also find it harder to evaluate transparency mechanisms critically, which can make them feel less in control (Lorenz-Spreen et al., 2020).

This study hypothesizes that digital skills influence how individuals experience perceived control, transparency, and search result diversity in relation to their sense of autonomy. Individuals with higher digital skills are expected to benefit more from

transparency and control features. In contrast, individuals with lower digital literacy may not fully engage with these features, limiting their ability to control their online experience.

Beyond technical literacy, digital skills also affect how users recognize algorithmic biases and personalization mechanisms. Individuals with greater algorithmic literacy are better able to assess search results critically, reduce the impact of filter bubbles, and make more informed choices (Liu & Han, 2022). As a result, they are more likely to experience greater perceived autonomy. Based on this, the following hypothesis is proposed:

H4: Digital skills positively influence personalization control, algorithmic transparency, and search result diversity, such that individuals with higher digital skills report greater autonomy across these dimensions.

Conceptual Framework

The conceptual framework builds on the Self-Determination Theory (SDT) (Deci & Ryan, 2012), emphasizing autonomy as a core psychological need. In digital contexts, autonomy is fundamentally associated with users' ability to control their data, make informed decisions regarding information processing, and prevent algorithmically generated echo chambers. Algorithmic personalization raises concerns regarding diminished user control, lack of transparency, and reduced diversity, potentially affecting users' sense of agency in online environments (Calvo et al., 2020).

The initial key construct, perceived control, denotes users' capacity to regulate the collection, storage, and utilization of their personal data by search engines. Hypothesis 1 (H1) suggests that individuals who perceive a higher degree of control over their personal data will experience increased empowerment in their online interactions. Users who can modify privacy settings and impact personalization algorithms are more inclined to experience autonomy in their search activities.

The second construct, perceived transparency, reflects the extent to which users believe search engines clearly communicate their data practices. Hypothesis 2 (H2) posits that higher perceived transparency is associated with a greater sense of agency in search engines. Transparency allows users to understand the trade-offs involved in data collection, enabling them to make informed choices about their privacy and online interactions.

The third construct, search result diversity, refers to the variety of perspectives and sources users encounter in search results. Hypothesis 3 (H3) asserts that exposure to diverse viewpoints enhances perceived autonomy, as it reduces the risk of algorithmic filter bubbles and gives users broader access to information. When individuals can explore multiple perspectives, they are better positioned to form independent judgments, reinforcing their sense of control over information consumption.

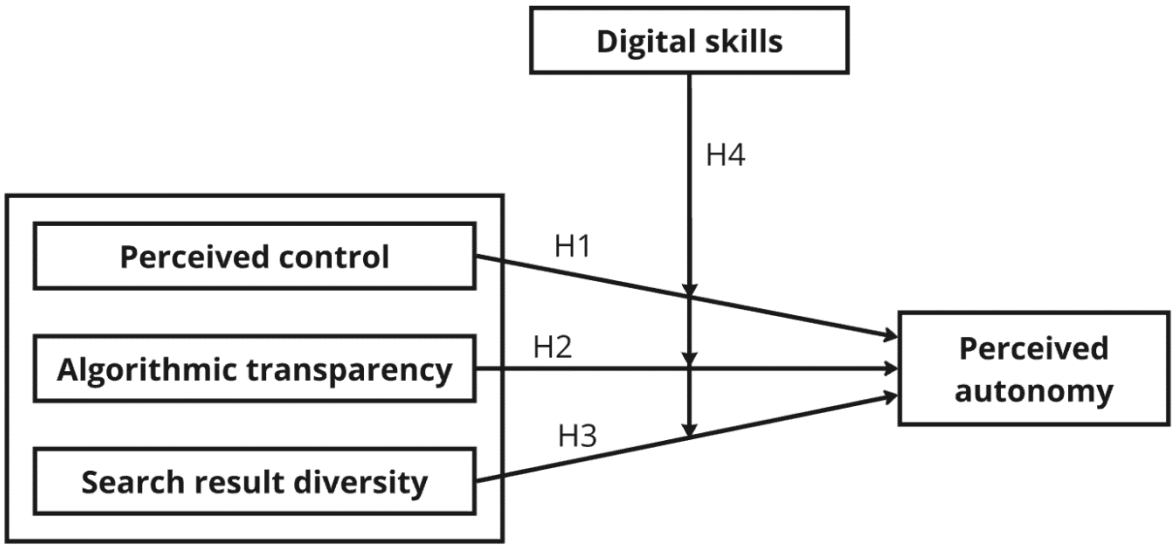
In addition to examining these relationships, this study explores how digital skills and GDPR knowledge influence users’ perceptions of autonomy. Digital skills affect how effectively users can manage control settings, interpret transparency disclosures, and navigate diverse search results. Hypothesis 4 (H4) proposes that individuals with higher digital skills are better equipped to utilize privacy controls, understand transparency information, and critically engage with diverse search results. Thus, enhancing their overall sense of autonomy.

This study aims to identify which of these predictors most significantly shape perceived autonomy in search engines and how digital skills influence these relationships. By shifting the focus away from direct autonomy measurement and instead assessing its

underlying components, this framework offers a more nuanced understanding of how users experience agency in online search environments. This is depicted in Figure 1.

Figure 1

The conceptual model



Methods

To investigate how consumers perceive their autonomy when using search engines, this study used a quantitative online survey. This method was chosen as the most appropriate, as it allows for the systematic measurement of perceived autonomy across a large sample. Surveys enable the quantification of key constructs such as perceived control, algorithmic transparency, and search result diversity, allowing for statistical comparison of differences across user groups (Andrews et al., 2003). Additionally, quantitative surveys provide replicable insights, making them well-suited for studying population-wide trends in user perceptions of autonomy in search engines. While qualitative methods (e.g., interviews) could offer deeper contextual insights, they would limit the ability to test statistical relationships between the variables of interest. Future research may enhance this approach by integrating methodologies such as interviews or focus groups to obtain more comprehensive and nuanced insights.

Participants

The target group for this study consisted of individuals aged 18 and older living in the Netherlands. This age group was selected because it covers a broad range of adults who actively use digital platforms, making them well-suited to provide insights into how personalized search engines impact their sense of autonomy. While the focus was on this specific region, participants came from a variety of backgrounds, offering diverse perspectives.

In total, 374 individuals participated in the survey. After removing respondents who did not fall within the scope of this research (e.g., based on age, missing values, or invalid responses), the final dataset consisted of 349 valid cases used for analysis. The sample was collected using convenience and snowball sampling techniques. Recruitment was facilitated through the following social media platforms: WhatsApp, LinkedIn, and Facebook, where participants were encouraged to share the survey within their networks. While this approach enabled the rapid collection of responses from a heterogeneous participant pool, it inherently limits generalizability, as individuals who engage in online research communities or have prior knowledge of digital privacy issues may be overrepresented. However, the study mitigated selection bias by ensuring demographic diversity in age, gender, education, and search engine usage patterns.

Table 1 provides an overview of the demographic characteristics of the sample. Respondents ranged in age from 18 to 80 years, with an average age of 29.02 years (SD = 11.88). The

gender distribution was slightly skewed, with 54.4% identifying as female, 44.6% as male. Some respondents preferred not to disclose their gender or identified as non-binary. Due to the small sample sizes of these groups, they were excluded from further analyses to ensure the statistical reliability and validity of the results. Including them would have introduced high variance and potential misrepresentation in statistical comparisons. However, their exclusion does not diminish the importance of gender diversity in digital autonomy research. Future studies should aim for larger, more inclusive samples to examine potential gender-based differences in perceived autonomy.

In terms of education, the sample was well-distributed across various educational levels. The largest group of respondents (46.4%) had completed higher vocational education (HBO), followed by 18.6% who held a university master's degree, and 14.3% with a bachelor's degree. Additionally, 14.3% had completed secondary vocational education (MBO), and 6.3% reported having a high school diploma as their highest level of education.

Regarding search engine usage, most respondents reported using search engines frequently, with 61.0% using them more than three times a day and 33.0% using them daily (1–2 times per day). Only 5.2% reported weekly usage, while 0.6% and 0.3% reported using search engines monthly or less than once a month, respectively. The majority of respondents (94.6%) primarily used Google as their search engine, followed by DuckDuckGo (2.3%), Microsoft Bing (1.7%), Yahoo! (0.9%), and other search engines (0.6%).

In addition to demographic and behavioral characteristics, the survey also captured respondents' self-reported knowledge and understanding of the GDPR. Participants were asked to indicate how well they believed they understood and were informed about the GDPR. GDPR knowledge was measured with three categories: no knowledge, some knowledge, and good knowledge. Similarly, GDPR understanding was assessed using the categories no understanding, some understanding, and good understanding. The majority of participants indicated limited or moderate knowledge and understanding of the GDPR. These subjective categorizations were used to explore whether greater familiarity with digital privacy regulation influences perceptions of transparency, control, and diversity.

This sample provides a strong foundation for analyzing how individuals from different age groups, genders, educational levels, and search engine usage patterns experience autonomy in their online interactions. While the study does not fully represent the diversity of the Dutch population, the range of demographics and behaviors strengthens the breadth and relevance of the findings.

Table 1

Demographic statistics of the sample (frequency, percentage, mean, standard deviation, minimum and maximum)

Variable	Answer categories	*n*	*%*	*M*	*SD*	*Min/Max*
Age				29.02	11.88	18/80
Gender	Male	159	44.6			
	Female	190	54.4			
Educational level	Academic master's degree	65	18.6			
	Academic bachelor's degree	50	14.3			
	Higher vocational education (HBO)	162	46.4			
	Secondary vocational education (MBO)	50	14.3			
	High school diploma	22	6.3			
Search engine usage	More than 3 times per day	213	61			
	Daily (1 to 2 times per day)	115	33			
	Weekly	18	5.2			
	Monthly	2	0.6			
	Less than once per month	1	0.3			
Search engine	Google	330	94.6			
	DuckDuckGo	8	2.3			
	Microsoft Bing	6	1.7			
	Yahoo!	3	0.9			
	Other search engines	2	0.6			
GDPR knowledge	No knowledge	165	47.3			
	Some knowledge	154	44.1			
	Good knowledge	30	8.6			
GDPR understanding	No understanding	170	48.7			
	Some understanding	160	45.9			
	Good understanding	19	5.4			

Instrument for online questionnaire

All items in the online questionnaire were measured using a seven-point Likert scale was used, with responses ranging from 1 ("strongly disagree") to 7 ("strongly agree"). This scale was chosen to capture a more nuanced range of participant responses, providing greater flexibility in how participants could express their opinions. The 7-point scale is widely

regarded as offering a more detailed reflection of attitudes and perceptions, allowing for finer distinctions between levels of agreement (Finstad, 2010).

Although the 7-point scale requires slightly more cognitive effort from participants compared to simpler alternatives, it enhances the richness of the data by offering more choices. This added precision is valuable for research examining perceptions of autonomy, as participants' feelings toward personalized search engines may vary in subtle ways. By offering a broader range of response options, the study aimed to better capture these nuanced differences in perception.

The use of a 7-point scale is also supported by research suggesting that it can improve the reliability and validity of the data, especially when assessing subjective experiences (Preston & Colman, 2000). Despite the potential for increased cognitive load, the scale remains straightforward enough for participants to complete the survey without unnecessary frustration.

Pre-tests

The survey developed for this study was pre-tested before formal distribution. A total of eleven participants from diverse demographic backgrounds, including variations in age, education levels, and professional fields, participated in the pre-testing process. This demographic variety provided a comprehensive perspective on potential respondent experiences and interpretations of survey questions.

Initially, a pre-test was conducted with five participants using the think-aloud method, which allowed for detailed observations of how respondents interpreted the questions and revealed opportunities to improve wording and clarity. Based on the feedback gathered through this process, several adjustments were made, including merging and removing certain questions to streamline the survey and minimize respondent fatigue.

The most significant changes were the rewording of the opening statement, rewriting the answer options and simplifying the question formulations. For instance, in pre-test version of the survey, questions regarding GDPR knowledge and understanding were phrased in complex terms (e.g., "To what extent are you familiar with how GDPR regulations influence the functioning of search engines?"). In the final survey, this was revised into a more direct question: "Do you know how the GDPR protects your personal data in search engines?" This modification made it easier for respondents to assess their level of knowledge.

Another important adjustment was the revision and shortening of instructions and descriptions. In the pre-test version of the survey, respondents unfamiliar with the GDPR

received a relatively lengthy explanation. In the final survey, this explanation was made more concise and focused on key aspects of the regulation, ensuring that respondents could quickly grasp the most relevant information.

Following these revisions, a second round of pre-testing was conducted with six new participants to verify that previous issues had been effectively resolved and to identify any remaining areas for refinement. The results indicated that the earlier adjustments had significantly improved the clarity and objectivity of the questionnaire.

Additionally, some questions were restructured for greater clarity. For example, in the pre-test version of the survey, search engine usage frequency was measured with "Multiple times per day" as the highest category. In the final survey, this was refined to "More than 3 times per day" and “Daily (1 to 2 times per day)” to create a clearer distinction between intensive and less frequent users.

Lastly, the wording of comparative questions regarding the pre-GDPR period was adjusted in the final survey to enhance objectivity. Instead of asking about perceived changes in absolute terms (e.g., "Since the introduction of the GDPR, I see more diverse search results..."), the question was rephrased to focus on individual experiences and perceptions. This reduced potential response bias by minimizing leading phrasing.

This iterative, structured approach to pre-testing enabled a thorough refinement of the survey instrument, ensuring both clarity and applicability across a broad range of demographic groups.

Measures

This study examines perceived online autonomy in search engines through the lens of three key predictors: perceived control, algorithmic transparency, and search result diversity, while also exploring the influence of digital skills through group-based comparisons. To accurately capture participants' perceptions of these constructs, validated scales were adapted from existing literature, and complemented by self-developed items where necessary. All constructs were measured using a seven-point Likert scale (1 = Strongly Disagree, 7 = Strongly Agree), allowing for nuanced responses.

Perceived control is defined as users' ability to manage and influence how their personal information is collected, used, and stored by search engines (Xu, 2007; Sankaran et al., 2021). Greater control over personalization mechanisms allows users to align their search experiences with their values and preferences, reinforcing their autonomy (Acquisti et al.,

2015). This construct was measured using items adapted from Xu (2007) and Sankaran et al. (2021). A representative item includes: "I can easily adjust my privacy settings to manage how search engines use my personal data." Measuring perceived control allows us to determine whether users feel empowered or constrained in regulating their data usage and personalization settings.

Algorithmic transparency refers to the extent to which search engines clearly communicate their data collection, processing, and personalization practices (Agozie & Kaya, 2021; Sankaran et al., 2021). Transparency helps users understand how search results are generated, which in turn enhances trust, reduces uncertainty, and fosters greater autonomy (Ackermann et al., 2021). To measure transparency, we adapted items from Agozie and Kaya (2021) and Sankaran et al. (2021). An example item includes: "Search engines provide clear information about how long they store my personal information." By assessing transparency, we can determine whether users feel sufficiently informed about algorithmic decision-making and data handling processes in search engines.

Search result diversity refers to the variety and balance of perspectives and sources within search engine results, ensuring that users are exposed to multiple viewpoints and avoiding ideological echo chambers (Bozdag, 2013). Diverse search results contribute to autonomy by enabling users to critically evaluate different perspectives, form independent opinions, and make well-informed decisions (Helberger, 2011). This construct was assessed using seven items, with two adapted from Sankaran et al. (2021) and the rest self-developed. A sample item includes: "The search engine provides options that align with my interests while still offering a variety of perspectives and content choices." Measuring diversity allows us to evaluate whether search engines effectively balance personalization and exposure to a broad range of viewpoints, which is essential for maintaining user autonomy in digital environments (Steiner et al., 2022).

Digital skills are defined as users' ability to navigate, critically assess, and effectively interact with digital platforms, including the management privacy of settings (van Deurson et al., 2014). This study examines digital skills as an influencing factor, assessing whether individuals with higher digital literacy report greater autonomy when interacting with transparency, control, and diversity features. An example item includes: "I can easily navigate the settings of my search engine to adjust my preferences." By including digital skills as a grouping variable in the analysis, the study explores whether higher digital skills are associated with stronger perceptions of autonomy across these dimensions (Lorenz-Spreen et al., 2020)

All constructs were measured using a seven-point Likert scale, ensuring both strong and subtle variations in participants' perceptions. The final survey incorporated validated and adapted items to comprehensively assess how users experience control, transparency, diversity, and digital literacy in search engines (see Appendix 1 for the full survey).

Validity and reliability of the measures

To assess the validity of the multi-item constructs used in this study (transparency, control, search result diversity, and digital skills) a first-order Confirmatory Factor Analysis (CFA) was conducted. The model was estimated using Maximum Likelihood with Robust Standard Errors (MLR) to account for potential non-normality in the data.

The initial CFA showed that all four factors (Transparency, Control, Diversity, and Digital Skills) were well-defined, with items loading significantly onto their respective constructs. However, Digital Skills showed slightly lower factor loadings compared to the other factors, suggesting that it may contribute less strongly to the overall measurement model. Despite this, the refined model maintained all four factors, as they collectively contribute to measuring autonomy.

A subsequent CFA on the final model confirmed that the measurement structure was statistically robust. The final model retained Transparency (4 items), Control (4 items), Diversity (4 items), and Digital Skills (4 items) as first-order factors, with Autonomy as a second-order latent construct. The model fit indices indicated a strong model fit, confirming that the constructs appropriately capture the theoretical dimensions they represent. Specifically, the chi-square statistic was $\chi^2(98) = 216.31$, suggesting an acceptable fit given the sample size. The Comparative Fit Index (CFI) was 0.947 and the Tucker-Lewis Index (TLI) was 0.936, both exceeding the recommended threshold of 0.90. Additionally, the Root Mean Square Error of Approximation (RMSEA) was 0.059, remaining just below the commonly accepted cutoff of 0.06, indicating a close fit between the model and the data.

To assess the reliability of the multi-item constructs, both Cronbach's alpha (α) and McDonald's omega (ω) were calculated. The results show that Transparency ($\alpha = 0.86$) and Control ($\alpha = 0.85$) exhibit high reliability, indicating strong internal consistency among their respective items. Digital Skills ($\alpha = 0.77$) falls within an acceptable reliability range, while Diversity ($\alpha = 0.70$) meets the minimum threshold for acceptable reliability.

Given the known limitations of Cronbach's alpha, McDonald's omega was also computed to provide a more robust measure of reliability. The omega values for transparency

(ω = 0.88), control (ω = 0.88), and digital skills (ω = 0.78) further confirm their strong internal consistency. However, the diversity construct exhibited lower reliability (ω = 0.71), which aligns with the results from Cronbach's alpha and suggests that this construct may benefit from further refinement.

Overall, the validity and reliability analyses indicate that the final measurement model is statistically sound and theoretically justified. The refined factor structure aligns with theoretical expectations, and all retained items demonstrate adequate to strong factor loadings and acceptable internal consistency. Detailed factor loadings, eigenvalues, and reliability metrics are provided in Table 2 (see full overview below), with additional statistical outputs included in Appendix 2.

Table 2

Validity and reliability of measures (factor loadings and omega's)

Items	Loading	ω
Transparency		0.88
My search engine clearly indicates what personal information is collected about me.	0.818	
My search engine provides information on how long my personal data is retained.	0.698	
My search engine clearly communicates my rights regarding my personal information.	0.800	
My search engine clearly explains how my personal information is used.	0.825	
Control		0.88
I have control over the personal information my search engine collects about me.	0.707	
I can easily adjust my privacy settings to manage how my search engine uses my personal information.	0.823	
I can configure how my personal information is used to personalize my search results.	0.731	
I can easily find and modify settings related to how my personal data is stored and shared.	0.791	
Diversity		0.71
My search engine presents me with different perspectives that match my interests.	0.684	
I feel that my search engine displays results from a broad selection of reliable sources.	0.751	
Personalization of search results does not limit my access to diverse viewpoints.	0.532	
The variety in search results helps me make better choices.	0.473	

Digital Skills		0.78
I can easily navigate my search engine's settings to adjust my preferences.	0.659	
I know how to find reliable information using a search engine.	0.782	
I know how to identify and avoid dangerous links and content in search results.	0.632	
I effectively use my search engine to find information that helps me with personal and work-related goals.	0.654	

Procedure

The data for this study were collected between November 8th, 2024, and February 12th, 2025. To uphold ethical standards, the study received approval from the BMS Ethical Committee / Domain Humanities & Social Sciences, with Request Number 241114, on July 9, 2024. Participants were first introduced to the general topic of the research without revealing the specific objectives of the study, to prevent bias in their responses. This approach ensured that participants remained unbiased in how they reported their experiences. Before starting the survey, participants were informed that their involvement was entirely voluntary, and that they could withdraw from the study at any point without any consequences. If a participant chose to withdraw, their data was automatically excluded from the analysis. To protect privacy, participants were assured that their responses would remain anonymous and be handled confidentially, in line with standard ethical research practices. After obtaining informed consent, participants were asked to proceed with the survey, which focused on their experiences with search engines. The questionnaire included a mix of Likert-scale and multiple-choice questions to capture their perceptions of control, transparency, and search result diversity. Additionally, participants provided basic demographic details to ensure a well-rounded analysis. The survey took approximately 8 to 12 minutes to complete. The study followed all ethical guidelines and received approval from the ethics committee prior to data collection, ensuring that participants' rights and privacy were fully protected throughout the process.

Data analysis method

To analyze the collected data, several statistical tests were conducted using RStudio. Descriptive analyses were first performed to examine mean scores, standard deviations, and frequency distributions for the main variables of interest. These included algorithmic

transparency, personalization control, search result diversity, perceived autonomy, GDPR knowledge and understanding, and digital skills.

Subsequently, one-way analyses of variance (ANOVA) were used to determine whether levels of GDPR-related knowledge, GDPR understanding, and digital skills had a statistically significant effect on perceptions of transparency, control, diversity, and overall perceived autonomy. All statistical analyses were conducted using structured code within R. Digital skills were split into two groups (low vs. high) using a median split based on participants' scores on the digital skills scale.

Meanwhile, GDPR knowledge and GDPR understanding were each divided into three self-reported levels: low, moderate, and high. These groupings were based on participants' subjective assessments and aimed to reflect meaningful distinctions in familiarity and comprehension.

These preliminary analyses confirmed significant variation in digital skill levels across the sample and validated the grouping strategy. The results of the ANOVA tests and post-hoc comparisons confirmed that significant differences existed between groups on several dependent variables, supporting the analytical value of the group classifications. This structured and reproducible approach to data processing ensured that the dataset was both statistically robust and theoretically meaningful, providing a solid foundation for hypothesis testing and group-based comparisons across different levels of digital proficiency and regulatory awareness.

Results

This section begins with descriptive statistics to summarize the sample, followed by an analysis of survey responses on transparency, control, diversity, and digital skills. All items were rated on a seven-point Likert scale (1 = weak perception, 7 = strong perception). Composite scores were calculated per respondent across the three dimensions. On average, transparency received the lowest rating ($M = 3.41$), followed by control ($M = 3.86$), while diversity received the highest rating ($M = 4.48$), indicating a modest but notable difference in perceptions across these dimensions.

Before conducting further analyses, a second-order Confirmatory Factor Analysis (CFA) was performed to validate whether the three core dimensions—transparency, control, and diversity—can be meaningfully grouped under a broader construct: perceived autonomy. The model showed a strong overall fit to the data, with CFI = 0.980, TLI = 0.974, RMSEA = 0.045, and SRMR = 0.036, indicating that the proposed structure is statistically robust and theoretically sound. All three dimensions loaded significantly on the second-order factor, with standardized loadings of 0.806 for transparency, 0.854 for control, and 0.635 for diversity. These findings support the multidimensional conceptualization of autonomy, as formulated in this study. For a detailed breakdown, see Table 3, and refer to Appendix 3 for full model diagnostics and loadings.

Table 3

Second-Order Confirmatory Factor Analysis:

First-Order Construct	Standardized Loading	Standard Error	*t*-value	*p*
Algorithmic Transparency	0.806	0.086	7.290	$p < .001$
Personalization Control	0.854	0.085	7.209	$p < .001$
Search Result Diversity	0.635	0.085	6.273	$p < .00$

Model Fit Indices for the Confirmatory Factor Analysis (CFA)

Fit Index	*Value*
χ^2 ($df = 51$)	86.37
CFI	0.980
TLI	0.974
RMSEA	0.045
SRMR	0.036

To further examine the influence of individual differences in digital skills, a series of univariate analyses of variance (ANOVAs) were conducted. These analyses tested whether perceived transparency, control, and diversity differed as a function of age, education level, GDPR knowledge, GDPR understanding, and digital skills. The goal was to explore how personal characteristics and competencies shape individuals' perceptions of autonomy-related constructs in digital environments.

Algorithmic transparency

A series of ANOVA tests was conducted to examine whether education level, GDPR knowledge, GDPR understanding, and digital skills significantly influenced perceived algorithmic transparency. Table 4 presents the means, standard deviations, and test statistics. Results showed that education level significantly predicted transparency perceptions ($F(2, 347) = 6.97$, $p = .001$, $\eta^2 = 0.039$). Participants with a lower education level perceived search engines as more transparent than those with middle or high education, possibly reflecting a more trusting or less critical stance toward online data practices.

In addition to education, familiarity with GDPR policies had a strong effect on perceived transparency. GDPR knowledge significantly influenced transparency perceptions ($F(2, 347) = 11.9$, $p < 0.001$, $\eta^2 = 0.065$), with individuals demonstrating high GDPR knowledge perceiving transparency more favorably than those with moderate or low GDPR knowledge.

Similarly, GDPR understanding played a significant role in shaping transparency perceptions ($F(2, 347) = 10.0$, $p < 0.001$, $\eta^2 = 0.055$). Respondents with a strong comprehension of GDPR policies reported significantly greater transparency perceptions than those with moderate or low understanding.

A one-way ANOVA revealed a significant effect of digital skills on perceived transparency ($F(1, 347) = 49.7$, $p < 0.001$, $\eta^2 = 0.125$). Individuals with high digital skills perceived significantly greater transparency than those with lower digital skills. This finding highlights the role of digital literacy in shaping perceptions of data transparency, suggesting that individuals who are more proficient in navigating online platforms and managing privacy settings may feel better informed about how search engines collect and use personal data.

Overall, the results indicate that while age does not significantly impact transparency perceptions, factors such as education level, GDPR knowledge, GDPR understanding, and digital skills do play a significant role. Lower education levels, greater familiarity with GDPR policies, and higher digital skills contribute positively to perceptions of transparency in search

engines. These findings suggest that increasing public awareness of GDPR regulations and improving digital literacy may enhance perceptions of transparency in online environments.

Table 4

Effects of education, GDPR knowledge and digital skills and algorithmic transparency

Variable	Group	*M*	*SD*	*N*	*df*	*F*	*p*	η^2
Education Level	Low	3.88	1.35	15	2	6.97	0.001	0.039
	Middle	3.19	1.21	162				
	High	3.42	1.39	115				
GDPR Knowledge	Low	3.13	1.25	165	2	11.9	< .001	0.065
	Moderate	3.54	1.30	154				
	High	3.55	1.30	60				
GDPR Understanding	Low	3.18	1.34	170	2	10.0	< .001	0.055
	Moderate	3.53	1.30	113				
	High	4.47	1.33	96				
Digital Skills	Low	2.95	1.09	178	1	49.7	< .001	0.125
	High	3.75	1.36	176				

Perceived personalization control

A series of ANOVA analyses were conducted to examine differences in perceived control across cognitive variables (see results in Table 5 below). Education level did not significantly affect perceived control ($F(2, 347) = 2.04$, $p = 0.132$, $\eta^2 = 0.012$), indicating that perceptions of control over search engine personalization do not meaningfully differ across educational backgrounds.

GDPR knowledge, however, was found to be a significant predictor of perceived control ($F(2, 347) = 9.04$, $p < .001$, $\eta^2 = 0.050$). Individuals with high GDPR knowledge perceived more control than those with moderate or low GDPR knowledge. Similarly, GDPR understanding significantly influenced perceived control, with respondents demonstrating good understanding reporting greater perceived control compared to those with moderate or low understanding.

Finally, digital skills showed the strongest effect on perceived control ($F(1, 347) = 50.6$, $p < .001$, $\eta^2 = 0.127$). Individuals with high digital skills perceived substantially more control than those with lower digital skills. These findings underscore the importance of

cognitive factors, particularly GDPR awareness and digital competence, in shaping individuals' perceived control over personalization in search engines, whereas formal education level does not appear to play a significant role.

Table 5

Effects of education, GDPR knowledge, and digital skills on personalization control

Variable	Group	*M*	*SD*	*N*	*df*	*F*	*p*	η^2
Education Level	Low	3.99	1.44	72	2	2.04	.132	0.012
	Middle	3.71	1.15	162				
	High	3.98	1.33	115				
GDPR Knowledge	Low	3.60	1.28	165	2	9.04	< .001	0.050
	Moderate	4.00	1.19	154				
	High	4.54	1.32	60				
GDPR Understanding	Low	3.18	1.34	170	2	14.0	< .001	0.075
	Moderate	4.06	1.08	160				
	High	4.87	1.28	19				
Digital Skills	Low	3.41	1.17	178	1	50.6	< .001	0.127
	High	4.32	1.22	171				

Search engine results diversity

ANOVA analyses were conducted to investigate the impact of education, GDPR knowledge, GDPR understanding, and digital skills on perceived diversity in search results. A full summary of the mean scores, standard deviations and ANOVA test are reported in Table 6 below. Education level did not yield a significant effect, indicating that respondents with high, middle, and low education levels perceived diversity in a comparable manner.

GDPR knowledge was a significant predictor of perceived diversity ($F(2, 347) = 3.76$, $p = 0.024$, $\eta^2 = 0.021$). Individuals with greater knowledge of GDPR reported higher diversity in search results, suggesting that awareness of data protection rights may heighten sensitivity to the variety of viewpoints presented. GDPR understanding also had a notable effect on perceived diversity ($F(2, 347) = 2.73$, $p = 0.067$, $\eta^2 = 0.016$). Although just above conventional significance thresholds, the pattern suggests that respondents with a stronger understanding of GDPR policies perceived search results as more diverse. Digital skills demonstrated the strongest influence on perceived diversity ($F(1, 347) = 30.3$, $p < 0.001$, $\eta^2 =$

0.08). Those with high digital competencies perceived significantly more diversity in search engine outputs than their less digitally skilled counterparts.

Taken together, these results indicate that while education does not significantly shape diversity perceptions, cognitive variables such as GDPR knowledge, GDPR understanding, and especially digital skills do play a meaningful role.

Table 6

Effects of education, GDPR knowledge, and digital skills on search results diversity.

Variable	Group	*M*	*SD*	*N*	*df*	*F*	*p*	η^2
Education Level	Low	4.53	1.03	72	2	0.89	0.41	0.005
	Middle	4.41	0.95	162				
	High	4.56	0.99	115				
GDPR Knowledge	Low	4.40	1.06	165	2	3.76	0.024	0.021
	Moderate	4.48	0.92	154				
	High	4.93	1.05	30				
GDPR Understanding	Low	4.47	1.06	170	2	2.73	0.067	0.016
	Moderate	4.44	0.88	160				
	High	4.99	0.94	19				
Digital Skills	Low	4.21	0.95	178	1	30.3	<0.001	0.080
	High	4.77	0.93	171				

Additional results

In addition to the general perception, this study examined whether individuals perceive GDPR as effectively improving transparency, granting more control over their data, and increasing the diversity of search engine results. First, this study examined if respondents perceive GDPR-related transparency lower or higher than general search engine transparency. A paired-samples t-test confirmed this difference ($t(348) = -5.31$, $p < 0.001$), suggesting that while GDPR aims to improve openness in data practices, individuals do not necessarily experience it as achieving this goal.

Further analysis revealed that GDPR understanding plays a role in shaping these perceptions. A one-way ANOVA showed that individuals with a strong understanding of GDPR perceived significantly higher transparency than those with little understanding of

GDPR ($F(2, 346) = 4.15$, $p = 0.0165$; TukeyHSD: $p = 0.0169$). However, no significant difference was found between those with moderate and high GDPR understanding, suggesting that only a deeper comprehension of GDPR provisions contributes to a more positive perception of transparency.

When comparing general perceptions of control over data in search engines with GDPR-specific control, a paired-samples t-test revealed a small but significant difference ($t(348) = 2.32$, $p = 0.021$, mean difference = 0.168). Respondents perceived slightly more general control over their personal data in search engines than control specifically attributed to GDPR. Repeatedly, the extent to which individuals understood GDPR influenced their perceived level of control. A one-way ANOVA showed a significant effect of GDPR understanding on GDPR-related control perception ($F(2, 346) = 10.54$, $p < 0.001$). Post-hoc Tukey tests indicated that individuals with a strong understanding of GDPR felt significantly more in control than those with little understanding ($p < 0.001$). However, the difference between moderate and high levels of understanding was not statistically significant.

Unlike transparency and control, perceptions of diversity in search results followed a different trend. A paired-samples t-test found that respondents perceived GDPR-related diversity as significantly higher than general diversity in search results ($t(348) = 11.59$, $p < 0.001$). This suggests that, unlike transparency and control, GDPR is viewed as contributing positively to the variety of information available online.

The role of GDPR understanding in shaping these perceptions was less clear. A one-way ANOVA assessing the influence of GDPR understanding on GDPR-related diversity perception was only marginally significant ($F(2, 346) = 2.91$, $p = 0.056$). However, post-hoc Tukey tests showed that individuals with a strong understanding of GDPR perceived significantly greater diversity in search results compared to those with little understanding ($p = 0.0446$), though the difference between moderate and high levels of understanding was not statistically significant.

These findings highlight a complex relationship between GDPR and public perceptions of transparency, control, and diversity in search engine results. While GDPR is intended to enhance transparency and empower users, the public does not necessarily perceive it as fulfilling these objectives. Instead, transparency and control are viewed as slightly lower when considered through the lens of GDPR, while diversity is perceived as higher.

Across all three dimensions, individuals' general perceptions of transparency, control, and diversity were the strongest factors shaping their GDPR-related perceptions. Those who already viewed search engines as transparent, granting sufficient control, and offering diverse

results were more likely to believe that GDPR supports these qualities. However, while a strong understanding of GDPR was linked to higher transparency and diversity perceptions in categorical comparisons, it did not consistently influence control perceptions.

Overall, these results suggest that while GDPR may have had a positive impact on perceptions of search result diversity, its effects on transparency and control remain limited. Additionally, public understanding of GDPR does not always translate into stronger perceptions of its benefits. These findings underscore the importance of improving public awareness and communication regarding GDPR's impact on online data practices, ensuring that individuals not only understand the regulation's provisions but also recognize its role in shaping digital transparency and control. An overview of the hypothesis outcomes is provided in Table 7.

Table 7

Summary of hypotheses and conceptual model

Hypothesis	Description	Status
H1	Perceived control over personalization in search engines is positively related to consumers' perceived online autonomy.	Accepted
H2	Higher levels of algorithmic transparency directly increase perceived online autonomy.	Accepted
H3	Higher diversity in search results enhances perceived online autonomy.	Accepted
H4	Digital skills positively influence personalization control, algorithmic transparency, and search result diversity, such that individuals with higher digital skills report greater autonomy across these dimensions.	Accepted

Discussion

This study set out to investigate how individuals perceive algorithmic transparency, personalization control, and search result diversity in the context of search engines, and to what extent these perceptions are shaped by digital skills and GDPR literacy. Drawing on Self-Determination Theory (Deci & Ryan, 2012), perceived online autonomy was conceptualized as a multidimensional construct composed of three interrelated dimensions: transparency, control, and diversity. Through this lens, the study examined not only general user perceptions but also whether the GDPR is seen as an effective regulatory framework that enhances these dimensions. Overall, the findings provide a nuanced view of how structural regulation and individual user competencies interact in shaping online autonomy.

The results showed that digital skills were a consistent predictor of perceived autonomy across all dimensions. Respondents with higher levels of digital literacy reported significantly greater control over personalization, more clarity regarding algorithmic processes, and higher perceived diversity in search results. These findings resonate with existing literature that emphasizes the importance of both technical and critical digital literacy for navigating algorithmic environments (van Deursen & van Dijk, 2014). While GDPR knowledge and understanding also contributed positively to transparency and diversity perceptions, their effect on perceived control was less consistent. This supports earlier findings that knowledge of privacy rights does not automatically translate into empowerment, especially when the mechanisms for exercising those rights are complex, legalistic, or poorly communicated (Marikyan et al., 2024).

A central component of this study was the comparison between general perceptions and GDPR-specific perceptions of transparency, control, and diversity. Findings showed that GDPR was associated with lower perceived transparency and control but higher perceived diversity. Even highly GDPR-literate users did not rate GDPR-related transparency and control more positively underscores a gap between regulatory intention and user experience. This aligns with critiques arguing that although GDPR formalizes data rights, it does not always offer usable or accessible ways for individuals to act on them (Sealey, 2020). The positive association with diversity may reflect a perception that GDPR has reduced algorithmic profiling, although further research is needed to verify actual changes in algorithmic outputs. However, this remains a perception-based conclusion. Future research should empirically test whether GDPR has produced measurable shifts in actual content diversity by analyzing search engine outputs longitudinally.

An important insight emerging from the data is the role of pre-existing attitudes toward search engines. Individuals who already held favorable views on the transparency and fairness of search platforms tended to perceive GDPR more positively as well. This reinforces the notion that regulatory perception is often filtered through prior user experiences and platform trust, rather than legal awareness alone. Additionally, while age was included as a demographic variable and analyzed in two broad groups (18–29 and 30+), this categorization may have oversimplified age-related effects. Future studies should consider more granular age groupings to capture nuanced generational differences in digital autonomy. In this regard, even well-designed regulations may fail to shift public attitudes if they are not accompanied by visible, user-centric improvements in platform governance.

Taken together, these findings contribute to ongoing academic debates in algorithmic governance, digital autonomy, and data protection regulation. Conceptually, the study validates the conceptualization of autonomy as a second-order factor composed of transparency, control, and diversity, offering an integrative model for future research. Empirically, the results suggest that digital skills are not merely an enabler of autonomy but a precondition for experiencing it. Although the GDPR was perceived as enhancing diversity, its role in strengthening user control and transparency remains ambiguous. The study also illustrates the limitations of assuming that legal frameworks inherently empower users. Without clear communication, intuitive design, and critical literacy, regulatory goals remain largely aspirational.

From a policy perspective, these findings underscore the urgency of making data rights more actionable. Regulators must go beyond mandating disclosures and develop standards for simplicity, accessibility, and real-time user feedback. Consent flows, privacy settings, and algorithmic explanations need to be designed not only for legal compliance but for everyday usability. Search engines should take responsibility for making data practices transparent and customization intelligible. Features like “Why this result?” explanations, personalization controls, and transparent ranking criteria could help users feel genuinely in charge of their online experience.

Educational institutions and digital rights organizations also have a critical role to play. Integrating critical algorithmic literacy into broader digital citizenship curricula will better prepare users to interpret and question personalization and data usage mechanisms. Autonomy in digital environments is not merely a legal or technical matter, but also a civic one.

Finally, looking forward, the arrival of the Digital Services Act (DSA), Digital Markets Act (DMA), and the AI Act suggests that the regulatory landscape will continue to evolve rapidly. These new frameworks promise stronger transparency obligations, algorithmic accountability, and enhanced user protections. However, their success will depend on whether they can address the shortcomings observed in the implementation of GDPR, particularly the persistent gap between having rights and being able to meaningfully exercise them. Future research should explore whether these new laws will succeed in closing the autonomy gap, or whether structural and cognitive barriers to digital empowerment will continue to persist.

Limitations and future research

As with any study, this research has several limitations that should be acknowledged. These limitations provide opportunities for future research to refine and expand upon the findings presented here. The main limitations of this study concern the sampling method, the reliance on self-reported perceptions, the cross-sectional design, and the scope of the measurements used.

One of the primary limitations of this study is the sampling method. The study relied on convenience sampling via online recruitment platforms such as WhatsApp, LinkedIn, and Facebook. While this approach ensured a relatively diverse sample, it was not representative of the entire population. The sample primarily consisted of Dutch respondents, which limits the generalizability of the findings to other countries and regulatory environments. Additionally, the sample may not fully capture individuals with lower digital literacy levels or those who are less engaged with online privacy discussions. Future research could benefit from probability sampling techniques to recruit a more representative sample and ensure broader applicability of the results.

Another limitation of this study is its reliance on self-reported data to assess perceptions of transparency, control, and diversity in search engine results. While surveys are a useful tool for gathering subjective experiences, they are also susceptible to biases such as social desirability bias and recall bias. Participants may have provided responses that they believed were expected rather than their actual experiences. Furthermore, self-reported perceptions do not necessarily reflect objective reality. For instance, individuals might perceive GDPR as ineffective in improving transparency, even if search engines have made compliance changes that enhance data transparency. Future studies could incorporate behavioral measures or experimental designs to complement self-reported data and gain a more comprehensive understanding of the relationship between GDPR and user experiences.

This study employed a cross-sectional design, meaning that all data were collected at a single point in time. While this approach allows for the identification of associations between variables, it does not establish causality. For example, while the study found that individuals with higher digital skills perceive greater transparency, it remains unclear whether digital literacy causes higher transparency perceptions or whether individuals who already perceive transparency more positively also tend to have greater digital skills. A longitudinal design could help clarify these relationships by examining how perceptions evolve over time, particularly as individuals become more familiar with GDPR regulations and their implications.

Another limitation concerns the lack of pre-GDPR data. Since all data were collected after GDPR implementation, this study cannot definitively measure whether perceptions of transparency, control, and diversity have changed as a direct result of GDPR. Instead, the study only captures how respondents currently perceive these aspects. Future research could compare data from different post-GDPR time points to assess whether perceptions shift as people become more accustomed to GDPR regulations or as enforcement mechanisms evolve.

The study primarily relied on closed-ended survey questions, which provided structured and comparable data, but limited the depth of responses. As a result, the underlying reasons for respondents' perceptions remain unexplored. For instance, while the study found that GDPR-related transparency is perceived as lower than general transparency, it does not fully explain why respondents hold this view. Future studies could employ qualitative methods such as interviews or focus groups to explore why users hold certain perceptions of GDPR's impact. Additionally, incorporating open-ended questions in surveys could allow participants to elaborate on their experiences and provide richer insights.

Finally, the study focused on GDPR as the primary regulatory framework but did not account for other evolving policies, such as the Digital Markets Act (DMA) or the Digital Services Act (DSA), which may also influence transparency, control, and diversity in search engines. Additionally, search engine algorithms and data practices continue to evolve, which implies that the perceptions measured in this study may change over time. Future research should adopt a longitudinal approach to track how perceptions shift as both regulatory measures and technological landscapes develop.

Despite these limitations, this study provides meaningful insights into how individuals perceive transparency, control, and diversity in search engines in the context of GDPR. The findings suggest that while GDPR has had some impact on perceived diversity, its effects on transparency and control remain limited in public perception. Future research can build upon

these findings by employing more representative samples, incorporating behavioral data, and exploring longitudinal changes in GDPR-related perceptions. By addressing these limitations, further studies can contribute to a more comprehensive understanding of how privacy regulations, such as the GDPR, influence perceived autonomy in digital environments.

Conclusion

This study explored the extent to which the General Data Protection Regulation (GDPR) has influenced perceived consumer autonomy in search engines, using three dimensions—personalization control, algorithmic transparency, and search result diversity—as indirect indicators of perceived autonomy. The findings suggest that while GDPR provides a legal framework intended to increase user control and transparency, user perceptions of its influence on autonomy appear to be mixed. Respondents with higher digital skills and GDPR knowledge perceived significantly more control and transparency, yet overall perceptions remained moderate, indicating a disconnect between regulatory intent and user experience. In contrast, search result diversity was rated highest among the three dimensions and emerged as the strongest contributor to perceived autonomy. This highlights that, although transparency and control remain abstract or difficult to operationalize for users, the increased exposure to varied viewpoints feels more tangible. Digital skills played a crucial role across all three dimensions. Users with higher digital competencies were better equipped to navigate privacy settings, interpret data policies, and critically engage with content personalization, underscoring the importance of public education and skill-building in enabling the full exercise of GDPR rights. Interestingly, demographic factors like education and age also shaped perceptions, with younger and less-educated respondents reporting more favorable views, potentially reflecting lower levels of critical scrutiny or lower privacy expectations. Moreover, a comparison between general and GDPR-specific perceptions revealed that while users felt GDPR improved diversity in search results, it did not lead to higher perceived transparency or control, raising questions about the practical accessibility of these rights. These results underline that regulation alone does not guarantee empowerment; users must be able to understand and engage with digital systems meaningfully. Therefore, improving the clarity of privacy interfaces, simplifying consent mechanisms, and promoting digital literacy are key to closing the gap between legal protection and user experience. This study contributes to ongoing debates in data privacy and algorithmic governance by showing that perceived online autonomy is not only shaped by structural regulation, but also by the user's ability to interact with that structure. While the GDPR lays a strong foundation, future policy

efforts must ensure that individuals are not only protected by law, but also empowered in practice.

Literature

Ackermann, K. A., Burkhalter, L., Mildenberger, T., Frey, M., & Bearth, A. (2022). Willingness to share data: Contextual determinants of consumers' decisions to share private data with companies. *Journal of Consumer Behaviour, 21*(2), 375-386.

Agozie, D. Q., & Kaya, T. (2021). Discerning the effect of privacy information transparency on privacy fatigue in e-government. *Government Information Quarterly, 38*(4), 101601.

Akbar, A., Caton, S., & Bierig, R. (2022, December). Personalised Filter Bias with Google and DuckDuckGo: An Exploratory Study. In *Irish Conference on Artificial Intelligence and Cognitive Science* (pp. 502-513). Cham: Springer Nature Switzerland.

André, Q., Carmon, Z., Wertenbroch, K., Crum, A., Frank, D., Goldstein, W., ... & Yang, H. (2018). Consumer choice and autonomy in the age of artificial intelligence and big data. *Customer needs and solutions, 5*, 28-37.

Andrews, D., Nonnecke, B., & Preece, J. (2003). Electronic survey methodology: A case study in reaching hard-to-involve Internet users. *International journal of human-computer interaction, 16*(2), 185-210.

Acquisti, A., Brandimarte, L., & Loewenstein, G. (2015). Privacy and human behavior in the age of information. *Science, 347*(6221), 509-514.

Bleier, A., Goldfarb, A., & Tucker, C. (2020). Consumer privacy and the future of data-based innovation and marketing. *International Journal of Research in Marketing, 37*(3), 466-480.

Bozdag, E. (2013). Bias in algorithmic filtering and personalization. *Ethics and information technology, 15*, 209-227.

Brehm, S. S., & Brehm, J. W. (2013). Psychological reactance: *A theory of freedom and control*. Academic Press.

Cabral, L., Haucap, J., Parker, G., Petropoulos, G., Valletti, T. M., & Van Alstyne, M. W. (2021). The EU digital markets act: a report from a panel of economic experts. *Cabral, L., Haucap, J.,*

Parker, G., Petropoulos, G., Valletti, T., and Van Alstyne, M., The EU Digital Markets Act, Publications Office of the European Union, Luxembourg.

Calvo, R. A., Peters, D., Vold, K., & Ryan, R. M. (2020). Supporting human autonomy in AI systems: A framework for ethical enquiry. *Ethics of digital well-being: A multidisciplinary approach*, 31-54.

Charif, A., Kassir, A., & Ashaal, A. (2020). General Data Protection Regulation (GDPR) in the airlines industry: privacy in the eyes of the Lebanese consumers. *European Journal of Interdisciplinary Research, 1*(1), 60-81.

Coen, R., Paul, E., Vanegas, P., Lange, A., & Hans, G. S. (2016). *A user-centered perspective on algorithmic personalization* (MIMS Final Project, University of California, Berkeley). https://www.ischool.berkeley.edu/projects/2016/user-centered-perspective-algorithmic-personalization

Deci, E. L., & Ryan, R. M. (2012). Self-determination theory. *Handbook of theories of social psychology, 1*(20), 416-436.

Deloitte. (2018). "A New Era for Privacy: GDPR Six Months On." https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Risk/gx-deloitte-risk-gdpr-six-months-on.pdf

Dogruel, L., Facciorusso, D., & Stark, B. (2022). 'I'm still the master of the machine.' Internet users' awareness of algorithmic decision-making and their perception of its effect on their autonomy. *Information, Communication & Society, 25*(9), 1311-1332.

European Commission. (2019). "Special Eurobarometer 487a – March 2019: The General Data Protection Regulation." Kantar Public [producer]. https://europa.eu/eurobarometer/api/deliverable/download/file?deliverableId=69701

Evans, R., Jackson, D., & Murphy, J. (2023). Google News and machine gatekeepers: Algorithmic personalisation and news diversity in online news search. Digital Journalism, 11(9), 1682-1700.

Fabbri, M. (2023, August). How and to which extent will the provisions of the Digital Services Act of the European Union impact on the relationship between users and platforms as information providers?. *In Proceedings of the 2023 AAAI/ACM Conference on AI, Ethics, and Society* (pp. 1002-1003).

Fassiaux, S. (2023). Preserving consumer autonomy through European Union regulation of artificial intelligence: A long-term approach. *European Journal of Risk Regulation, 14*(4), 710-730.

Finstad, K. (2010). Response interpolation and scale sensitivity: Evidence against 5-point scales. *Journal of usability studies, 5*(3), 104-110.

Fox, G., Lynn, T., & Rosati, P. (2022). Enhancing consumer perceptions of privacy and trust: a GDPR label perspective. *Inf. Technol. People, 35*, 181-204.

Gal, M. S., & Aviv, O. (2020). The competitive effects of the GDPR. *Journal of Competition Law & Economics, 16*(3), 349-391.

Galindo, F., & Garcia-Marco, J. (2017). Freedom and the Internet: Empowering citizens and addressing the transparency gap in search engines. *European journal of law and technology, 8*(2).

Guo, Y., Li, S., Zhou, L., & Sun, Y. (2024). Exploring the influence of technology regulatory policy instruments on public acceptance of algorithm recommender systems. *Government Information Quarterly, 41*(3), 101940.

Gillespie, T. (2014). The relevance of algorithms. *Media technologies: Essays on communication, materiality, and society, 167*(2014), 167.

Goddard, M. (2017). The EU General Data Protection Regulation (GDPR): European regulation that has a global impact. *International Journal of Market Research, 59*(6), 703-705.

Gramegna, A. (2018). *Data-gathering, governance, and algorithms: how accountable and transparent practices can mitigate algorithmic threats* (Doctoral dissertation, Toronto Metropolitan University).

Gumzej, N. (2021). 'The Right to Be Forgotten'and the Sui Generis Controller in the Context of CJEU Jurisprudence and the GDPR. *Croatian yearbook of European law & policy, 17*(1), 127-158.

Han, B., Shah, C., & Saelid, D. (2021, April). Users' perception of search-engine biases and satisfaction. In *International Workshop on Algorithmic Bias in Search and Recommendation* (pp. 14-24). Cham: Springer International Publishing.

Hutmacher, F., & Appel, M. (2023). The psychology of personalization in digital environments: From motivation to well-being–a theoretical integration. *Review of General Psychology, 27*(1), 26-40.

Helberger, N. (2011). Diversity by design. *Journal of Information Policy, 1*, 441-469.

Helberger, N. (2021). On the democratic role of news recommenders. In *Algorithms, automation, and news* (pp. 14-33). Routledge.

Kesan, J. P., Hayes, C. M., & Bashir, M. N. (2015). A comprehensive empirical study of data privacy, trust, and consumer autonomy. *Ind. LJ, 91*, 267.

Kezer, M., Sevi, B., Cemalcilar, Z., & Baruh, L. (2016). Age differences in privacy attitudes, literacy and privacy management on Facebook. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace, 10(*1).

Kleanthous, S., & Siklafidis, C. (2023, September). Perception of Personalization Processes: Awareness, Data Sharing and Transparency. In *Proceedings of the 2nd International Conference of the ACM Greek SIGCHI Chapter* (pp. 1-5).

Krafft, T. D., Gamer, M., & Zweig, K. A. (2019). What did you see? A study to measure personalization in Google's search engine. *EPJ Data Science, 8*(1), 38.

Lambillotte, L., Bart, Y., & Poncin, I. (2022). When does information transparency reduce downside of personalization? Role of need for cognition and perceived control. *Journal of Interactive Marketing, 57*(3), 393-420.

Lee, W. Y., Tan, C. S., & Siah, P. C. (2017). The role of online privacy concern as a mediator between internet self-efficacy and online technical protection privacy behavior. *Sains Humanika, 9(*3-2).

Liu, J., & Han, F. (2022, July). Matching search result diversity with user diversity acceptance in web search sessions. In *Proceedings of the 45th international ACM SIGIR conference on research and development in information retrieval* (pp. 2473-2477).

Lorenz-Spreen, P., Lewandowsky, S., Sunstein, C. R., & Hertwig, R. (2020). How behavioural sciences can promote truth, autonomy and democratic discourse online. *Nature human behaviour, 4*(11), 1102-1109.

Lukic, K., Miller, K. M., & Skiera, B. (2024). The impact of the general data protection regulation (gdpr) on online tracking. *Available at SSRN 4399388.*

Marikyan, D., Papagiannidis, S., Rana, O. F., & Ranjan, R. (2024). General data protection regulation: A study on attitude and emotional empowerment. *Behaviour & Information Technology, 43*(14), 3561-3577.

Martin, K. D., & Murphy, P. E. (2017). The role of data privacy in marketing. *Journal of the Academy of Marketing Science, 45*, 135-155.

McBurney, S., Taylor, N., Williams, H., & Papadopoulou, E. (2009, April). Giving the user explicit control over implicit personalisation. In *Procs. of Workshop on Intelligent Pervasive Environments (under AISB'09), Edinburgh, Scotland.*

Mik, E. (2016). The erosion of autonomy in online consumer transactions. *Law, Innovation and Technology, 8*(1), 1-38.

Nagpal, M., & Petersen, J. A. (2021). Keyword selection strategies in search engine optimization: how relevant is relevance?. *Journal of retailing, 97*(4), 746-763.

Norberg, P. A., Horne, D. R., & Horne, D. A. (2007). The privacy paradox: Personal information disclosure intentions versus behaviors. *Journal of consumer affairs, 41*(1), 100-126.

Pariser, E. (2011). The filter bubble: *What the Internet is hiding from you.* penguin UK.

Pentina, I., Zhang, L., Bata, H., & Chen, Y. (2016). Exploring privacy paradox in information-sensitive mobile app adoption: A cross-cultural comparison. *Computers in Human Behavior, 65*, 409-419.

Pinxteren, D. V. (2019). *Online personalization in the age of big data.* https://www.semanticscholar.org/paper/Online-Personalization-in-the-Age-of-Big-Data-Pinxteren/ba3a61dc1f3f648b80795a2ea4f948a0cadd838e

Pollack, R. (2016). Opening the Black Box: In Search of Algorithmic Transparency. *Available at SSRN 3837723.*

Robertson, R. E., Lazer, D., & Wilson, C. (2018, April). Auditing the personalization and composition of politically-related search engine results pages. *In Proceedings of the 2018 World Wide Web Conference* (pp. 955-965).

Preston, C. C., & Colman, A. M. (2000). Optimal number of response categories in rating scales: reliability, validity, discriminating power, and respondent preferences. *Acta psychologica, 104*(1), 1-15.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist, 55*(1), 68.

Ryan, R. M., Ryan, W. S., Di Domenico, S. I., & Deci, E. L. (2019). The nature and the conditions of human autonomy and flourishing. *The Oxford handbook of human motivation, 89.*

Sankaran, S., Zhang, C., Aarts, H., & Markopoulos, P. (2021). Exploring peoples' perception of autonomy and reactance in everyday ai interactions. *Frontiers in psychology, 12*, 713074.

Sealey, B. (2020). Has the 2016 General Data Protection Regulation really given consumers more control over their personal data?. *LJMU Student Law Journal, 1,* 17-41.

Sieger, L. N., & Detjen, H. (2021). Exploring Users' Perceived Control Over Technology. In *Proceedings of Mensch und Computer 2021* (pp. 344-348).

Steiner, M., Magin, M., Stark, B., & Geiß, S. (2022). Seek and you shall find? A content analysis on the diversity of five search engines' results on political queries. *Information, Communication & Society, 25*(2), 217-241.

Taylor, J. (2020). How Search Personalization Impacts Consumer Behavior.

Tufekci, Z. (2015). Algorithmic harms beyond Facebook and Google: Emergent challenges of computational agency. *Colo. Tech. LJ, 13*, 203.

Turillazzi, A., Taddeo, M., Floridi, L., & Casolari, F. (2023). The digital services act: an analysis of its ethical, legal, and social implications. *Law, Innovation and Technology, 15*(1), 83-106.

Van de Waerdt, P. J. (2020). Information asymmetries: recognizing the limits of the GDPR on the data-driven market. *Computer Law & Security Review, 38*, 105436.

Van Deursen, A. J. A. M., Helsper, E., & Eynon, R. (2014). Measuring digital skills: From digital skills to tangible outcomes project report.

Van Deursen, A. J., Helsper, E. J., & Eynon, R. (2016). Development and validation of the Internet Skills Scale (ISS). *Information, communication & society, 19*(6), 804-823.

Vansteenkiste, M., Ryan, R. M., & Deci, E. L. (2006). Self-determination theory and the explanatory role of psychological needs in human well-being.

Van Couvering, E. (2007). Is relevance relevant? Market, science, and war: Discourses of search engine quality. *Journal of Computer-Mediated Communication, 12*(3), 866-887.

Wedel, M., & Kannan, P. K. (2016). Marketing analytics for data-rich environments. *Journal of marketing, 80*(6), 97-121.

Wertenbroch, K., Schrift, R. Y., Alba, J. W., Barasch, A., Bhattacharjee, A., Giesler, M., ... & Zwebner, Y. (2020). Autonomy in consumer choice. *Marketing letters, 31*, 429-439.

Wulf, A. J., & Seizov, O. (2024). "Please understand we cannot provide further information": evaluating content and transparency of GDPR-mandated AI disclosures. *AI & SOCIETY, 39*(1), 235-256.

Wu, S., Zhang, Z., & Xu, C. (2019). Evaluating the effectiveness of Web search engines on results diversification. Information Research: *An International Electronic Journal, 24*(1), n1.

Xu, H. (2007). The effects of self-construal and perceived control on privacy concerns.

Zaeem, R. N., & Barber, K. S. (2020). The effect of the GDPR on privacy policies: Recent progress and future promise. *ACM Transactions on Management Information Systems (TMIS), 12*(1), 1-20.

Zhao, Y., Yildirim, P., & Chintagunta, P. K. (2021). Privacy regulations and online search friction: Evidence from GDPR. *Available at SSRN, 3903599.*

Appendix 1: Survey

Openings statement	Dear participant, Thank you for taking the time to participate in this survey. In this study, we aim to understand how Dutch consumers experience their freedom when using search engines, especially since stricter regulations have been introduced to better protect your online privacy. This questionnaire will ask various questions about your experiences with search engines. Completing the survey will take approximately 10 minutes. Your participation is entirely anonymous, and your responses will only be used for this research and will be processed confidentially. You may stop your participation at any time and withdraw your consent for the use of your responses. By proceeding, you confirm that you have understood the above information, wish to participate in this study, and consent to the processing of your (anonymized) responses. ☐ I agree ☐ I do not agree
Age	What is your age? _____
Gender	What is your gender? ☐ Male ☐ Female ☐ Prefer not to say ☐ Other, namely...
Educational level	What is the highest level of education you have started or completed? ☐ High school ☐ Vocational education (MBO) ☐ Applied sciences degree (HBO) ☐ University bachelor's degree ☐ University master's degree
Search engine type	Which search engine do you use the most? ☐ Google ☐ Microsoft Bing ☐ Yahoo!

	☐ DuckDuckGo ☐ Other, namely...
Search engine frequency	How often do you use a search engine? ☐ More than 3 times a day ☐ Daily (1-2 times per day) ☐ Weekly ☐ Monthly ☐ Less than once a month ☐ Never
GDPR awareness	Are you familiar with the GDPR (General Data Protection Regulation)? ☐ Yes ☐ No
GDPR knowledge	Do you know how the GDPR protects your personal data in search engines? ☐ I know little or nothing about this. ☐ I have some knowledge of it. ☐ I know a lot about it.
GDPR understanding	Do you understand how the GDPR protects your personal data when using search engines? ☐ I do not understand how my data is protected. ☐ I somewhat understand how my data is protected. ☐ I fully understand how my data is protected.
Short explanation of the GDPR. (Note: This text is only shown to participants who indicate that they are not familiar with the GDPR or do not understand its content.)	Before proceeding, you can read a short description of the GDPR below: The GDPR is a privacy law in the EU that gives individuals more control over their personal data. It requires companies to be transparent and securely manage data while providing users with more privacy settings and protection against data collection.
Instructions	Below are several statements about your experience with transparency and the use of personal data in search engines. Please indicate to what extent you agree with each statement. There are no right or wrong answers; we are only interested in your personal experience.
Algorithmic transparency	My search engine clearly states what personal information about me is collected. ☐ Strongly agree ☐ Agree ☐ Somewhat agree

	☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree My search engine indicates how long my personal information is stored. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree My search engine clearly communicates my rights regarding my personal information. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree My search engine clearly states how they use my personal information. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree
Comparison pre-GDPR	Since the introduction of the GDPR (May 2018), I feel that search engines have become more transparent about the collection and processing of personal data. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree

	☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree
Instructions	Below you will find statements about your control over personal data in search engines. Personal data refers to any information that can be traced back to you—such as your search history, IP address, and location—and is often used to personalize your search experience. There are no right or wrong answers; we are simply interested in your personal experience.
Perceived control	I have control over the personal information my search engine collects about me. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree I can easily adjust my privacy settings to manage how my personal information is used by my search engine. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree I can determine how my personal information is used to personalize my search results. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree

	I can easily find and change settings regarding how my personal data is stored and shared. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree
Comparison pre-GDPR Perceived control	Since the introduction of the GDPR (May 2018), I experience more control over my personal data in search engines. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree
Instructions	The following statements relate to the diversity of search engine results. There are no right or wrong answers; we are only interested in your personal experience.
Search results diversity	My search engine shows me different perspectives that match my interests. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree I feel that my search engine provides results from many different reliable sources. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree

	☐ Strongly disagree Personalization of search results does not limit my access to different viewpoints. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree The variety of search results helps me make better decisions. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree
Comparison pre-GDPR Search results diversity	Since the introduction of the GDPR (May 2018), I see more diverse search results with different perspectives, rather than only personalized content. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree
Instructions	Below you will find several statements about your digital skills. These statements assess your ability to effectively use the internet, including searching for, processing, and evaluating information. Please indicate to what extent you agree with each statement. There are no right or wrong answers; it is about your own assessment of your skills.

Digital Skills	I can easily navigate the settings of my search engine to adjust my preferences. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree _____ I frequently use search filters and refinements to quickly find specific information. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree _____ I know how to find reliable information using my search engine. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree _____ I know how to recognize and avoid dangerous links and content in search results. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree

	I effectively use my search engine to find information that helps me with personal and work-related goals. ☐ Strongly agree ☐ Agree ☐ Somewhat agree ☐ Neither agree nor disagree ☐ Somewhat disagree ☐ Disagree ☐ Strongly disagree _____
Closing statement	Thank you for participating in this study. If you have any comments or questions about (your participation in) this research, please send an email to: h.m.timmerman@student.utwente.nl

Appendix 2: Confirmatory Factor Analysis (CFA)

Model Fit Indices

Fit Index	Value
χ^2 (df = 98)	216.31
CFI	0.947
TLI	0.936
RMSEA	0.059
SRMR	0.061
AIC	17905.36
BIC	18051.85
SABIC	17931.30

Standardized Factor Loadings

Latent Variable	Item	Loading
Transparency	Q9.Transparency_1	0.818
	Q9.Transparency_2	0.698
	Q9.Transparency_3	0.800
	Q9.Transparency_4	0.825
Control	Q10.Control_1	0.707
	Q10.Control_2	0.823
	Q10.Control_3	0.731
	Q10.Control_4	0.791
Diversity	Q11.Diversity_1	0.684
	Q11.Diversity_2	0.751
	Q11.Diversity_3	0.532
	Q11.Diversity_4	0.473
Digital Skills	Q12.Digital.skills_1	0.659
	Q12.Digital.skills_3	0.782
	Q12.Digital.skills_4	0.632

Covariances Between Latent Variables

Variables	Estimate	p-value
Transparency ~~ Control	0.689	< .001
Transparency ~~ Diversity	0.512	< .001
Transparency ~~ DigitalSkills	0.387	< .001
Control ~~ Diversity	0.541	< .001
Control ~~ DigitalSkills	0.536	< .001
Diversity ~~ DigitalSkills	0.419	< .001

Appendix 3: Confirmatory Factor Analysis – Second-Order

Model Fit Indices

Fit Index	Value
χ^2 (df = 51)	86.37
p-value (Chi-square)	0.001
CFI	0.980
TLI	0.974
RMSEA	0.045
90% CI RMSEA	[0.028, 0.060]
SRMR	0.036
χ^2 (df = 51)	86.37
p-value (Chi-square)	0.001

Second-Order Factor Loadings

First-Order Construct	Standardized Loading	Std. Error	z-value	p-value
Transparency	0.806	0.112	7.290	< .001
Control	0.854	0.117	7.260	< .001
Diversity	0.635	0.085	6.273	< .001

Standardized Factor Loadings – Second-Order CFA

First-Order Factor	Item	Standardized Loading
Transparency	Q9.Transparency_1	0.818
Transparency	Q9.Transparency_2	0.697
Transparency	Q9.Transparency_3	0.800
Transparency	Q9.Transparency_4	0.826
Control	Q10.Control_1	0.709
Control	Q10.Control_2	0.822
Control	Q10.Control_3	0.732
Control	Q10.Control_4	0.789
Diversity	Q11.Diversity_1	0.693
Diversity	Q11.Diversity_2	0.745
Diversity	Q11.Diversity_3	0.534
Diversity	Q11.Diversity_4	0.465