Attention Receipts: Utilizing the Materiality of Receipts to Improve Screen-time Reflection on YouTube

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Figure 1: Left - the printer that provides receipts for the amount of time spent on YouTube; Right - the receipt contains the title of the video, the amount of time spent watching it and the total time.

ABSTRACT

YouTube remains a site of problematic persuasive media consumption, often overriding the goals of users when on the platform. In resistance, we present Attention Receipts — artifacts that materialize the cost of being persuaded by the engagement driven design of YouTube. We design and build a browser plugin and a receipt printer that helps users critically reflect upon their time spent watching videos on YouTube. In a 3 week field-deployment with 6 participants, we evaluate how the materiality of the receipt and their agency in the reflection process affect both the quality of reflection and the time spent consuming media. We find that the materiality of the receipts positively influences time spent consuming internet media and that users were split on having agency over when and how they reflect upon their screen-time. We conclude with design recommendations for domestic artifacts that utilize materiality to reveal the effects of persuasive technology.

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CCS CONCEPTS

• **Human-centered computing** → **Field studies**; **User studies**; *Visualization techniques*; *Interaction design.*

KEYWORDS

digital wellbeing, slow technology, screen-time reflection, youtube, materiality, persuasive technology, agency, ambient objects, internet of things

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1 INTRODUCTION

Over the last decade, the internet has become the de-facto option for media and content consumption owing to the explosion in personal computing availability and extensive wireless internet access. This convergence [31] affords several benefits to the various stakeholders in the system. It inherently simplifies the sharing and distribution process for producers and enhances the accessibility of content consumption for users. While the user may view such consumption platforms as easy and free pathways to media and

content, the platform is primarily concerned with holding the user's attention with the sole intention of monetizing it. This phenomenon, aptly termed the "attention economy" [71] tends to prevail over all aspects of the user experience and the decisions made during the design process [63]. The strongest indicator of success for a platform is "user engagement" [51]. From the techno-capitalist perspective, higher user engagement indicates that the choices made by the involved stakeholders have been successful. From the user's perspective, this can often result in heavy mismatches between their goals and the goals of the platform [44] resulting in low-quality and high-quantity screen-time [26, 43].

As a direct result, information overload [6], shortened attention spans [60] and general tech addiction [15] are commonplace and growing still. While these effects can sometimes be felt by individual users as negative affect [18, 19, 30, 65, 66] or when directed, most users are largely left shortchanged while trying to combat these ill-effects. Studies have shown that individual attempts to adjust screen-time on persuasive platforms are associated with alarmingly high rates of self-control failure [4, 21, 36, 37, 40, 57, 62]. Within HCI research, this has been discussed and demonstrated through the user agency lens [44], which argues that the inability to exercise agency over adjusting screen-time results in a direct failure of user needs.

Multiple solutions have been proposed by researchers to try and address this issue [47]. Some of these focus on redesigning the apps that are the sources of these problems [43, 44] and others suggest building external applications to increase self-control [28, 34, 36, 37]. Applications also allow users to impose restrictions on their usage based on time or frequency limits [47]. While allowing users to impose restrictions by themselves demonstrates potential for success, it also creates challenges finding the sweet spot in "provid[ing] support that is sufficient to change behavior without feeling too coercive" [46]. Several other applications have been designed by researchers, developers and corporations to allow users to reflect upon their time spent on specific platforms with the hope that reflection would encourage users to alter their habits.

In this work, we derive inspiration from the concepts of slow technology [27], adversarial design [16], and material centric design [68] to explore how a user's relationship with YouTube is impacted when they co-exist with a domestic object that prints receipts (§4) for their time spent watching videos on YouTube. While our work may seem like it's squarely situated in the field of personal informatics, our intervention does not focus on the novel data that users' can utilize to change their behavior, but *instead on the potential of using tangibility and materiality along with the cultural memory [14] of receipts (§3) in affective ways to provide avenues for reflection.*

We deployed our research product [55] in the homes of 6 participants for a ∼3-week period. Participants used our system under 3 different conditions (∼1 week each) during this period (§5). They completed questionnaires and engaged in interviews with the research team at the conclusion of each ∼week. Through our study, we found that the materiality of the receipt improved the quality of reflection as well as the quality and quantity of time spent on YouTube (§6). In addition, we found that while most users preferred retaining agency over when they choose to reflect, users were split on the quality of reflection in a hands-off approach where the object chooses for them. We first discuss the implications of our findings (§7) and next, by drawing from our findings and the design process, we synthesize a set of implications for other designers and researchers interested in utilizing materiality and building domestic objects that serve as resistive aids against persuasive technology (§8).

2 BACKGROUND AND MOTIVATION

In this section, we briefly review work by previous researchers on YouTube's persuasiveness, slow technology and designing for reflection, and then motivate the potential of using the materiality of receipts as a reflection mechanism.

2.1 The Persuasiveness of YouTube

YouTube is designed as a platform for online video sharing and social media. Over the last two decades it has firmly embedded itself into popular culture, regularly influences internet trends, and has created many internet celebrities. From the creator's perspective, YouTube is a way to reach an audience and to earn a living while doing so. From the content consumer's perspective, it is a free platform for content consumption with an option to pay to remove ads and gain some additional features. However, the perspective that heavily influences the design of YouTube is that of the platform that treats higher user engagement as potential revenue [7, 13, 33]. Lukoff et al. [44], keenly explore how this goal dissonance between the user and the platform affects user agency when they are interacting with YouTube and propose changes to increase user agency.

This loss of user agency leads to regular self-control failures while using persuasive platforms [4, 21, 36, 37, 40, 47, 57, 62]. Researchers have also explored other mechanisms that drive user engagement on YouTube [5, 33, 51, 52]. While some of these are attributed to choices made by the creator, these choices are eventually driven by YouTube's algorithm that heavily favors user engagement over other metrics [9]. While a large percentage of users are interested in changing their YouTube habits [43], users still regularly report failure in self-control while using the platform [15, 35, 50, 70]. Research suggests that users wish to change their media consumption habits by adjusting the *quality* and *quantity* of time they spend consuming media [26, 43].

Multiple methods have been proposed to return agency to users and help them adjust their usage. Changes have been suggested to the user interface to increase user agency [44]. Users reported a greater sense of agency while using SwitchTube [43], an alternative front-end to YouTube that allows users to switch between Explore Mode and Focus Mode. Several apps have been launched to provide users with tools to reduce their usage of devices and addictive platforms [47]. Some researchers have also suggested physical interventions to make phone use more intentional by adding a manual crank [64].

Our work is motivated by the persuasiveness of YouTube and its prevalence as an addictive platform. While our design can be extended to any other platform, in this work we focus on YouTube to study the effects of our system as it allows us to easily categorize *quality* (the title of the video) and *quantity* (the amount of time spent watching the video) at this stage. We also ignore YouTube

shorts for this study as categorizing the quality of content is significantly more challenging, as the videos themselves do not rely on descriptive titles to attract viewers.

2.2 Designing for Reflection and the Data-Driven Life

Designing technology with the sole intent to reflect is not a new concept. Slow technology [27] is a sub-field of HCI research that focuses on designing "technology aimed at reflection and moments of mental rest rather than efficiency in performance" [27].

Olly is a music player that encourages reflection by randomly grabbing a song from the user's listening history, allowing the user to "re-experience digital music that they listened to in the past" [54]. Photobox is a domestic object that "occasionally prints a randomly selected photo from the owner's Flickr collection inside of a wooden chest" [53, 56]. The Long Living Chair [58] is an object that visualizes the number of times someone has sat on the chair over its lifetime.

Apart from focusing on the design of objects to provoke reflection, researchers have also explored the practice of collecting data to "gain self-knowledge and produce change" [59] in the field of Personal Informatics. Similarly, The Quantified Self [45] movement – measuring aspects of your life with the intent to optimize them – has also gained traction over the years. While slow technology contributes a different positionality with respect to why and how we design new technological objects, the objects involved also often rely on collecting personal data and presenting it to the user in affective ways. Our design heavily draws philosophical inspiration from other work in the slow technology space by centering our inquiry around a domestic object that sits in the user's living space. We also employ a research product approach, commonly seen in slow technology work, that allows us to "investigate complex matters of human relationships with technology over time in the intimate and contested contexts of everyday life" [11, 55].

2.3 Material Centric Design

In recent years, design and interaction surrounding materiality has been a matter of interest to HCI researchers [8, 23, 25, 32, 68]. The materiality of objects and devices has the potential to generate and maintain very specific *affect* [66] that cannot be produced otherwise [22, 38]. Schoemann et al. [61] explore how a needle can be perceived as an input device when viewed through a crafting lens. transTexture lamp [72] uses surfaces deformations on a lamp to understand lived experiences through a materiality lens.

HCI researchers have also used thermal printers to engage with the materiality of paper in specific interactions. The reflexive printer uses a thermal receipt printer to explore the idea of "technology-mediated reminiscence" [39, 67]. Gaver et al. [24] used a thermal printer to print an AI generated horoscope depicting 'domestic wellbeing'. Botanical Printer [29] uses a thermal receipt printer to represent "plantness" by printing the WiFi signal strength and the CO2 intensity. The designers use the receipt as a medium to convey an invisible entity that is "plantness". Designers have also used thermal receipt printers to encourage social contribution in a care home [20].

Our interest in using a thermal receipt printer is two-fold. One, it allows us to generate a material token that the user has to interact with. Two, the materiality of the receipt allows us to produce affect that reimagines time spent on YouTube as a cost. We believe that this novel reimagination is highly appropriate given the proliferation of the attention economy [69, 71]. This is discussed further in Section 3.

2.4 Research Questions

Focusing on providing a way to resist the persuasiveness of YouTube, we address 2 research questions:

RQ1 *How does the materiality of a receipt affect the quality of reflection and the user's time spent on YouTube?* The use of domestic objects to induce long-term reflection has been studied in the slow technology space. We ask whether the materiality of the printed receipt itself affects the quality of reflection as well as the user's time spent on YouTube, as compared to simply allowing users to reflect on their usage using digital methods.

RQ2 *How does having agency over the printing of the receipt affect the quality of reflection and the user's time spent on YouTube?* The user can decide when to reflect upon their YouTube usage by requesting a receipt or, the printer can automatically print a receipt without the user requesting it. We ask whether this agency or the lack of it in the reflection process itself affects the quality of reflection and the user's time spent on YouTube.

We define *quality of reflection* by the effect it has on the *quantity* and *quality* of time spent on YouTube. We do not prescribe whether higher or lower *quantity* is better for the user. We made this design choice based on prior research [43] suggesting that while a large percentage of users would like to reduce the amount of time they spend on YouTube, several others would prefer to maintain their current usage or not alter it in any way.

3 THE MATERIALITY OF A RECEIPT

Traditionally, materiality in a design research context refers to the physical properties of the material [68]. In our case, while the physical properties of the material in question – thermal paper – does provide some affordances as discussed in Section 4.2, we extend the definition of materiality to include the aspects of it that maintain the cost metaphor in our collective cultural memory [14]. Next, we discuss the history of receipts, the cost metaphor in question and the attachment of the metaphor to the attention economy in our inquiry.

Receipts are one of the oldest forms of recorded writing. In fact, it is even theorized that cuneiform was a tool developed to help run the economy. A Proto-Cuneiform tablet from Mesopotamia shown in Figure 2 is estimated to be from around 3500-3000 BCE and contains information regarding a transaction involving a small amount of grain. Transactions that are prone to complexity, fraud, or even the potential of returns or exchanges require some sort of record-keeping which explains the development and deployment of receipts in various forms. These forms of record-keeping vary based on the cultures and the geographic regions in which they were developed.

Figure 2: (a) A Proto-Cuneiform Tablet from 3500–3000 BCE designed to function as a receipt for two small amounts of grain. (Source: Oriental Institute, University of Chicago) (b) The TI Silent 700. A remote terminal with a built in thermal printer. (c) A modern Point of Sale terminal printing a receipt.

The development of the modern printed receipt can be traced back to the cash register. Even early cash registers included the option to print a receipt. Although thermal paper – special fine paper coated with a heat sensitive color changing material – was invented in the late 1960s, it stayed out of consumer usage until a thermal printer was included in the Silent 700 [2] – a remote terminal developed by Texas Instruments in 1971. The higher durability of laser printing and other methods eventually phased out the usage of thermal paper in industrial settings, but the efficient exclusion of the need to change both paper and ink meant that thermal paper would gain immense popularity in point-of-sale terminals at retail stores and other locations which required quick physical tokens.

In addition to the ubiquity of receipts as a transactional artifact, in recent years, pop-culture references to receipts and specifically the length of receipts is common in film, television and social media [1]. Although digital receipts are increasingly more common at the time of writing this paper and are undoubtedly the more environmentally friendly option, the collective cultural memory [14] of a cost being attached to the thermally printed receipt is still very much in existence.

In the modern attention economy [10, 71], human attention is treated as a commodifiable resource in a complex data economy [17, 48, 49]. Although the specific monetary value of attention from an individual user is debatable, a result of this economy is the volunteering of attention in a complex economical transaction that is abstracted from the user. Similar to the origins of the original receipt designed to track complex economical transactions, through our design, we aim to bring this commodification into the forefront by utilizing the materiality of the receipt as a method for screen-time reflection on YouTube.

4 ATTENTION RECEIPTS

In this section, we summarize the design of our system, our approach, and its various components.

4.1 The Printer

While the focus of our work is centered around the materiality of the receipt, the source of the receipt is an internet connected receipt printer. We chose to utilize a research product [55] approach as this allows users to judge the actuality of our system rather than the potential of it. We also believe that users would prefer co-existing with a "finished" product rather than an object that evokes the feeling of a technical prototype. This is manifested through a heavier focus on the *finish*, *fit*, and the *independence* [55] of the artifact. Our hope is to effectively design a relationship between the artifact and the user that can be perceived as one that is long-lasting. While this creates some trade-offs that complicate the development and deployment process, we believe that the trade-offs are worthwhile within the context of our inquiry.

Our artifact (Figure 1 left) is built around the guts of a thermal printer and an ESP32. Care was taken to ensure that the only setup required by the user would be to plug-in our artifact using a power supply and then follow a short set of setup instructions that are commonly seen in consumer products. We constructed an interior chassis that is FDM 3D printed (Figure 3e). This chassis is enclosed within a wooden box (Figure 3b) – 84mm × 76mm × 94mm ($L \times W \times H$). The external enclosure is custom built using 4mm walnut hardwood sheets (Figure 3a). A threaded DC barrel jack connector and a stainless steel push button are included at the back of the printer. The push button feeds the paper through the printer's print mechanism, allowing the user to change paper when the thermal paper roll runs out. The front panel is FDM 3D printed using PLA. Our goal during the design process was to create an artifact that would have a relatively strong *presence* that users wouldn't want to hide away or allow it to recede into the background in a household. As a direct result of this design goal, we chose a bright yellow PLA for the front panel that helps increase its presence. Overall, we focused on creating a mid-century modern aesthetic that we believe would fit in well in most interior aesthetics.

Another major design decision was to flip the orientation of the paper feed. This allows the printed receipts to fall to the ground in front of the printer instead of pooling together at the back of the printer. The intention with this design was to establish more opportunities for the user to interact with the printed receipt, as it would collect on the floor or on the surface in front of the printer when it reaches a certain length, requiring attention or intervention from the user. This orientation also highlights the length of the receipt when it is printed. We hope that this design strongly aligns with the goals of our inquiry.

4.2 The Receipt

Prior research has established that common goals related to media consumption include reducing the *quantity* of use and shifting the *quality* of use [3, 5, 26, 43]. In recognizing that these goals are not universal, we do not prescribe or expect users to reduce the quantity of their usage within our inquiry, but we do hope that they reflect on it. To that effect, we include the title of the video

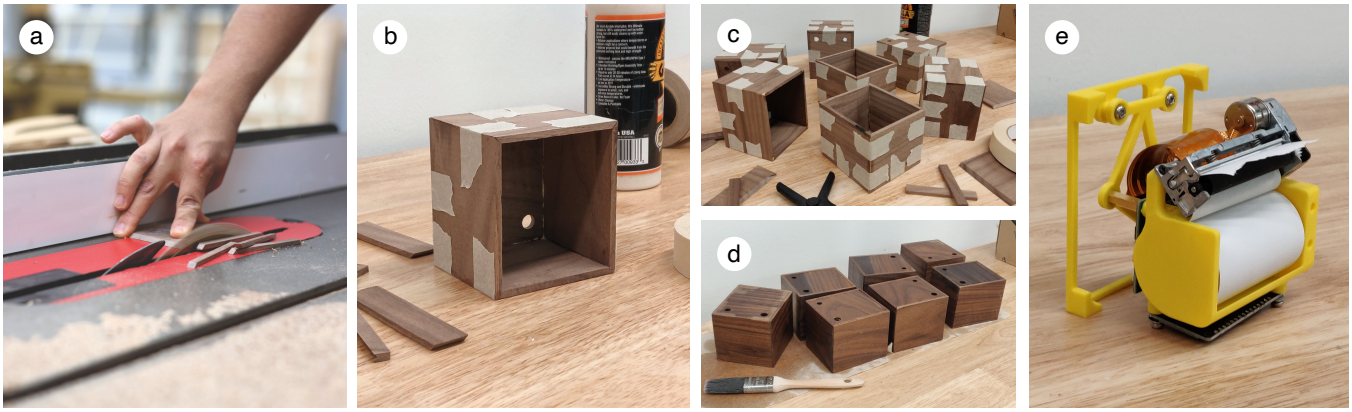

Figure 3: (a) Cutting and beveling the walnut wood sheets using a table saw. (b) Assembling the exterior box. (c) Low-volume batch assembly of the boxes. (d) Staining the walnut wood. (e) The interior guts of the receipt printer.

and the amount of time spent by the user watching it (Figure 1 right). This is a shift from the standard design pattern seen in screen-time monitoring applications that categorizes screen-time into different categories [47] (entertainment, education etc.,). While this definitely increases the amount of information that the user needs to parse, we try to adhere to receipt designs that preserve the cost metaphor established by common receipts that generally list the item description and the cost.

We hope that this more granular form of reflection can lead to varied insights for users. Apart from the basic information related to the quality and quantity, we include a few design elements to enhance and maintain the cost metaphor of the receipt. We include the date to provide a timed element but we refrain from including other metadata like the exact time the receipt was printed, or timestamps for when the video was watched etc. Our design intention was to create enough of a starting point and then provoke users to think about what other information could be included, through the study.

We use a 50ft long, 2.25inch wide BPA free thermal paper that fits into our thermal printer. The material properties of this paper provide some affordances compared to other physicalization mediums. Firstly, the length of the receipt is solely decided by the quantity of data on the receipt. This serves a purpose in our design as the length of the receipt increases with the number of videos that have been watched. While we considered attaching the amount of time spent to the length instead of the number of videos, we believe that such a design would inadvertently imply that more screen-time is detrimental to digital wellbeing without taking the user's goal into account. While our choice can imply that watching a higher number of videos is detrimental to digital wellbeing, this implication is weaker than directly attaching the length to the amount of time spent. We hope that the inclusion of the time spent per video along with the total time spent provides enough information to allow user's to critically reflect. Secondly, the nature of the roll of thermal paper means that when the receipt is printed, it falls towards the ground while slightly curling into itself. Users have to engage with the paper and slightly uncurl it when they want to parse the information on it. This creates a moment when the user *has* to physically engage with the information on the receipt and choose how to handle it.

4.3 Components and Pipeline

There are 3 main components that influence our software pipeline – a browser plugin, an ESP32 and a cloud server.

4.3.1 Browser Plugin. The browser plugin is compatible with Firefox and Google Chrome. The plugin only has access to the HTML DOM and runtime JavaScript events from YouTube. YouTube generates JavaScript events when a video is played, paused or ended. We use these events to trigger the timers on the plugin. When a video is played, the timer starts and when it is paused or ended, an API call is made to the server with the title and the time. Typically, the plugin would only require an interface to input a username that would connect the plugin to the printer, but due to our multi-condition study, the interface changes based on the condition that the participants' have been assigned. These conditions and the UI changes are further discussed in Section 5.

4.3.2 ESP32. The ESP32 breakout module serves two functions – retrieve data from the server and communicate the data to the thermal printer. The data is retrieved in JSON via the REST API. As the dynamic memory on the ESP32 is limited, the data is sent in batches to the printer when a print request is made and when the ESP confirms that the print was successful, an API call is made to erase the data. In addition to the base functionality, the ESP32 also allows users to easily connect the printer to their home WiFi. When the printer is plugged in, it sets up a Wireless Area Network (WAN). Users can connect to this network via their personal devices (phone, tablet, computer etc.,) and connect the printer to their home Wi-Fi by entering their SSID and password in a captive portal created by the printer. At this stage, users also enter their selected usernames to link the printer with the browser plugin.

4.3.3 Server. We built an HTTP server using Rust that serves a REST API. The server essentially works as a pipeline between the ESP32 and the browser plugin. The server also supports a local web dashboard for the research team built using React.js to help with participant onboarding, to make sure that the printers are online

during the period of the study and to assign study conditions to participants. The server also collects logs of API calls and the data required for the study.

4.3.4 User Privacy. While the plugin tracks the video titles that the users are watching and the time they spent watching the videos, we do not store the titles of the videos in our logs. The titles are erased from volatile memory once the user retrieves them. We only track the time for the purposes of our study. Apart from the time, we keep a log of the API calls made to the server when the user reflects on their YouTube usage.

5 USER STUDY: PERCEPTIONS OF AN ATTENTION RECEIPT

Previously, we have outlined our approach to reflection utilizing the materiality of thermally printed receipts. Next, we summarize the evaluation of our approach.

As the focus of our approach is centered around the materiality of receipts and longer-term interactions, we chose to deploy the low-volume batch-produced printers described in Section 4.1 in the homes of our participants. Allowing the participants to reflect on their YouTube usage in the comfort of their own homes provides an opportunity for the participants to provide valuable feedback based on their everyday lived experience. The nature of the inquiry also allows us to gather accounts of variance across multiple participants and households [11].

5.1 Study Design

To answer the questions that we put forward in Section 2.4, we designed a ~3 week within-subjects study where the participants spent each ~week in one of the following 3 conditions:

- **A: On-demand digital reflection.** In this condition, participants receive a HTML table on the browser plugin when they demand it. The information contained in the table is the same as the information contained in the receipt. This allows us to test whether the convenience of digital reflection would supersede the affect produced by the materiality. (RQ1).
- **B: On-demand material reflection.** In this condition, participants receive a printed receipt when they demand it. This condition serves as a comparison to condition A to understand the effects of the materiality of the receipt (RQ1). This condition also allows us to explore the effects of having agency over when the receipt is printed (RQ2).
- **C: Daily randomized material reflection.** In this condition, participants receive a receipt at a random time within a 23-25 hour interval since the previous receipt. This condition helps us explore the effects of not having agency over when the receipt is printed (RQ2).

The conditions were counter-balanced to reduce the effects of novelty experienced while installing and using the printer in the participants' household. The specific order in which the participants encountered the conditions are detailed in Table 1. In this study, we are not interested in exploring the effects of having agency over the digital reflection as we believe that it raises larger questions about the effects of push notification driven reflection vs user intended

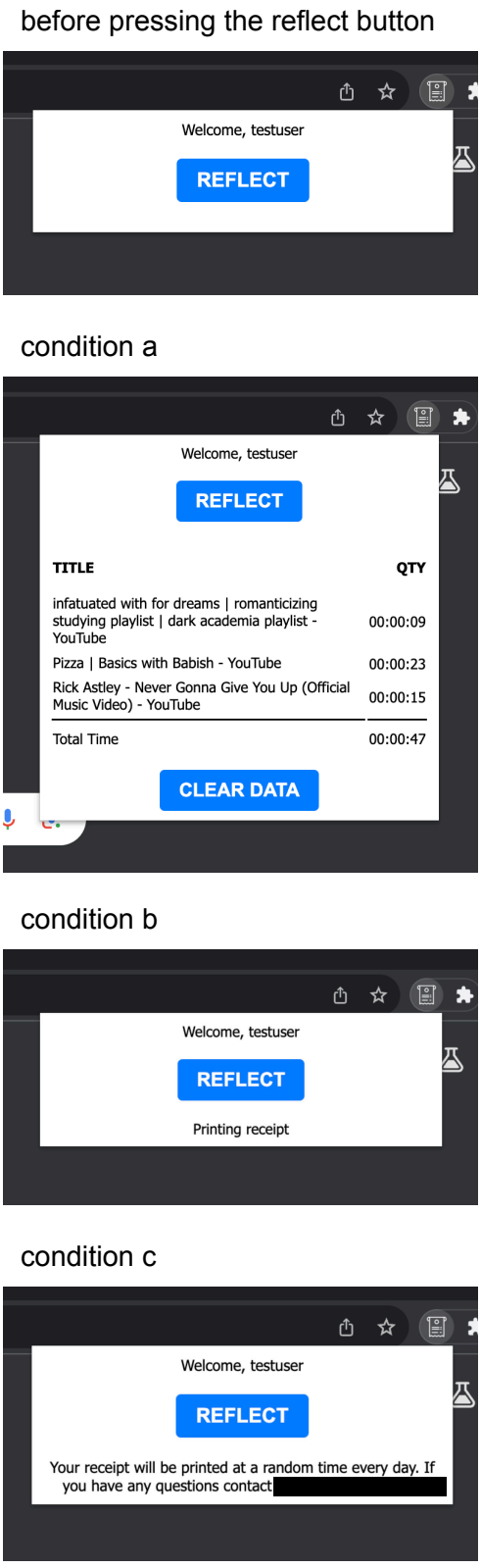

Figure 4: Screenshots of the browser plugin under the 3 different study conditions.

Table 1: Participant pseudonyms, a description of their homes and the order in which they encountered the conditions in our study. A - on-demand digital reflection. B - on-demand material reflection. C - daily randomized material reflection.

Pseudonym	Home	Study Order
Alex	Renting, 5-bedroom apartment, living with my partner and 3 roommates, two cats	$A \rightarrow B \rightarrow C$
Ruby	Renting, 1-bedroom apartment, living with a cat	$A \rightarrow C \rightarrow B$
Casey	Renting, 3-bedroom apartment, living with two other roommates	$B \rightarrow A \rightarrow C$
Taylor	Renting, 5-bedroom apartment with my partner, 3 friends, and 2 cats	$B \rightarrow C \rightarrow A$
Avery	Renting, 2-bedroom apartment, roommate moving in soon	$C \rightarrow A \rightarrow B$
Jordan	Renting, 1-bedroom apartment	$C \rightarrow B \rightarrow A$

reflection. Nudging users via push notifications co-opts methods used by persuasive technology, adding to digital overload, while asking the agency question solely with respect to the material reflection helps us compare a slow technology approach [27] where the object behaves as its own entity vs a more utilitarian system-centric approach. Similar views were shared by our participants which are discussed in later sections. Our study was considered exempt of ethical concerns from our Institutional Research Board (IRB23-0986).

5.2 Participants

We recruited 6 local participants (mean age: 28.6; SD: 4.44; 2 women, 1 man, 1 non-binary, 2 preferred not to say) who were interested in reflecting on their YouTube usage using online ads and flyers. We screened participants to make sure their main mode of YouTube consumption was through their personal computer on one of the compatible browsers. Additionally, we also asked all participants to refrain from consuming YouTube on their phones during the period of the study. A summary of the participants, their households and the order in which they encountered the study conditions is provided in Table 1. Two of the participants (Taylor & Alex) were co-habiting during the study. Study conditions were assigned and counterbalanced based on appropriate availability for the specific study condition while also taking the partcipants' travel plans into account. We compensated the participants with 100USD when the study was completed.

5.3 Hardware and Onboarding

During an in-person onboarding session we gave participants the printer, a power cord and an instruction sheet to setup the printer and to install the browser plugin. We also demonstrated the setup procedure to reduce friction. After the onboarding session, participants took the printer home and set it up. We then confirmed that the printer and the plugin was setup correctly using our web dashboard. During the onboarding session, we encouraged participants to reflect on their YouTube usage as often as they'd like and to try and pay attention to their YouTube usage and the influence of the reflection method on it.

5.4 Study Procedures

At the end of each condition (more than 7 days but ~1 week based on participant schedules), participants completed a likert scale questionnaire and an interview (~20 minutes) with the first author surrounding their usage of the assigned reflection method and their usage of YouTube in the past ~week. All interviews were conducted remotely over Zoom and recorded for transcription, coding and thematic analysis. A few participants were traveling for short durations during which the study was paused. None of the participants used YouTube during their travels – which was confirmed by the data collected by the plugin.

5.5 Data Analysis

Along with the results of the questionnaire, the first author performed Thematic Analysis (TA) on the transcribed interviews using the method outlined by Braun and Clarke [12]. The theoretical flexibility of TA allows us to capture the complex interplay between the study conditions and our slightly disparate research questions.

The first author of this paper attempts to motivate their research as attempts to resist against the attention economy and actively takes multiple measures in their personal life to fight against it. This heavily informed the design of the system, and the positionality of this paper. The first author developed and maintained a friendship with one of the participants of this study who is also critical of the attention economy. Other participants were unknown to the first author but all reside in a relatively high-income neighborhood in Chicago. The details and the intentions of the intervention were not discussed in any shape or form before or during the study with any of the participants. During and before the multiple interviews, the first author tried to ensure that questions were open ended and created lines of inquiry rather than confirming the author's pre-existing notions about media consumption on the internet.

The first author performed qualitative coding as laid out by Braun and Clarke [12]. The theme formation happened in two stages: (1) the themes were initially grouped by condition to cluster accounts of similarity across participants and (2) similar themes across conditions were grouped along the lines of inquiry. The analysis of the data was performed on a QDA software. We acknowledge that the software exerts an influence on the outcomes of our analysis.

6 RESULTS

In this section, we start by discussing the overall perceptions of our object and the system, and follow up with a more detailed discussion of the findings from our study.

6.1 General Perceptions

Overall, participants enjoyed our system and were intrigued by it. All participants appreciated the design of the receipt printer. Taylor said, *"I like that it's just a cute object that I can put anywhere in*

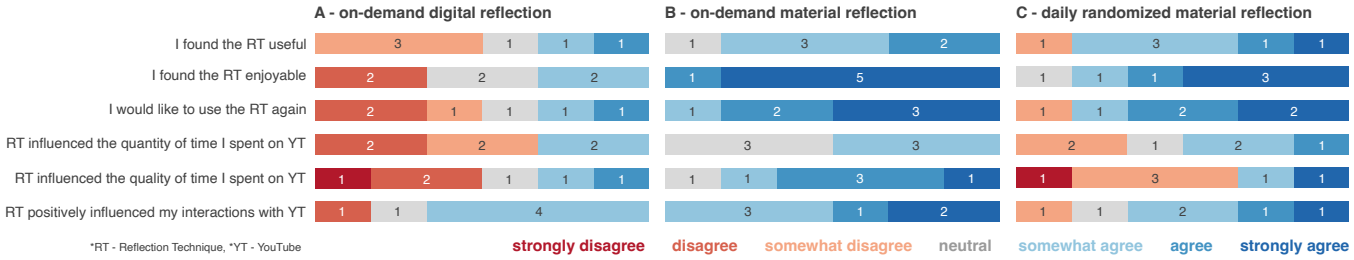

Figure 5: Questionnaire responses after each condition. Although our sample size is too small to declare statistical significance, the results indicate that participants preferred the materiality of the receipt and placed importance on having agency over when the receipt was printed.

my house." Alex said *"The fact that it's a nice looking object means that I can put it anywhere and be okay with it being there."* Jordan said *"My dad is an architect and he really liked how it looked. He was super impressed. I told him that you made it for a research project and he was like, wow."* When asked whether it was important how it looked, participants expressed that the fact that it looks like a "warm" domestic object helps make it feel like *"an actual product that they can go out and buy"* and that a "tech-y" looking object might be creepy and dissuade them from using it regularly. Jordan explains *"I can't say for sure because this is hypothetical, but I feel like if it wasn't cute, I wouldn't have set it up on my nightstand. I would have tried to put it somewhere I don't see it regularly."*. Participants also mentioned that the printer served as a physical reminder to reflect on their YouTube usage. This indicates that our design goal of creating a strong domestic presence for the printer might have been successful. Taylor said *"I think that even if I were in a different room and I wanted to print it, I probably would have gone into the same room to make sure that it actually printed (...) watching it getting printed is also like, fun."* Jordan said *"When I was just walking around my apartment, I would look at the printer and remember that this is something I can do!"*

From the results of the questionnaire (Figure 5) and our interactions with the participants in the multiple interviews, in general, we found that participants positively perceived the material reflection methods (conditions B & C) compared to the digital reflection method (condition A) and while most participants preferred having agency over when the receipt was printed (condition B), participants were split on not having agency over it (condition C). In the following subsections, we dive further into our findings to explore the nuances.

6.2 Explorations Provoked by Tangibility and Materiality

Multiple reflections from the participants suggested that some of their interactions with our system were purely afforded by the tangibility and the materiality of the receipt itself. We start by outlining these aspects as they're closely related to RQ1. Participants displayed tendencies to *curate the right receipt* in multiple ways, they used the receipt as a *physical representation of the rabbit holes* they went down, and heavily associated a *cost metaphor with the receipt*. These findings are heavily in line with our exploration.

Curating a receipt. Multiple participants mentioned how they felt the need to adjust their watching habits in a way that leads to "respectable" receipts. Alex said *"I felt myself like trying to spend more quality time on YouTube, in an effort to like, get respectable looking receipts when they got printed out."* This sentiment was echoed by Avery when they mention their need to "flush" out the bad data from their receipt. This is an interesting result of having agency over when the receipt is printed (cond. B). Casey explains *"I don't really want these videos on my next receipt. So I'm just going to flush it and then, you know, I can get a receipt that I enjoy."* While this seems like a way to avoid changing the quality of the videos being watched, it also implies a layer of reflection over *good* content versus *bad* content. Participants also speculated over using the receipt as a way to share videos. Avery said *"If I watch like three cooking videos (...) I think are interesting that I want to share with other people, I could like physically hand them a receipt and be like, here, look at these videos. (...) I can mold my receipts to a particular aesthetic"*. The need to "curate" a receipt in multiple ways, demonstrates a layer of reflection enabled by the materiality and the tangibility of the receipts.

Physicalizing the rabbit hole. One interesting aspect of the receipt that participants seemed to enjoy was the ability to use the receipt as a way to visualize the rabbit hole that they went down. Avery explains, *"I can also kind of see how my train of thought during a session goes. Like on this one, it's, I'm watching a video about trojans and then after that, I go on like a tangent about fake news and conservatism in the United States. And then I end it with something about like how one company owns color."* Jordan mentioned how this was especially interesting because the receipt also prints the video titles and times for half-watched videos and even when the video is watched multiple times. This highlights the appropriateness of using YouTube as a platform for this experiment. As participants didn't clear their data in the digital condition, we assume that it was difficult to create similar situations. Although, it can be argued that changes can be made to the plugin to create such situations, in our particular instantiation, we can attribute this to the materiality.

The cost metaphor of the receipt. Participants generally paid more attention to what they were watching while reflecting through the material methods (conds. B & C). When asked why they didn't feel that need in the digital reflection, Alex eloquently explains *"it's interesting to have this information translated from a totally like*

Figure 6: (a) Jordan chose to let their receipt fall to the floor because the length of the receipt was "comical" to them. (b) Taylor chose to make a neat stack of the receipts. They mentioned that because each of their individual receipts were short, saving it in a neat stack was convenient for future reflection. (c) Alex's installation of our receipt printer.

ephemeral digital format to something that sits around in like a box, on my shelf, potentially as long as I wanted to." When asked if the same effect could be achieved by using other forms of printing or physicalization, Jordan said *"I don't know, probably not. For me, I think the length of the receipt was very important. Also, like, waiting for the receipt to print and listening to it keep going and going when you've watched a lot of YouTube is kind of 'ridiculous'."* When pushed further to expand on what the physicality of the receipt means to them, Jordan explains,

> *"I feel like the physicality, in some way, it almost like* ***grounds your interactions with technology in the real world*** *in a way that like, I'm not used to thinking. I feel like I'm used to thinking time spent watching YouTube as like an escape from the real world. But like, it is also some time of my life that I'm spending doing a thing and somehow, having* ***the receipt makes it feel like I'm doing a more real thing and not like a fake thing*** *that I'm stepping away from the world to do, you know?* ***The kind of, cost, makes it real.****"*

This powerful excerpt perfectly highlights the power of utilizing the materiality of receipts in our instantiation and heavily contributes towards answering RQ1.

6.3 The Complexities of Reflecting on Consumption Data

The act of reflecting on consumption data is slightly tricky and participants exhibited different behaviors based on the condition they are in. This presents interesting challenges that can be explored in terms of how consumption *data and metadata is handled.* Additionally, most participants mentioned in some form or the other that the digital condition (cond. A) served to increase *digital overload.* This highlights the challenges behind effectively using digital tools when the medium of consumption is also digital.

Handling data and metadata. While the title of the video and the time that was spent watching it is the actual 'data' that participants reflected upon, we define any information required to contextualize this data as 'metadata'. Although users had the option to clear the data whenever they wanted to, none of the 6 participants cleared their data during the digital reflection condition (cond. A). Some participants found it interesting to let the time accumulate just to see how much time they've spent on YouTube in the recent past, and others were afraid of losing the stats. Avery said *"I like the stats. I didn't want to lose it; kind of like a streak, I can see all the videos that I racked up, like a high score."* and Taylor said *"You could still, I don't know, keep that information. You could simultaneously reflect on that information from earlier and also maintain it for the next time you wanted to reflect. You could see exactly what you saw last time plus some more".* While this is an artifact of our design that doesn't segment the data on the browser plugin when the user does reflect, it indicates a need from the user to maintain some overarching stats about their usage apart from the individual *atomic* reflections currently provided by our system. The medium used to provide this metadata remains an interesting and open question. All participants tended to agree that it would be better to keep the receipts minimal but to have the option to receive extra data and statistics digitally, in addition to the material reflection.

Especially when participants had control over when they printed their receipts (cond. B), they expressed the need for more data on the receipt in order to contextualize it within other receipts. A main reason for this is the fact that users might not reflect every day in this condition. Participants who mentioned that they actively built a habit around daily reflection didn't find this as a major issue whereas others found it necessary. Taylor said *"It would be nice to segment the videos that I watched by the date, regardless of when I print it".* Avery said *"Having some kind of percentage figure that stayed across receipts would prevent me from flushing the data to have a cleaner receipt."* Alex mentioned that it would be nice to know when they watched the video but that it wasn't really necessary as they prefer the minimality of the current receipt.

Digital overload. All participants expressed concern in some form or the other that trying to increase engagement on the plugin (cond. A) would result in more digital information on top of all the existing digital information that they are regularly bombarded with. When asked whether receiving notifications or emails would make this method more effective, Avery said *"I think that would serve to help to remind me about it. But I think I would be also a little bit annoyed by it because it would just serve to clutter my digital life. You know, like I already get so many emails and so many notifications that like a usage summary for the day would just be, I wouldn't want to see it, right? (...) I get so many emails and I have so many notifications to contend with that I don't feel like I'm in a space where I would appreciate having an email or a notification."* Alex said *"(...) there's so many things in the world that grab – on your phone or whatever – that grab your attention and then insert themselves into your conscious mind (...) this would just be another one of those".* Casey explains *"I swipe so many notifications away every day without looking at them, this would probably be another one."* This pre-emptive aversion to

notifications signifies the challenges of using purely digital methods to resist persuasive technology and the importance of our inquiry. Although we could definitely improve the digital method by re-appropriating persuasive methods, in the eloquent words of Audre Lorde – *"For the master's tools will never dismantle the master's house"* [42].

6.4 The Convenience of Digitality and Concerns with Physicality

Participants tended to casually mention that *digital is more convenient, but less meaningful* when compared to the physical receipt. While the physical receipt was more meaningful, it also introduced a few complexities in terms of *maintaining privacy* as other people in the same household could always encounter these receipts. Some participants reported *increased usage, but did not report it as a concern* as they were more comfortable spending time on YouTube compared to TikTok or other platforms with more short form content.

Digital is convenient, but less meaningful. Although most participants agreed that the digital method was more convenient because they could use it wherever they were, they also mentioned that this convenience made it less meaningful. The novelty of the reflection technique wore off earlier when compared to other methods. A thought shared by Jordan exemplifies this – *"I kept forgetting to use it, if I'm honest. I don't know. Yeah. But I like how accessible it is, so maybe I feel conflicted about it because I like that it's just right there, like on the browser (...) this one's just built in, which is nice, but I also just kept not using it."*. Casey said *"I went back to my old habits of just watching stuff because I know I can just clear data anytime."* which further portrays the lesser meaning attached to this form of reflection. Although our sample size is too small to make any significant claims based on quantitative data, this is echoed by the API calls to the server. The mean total reflections per participant per day went from $3.43(SD : 0.54)$ in the first 3 days to $0.26(SD : 0.1)$ in the last ~4 days. This is a significant drop off that didn't occur in condition B. Another contributing factor to this feeling was that participants (Taylor, Alex and Casey) reported that this method was pretty similar to other methods that they have used in the past. Casey said *"I did use a couple of time monitoring softwares a couple of years ago and it feels similar to that (...) And those didn't work for me, so I don't use them now. So maybe it's because of that, that this feels not as useful."*

Privacy or the lack thereof. A consequence of printing receipts with one's YouTube usage is that if the printer is placed in a non-private space, the content on the receipts is free to see for anyone. While most participants said that this was not a huge concern to them as they placed the printer in semi-private locations, and they felt like the information on it wasn't heavily embarrassing or confidential, some participants expressed concern. During the study, Jordan's father stayed with them for a couple of days. During this period, Jordan made sure that they removed the receipts from plain view when they were printed. Participants also mentioned that the extent of their concern might change if it was a different platform. This represents a major downside to physicalizing personal data. While having complete agency over when the receipt is printed can solve this issue, for users who preferred the randomized reflection, it still remains a challenge that requires further exploration.

Increased usage with receipts, but not a concern? Some participants reported increased YouTube usage compared to their regular usage patterns but didn't think this was a matter of concern. For instance, Jordan said *"because YouTube definitely is more long-form content and at least with what I consume it's usually like either ASMR videos to help me sleep or educational videos. And maybe that's why I felt more inclined to engage with it more when I was being more mindful of it is because it's better to watch those things than to just scroll mindlessly on TikTok."* They also mentioned being disappointed when they received an empty receipt because it implied that they spent a lot of time on TikTok. While this is a slightly unintended consequence of our design, it highlights the necessity to not view digital wellbeing as "less screen-time is better" and the importance of taking a more holistic standpoint in the current state of the attention economy. It also implies that our method led to reflexivity about the quality of content consumed on the internet, which is a favorable outcome.

6.5 Agency Might be Good?

The questionnaire and some reflections from the participants suggests that having agency over when the receipt is printed is overall beneficial. Some participants mentioned that *not having agency over when the receipt is printed might be too passive* and therefore having agency is good. Other participants mentioned that when they did have agency over when the receipt is printed, they were *less surprised by the data on the receipt* indicating a layer of self-reflection just before they print the receipt. Our system also used *empty receipts* to indicate that the participants hadn't watched anything during condition C. Participants expressed that this did not feel as useful and would have preferred not to receive a receipt or suggested alternate designs for these receipts.

Concerns about passivity. Amongst the users that heavily disliked not having agency over when the receipt was printed (cond. C), the largest concern was passivity. Casey said *"I don't really have to do anything in this method. It just does its own thing without me requiring to do anything."* Taylor mentioned how the act of pressing the reflect button forced some internal reflection which was completely lost in this condition. *"This feels like I'm getting a bill in the mail and I'm used to ignoring those."* This was also manifested in Ruby's experience when after a long YouTube binge session, they went to print a receipt, forgetting that they could not no longer do that and being disappointed after realizing it. They mentioned that they were "craving" a reflection.

Less surprised by the data. Due to the fact that the users had direct control over when the receipt was printed during condition B, multiple participants reported that they built an intuition or a mental log of what they had watched. This meant that when the receipt was printed, they weren't surprised by the data. As this sentiment wasn't expressed during the digital condition – which presented the same data – it potentially implies that the materiality of the receipt is producing this effect. Taylor explains *"it didn't actually change the quantity of time that I was using [YouTube]. I was making more of like a mental log of what it was that I was actually watching (...) I'm starting to watch this video. I will be able*

to see it on the reflection. That might not change what I'm doing. But like, I am keeping more of a mental tally of what I'm watching (...) so I wouldn't kind of be surprised by whatever got printed out."

The nature of the surprise though, was different based on the participant. Jordan mentioned how they built a mental log of the number of videos they watched and so the length of the receipt and its contents wasn't that surprising but the total time was, which affected the nature of the reflection. They explain by saying *"I was like, okay, I watched four videos. I'm going to print out the receipt (...) since I knew it was going to be four videos long, it was more about how much time I had spent in total."* as opposed to the case in condition C where *"(...) to me, it was like, how long the receipt was printing for was always surprising when it was random, because it would just start going and going and going. But when I was doing it myself, then I would actually have to get up and go like look at it. And it would be like, oh, seven hours. That's crazy."* Ruby and Casey mentioned similar sentiments as well.

Figure 7: The empty receipt when the user hasn't watched any videos.

Handling empty receipts. Almost all participants that received an empty receipt (Figure 7) mentioned that they were an issue. Some participants even disposed their empty receipts while they hung onto the rest of the receipts. Almost all participants mentioned that they would rather not receive a receipt when they didn't watch anything. Avery mentioned that while it would be good to not print a receipt, they would also be interested in seeing a receipt that complimented them for staying away from YouTube. Participants also expressed concern about how it might be wasteful to use a piece of paper when there's nothing to reflect on. While this is solely an artifact of our design, it leads to an important, open and unanswered question about how we handle tangibility and materiality when there is no data to engage with.

6.6 Lack of Agency Might be Good?

While the quantitative results from the questionnaire and the previous section might suggest that having full agency over when the receipt is printed might be the most preferable mode, some participants suggested that while having agency over the printing led to feeling *more engaged with the receipts, it led to diminished reflection.* This is an interesting outcome that deserves further exploration. Participants who *built habits around the randomly printed receipt* reported higher satisfaction and tended to assert that this was the ideal method for reflection whereas participants who didn't build habits around it reported lower satisfaction. Lastly, participants reported that not having agency over when the receipt is printed resulted in *feelings of surveillance and enforced reflection.* While this frames the object in a negative light, this can potentially lead to higher quality reflection.

Engaging receipts, diminished reflection. While most participants felt like having agency over when the receipts are printed was effective (cond. B), some participants expressed that while the receipts were much more fun, the reflective aspect was slightly diminished, and that this shifted their use case. Avery expressed that while condition B led to them saving more receipts, the "souvenir" aspect of the reflection reduced the actual usefulness of it – *"the receipt itself is more engaging, but at the same time, it's less useful as a reflection tool (...) it becomes more of a souvenir because I control when I print."* Jordan echoed this sentiment by stating that while their view of the printer shifted from a "surveillance" device to a tool, this meant that they felt less pressure to change their habits. This reduction in the need to change usage patterns when the perception of the object is more favorable is a point of tension and exploring this tension can be essential in finding a potential Goldilocks zone for self-control [46]. Creating a more engaging system can lead to better usability and a more positive perception of our system, but it may not achieve the ultimate goal that we laid out. This is an important distinction to make while designing devices for reflection.

Building habits around reflection. Participants mentioned multiple interesting factors about their habits that affected their reflection when they didn't have agency over when the receipt was printed. Casey for instance, maintained a habit of reflecting everyday during the entire study in conditions A and B. For Casey, condition C was the least effective method out of the three. Upon probing further, Casey mentioned that they had built a habit of reflecting when they sat down at their desk everyday. The irregularity of the receipt and the lack of control over it meant that they couldn't always reflect when they sat down at their desk, which was frustrating. On the other hand, Alex – who vehemently believed that not having agency was for the best – built a habit around the reflection method itself. They said *"I feel like typically I came home from work and the receipt had printed out. And it's like, oh, you walk in the door, you take off your shoes, you put down your backpack, put down your keys and you go look at the receipt."*

While a lot of the friction around these habits can be placated by allowing the user to choose when the receipt is printed everyday,

it also indicates the user's need to have more agency over the reflection technique itself even when they cannot request a receipt on-demand. Taylor acutely observed how condition C might make more sense for someone who watches YouTube on a daily basis but not for someone who only accumulates enough videos for a meaningful reflection over the course of a couple of days.

Feelings of surveillance and enforced reflection. As a direct result of having agency over when they can print a receipt in condition B, participants reported that it felt like a tool that they could use at any time. While comparing with condition C, Avery said, *"Now it's just a regular object that I have control over instead of some sort of object outside of my control (...) so it's an artifact that's useful to me instead of an artifact that's kind of like watching me"*. Jordan expresses a similar sentiment by stating that in this condition, the printer was helping them "survey themself" whereas in condition C, the printer was "surveying them".

Multiple participants mentioned that during condition C, their perception of the system and the receipt printer was very different. Jordan mentioned that the printer felt less comfortable because it was "surveilling" them. Avery mentioned how in this condition, the artifact is kind of "watching" them. While this discomfort is concerning, some participants mentioned that this method of reflection was more effective. Other participants mentioned how the receipt "just being there" forced them to interact with it and reflect on the data. This again represents an important distinction to make while building devices for reflection. To reiterate, maximizing positive perceptions of the device and the system as is common with traditional interaction design can lead to a more engaging system, but on the other hand, it can potentially override the goals of the system.

7 DISCUSSION

In this section, we discuss the implications of our findings, some considerations for long-term use and the limitations of our study.

7.1 Tangibility as Resistance

A recurring theme during the design discussions and the analysis of our data was the role of tangibility in introspecting on media consumption and our digital lives. Just as our attention is volunteered in an invisible economical transaction pretty much every time we use the internet, multiple aspects of internet use are now marred with such abstractions. Seemingly innocuous interactions on the internet can have several layers of abstractions designed to either keep us on the platform or to nudge us towards a decision that platforms are making for us.

A primary goal of this work is to explore how tangibility, particularly materiality, can play a role in "de-abstracting" these complexities in our everyday interactions. While a lot of these mechanisms genuinely add value to our lives and make them easier, making these mechanisms transparent and easy to digest can reclaim much needed agency into the hands of the user who may choose to act differently. As we mention earlier, we avoid making value judgments about the quality and quantity of time spent on a platform and focus on creating avenues for reflection and contemplation. As Jordan found out during our study, more time spent on YouTube as a result of our intervention wasn't necessarily a bad thing as this meant that they spent lesser time on TikTok which they deem as "garbage".

7.2 Positive Perception of the System Doesn't Necessarily Lead to Better Reflection

Multiple findings in our study indicate that while a more positive perception of our intervention can be on the table, this doesn't necessarily lead to better reflection. While it is possible to build an engaging system with high agency or lowe agency, in our case, higher agency led to a more positive perception of the system overall, but some participants noted that this led to lower quality reflection. Building devices that hit the sweet-spot – not unlike the Golilocks zone encountered by previous researchers [46] – of maintaining a "good enough" perception with the user to prompt reflection while not trying to maximize the positive perception of the reflective system itself is an extremely delicate balance. This is a balance that has been completely overriden by the attention economy especially on YouTube by incentivizing maximum screen time with no regards to the users' larger goals. Striking this balance and studying the confounding effects perhaps remains the biggest challenge in building devices that maintain "digital wellbeing". For instance, if our analysis solely revolved around the results of the questionnaire to suggest an ideal system, we would recommend building a system that was closer to condition B. Whereas multiple participants expressed that while condition B was more fun, condition C led to higher quality reflection.

7.3 Overriding User Agency in the Process of Granting it

While we demonstrate that materiality can in fact have strong impacts on the perceptions of media consumption, adding an additional layer of "eyes" through our system also has the potential to override the user's agency. It is important to ensure that one form of agency loss is not being supplanted by another form of agency loss by a different entity. By positioning our work as an entity that aims to re-grant agency, we heavily run the risk of overriding user agency through our agenda. In all such endeavors, heavy care must be taken to ensure that the re-appropriation of hegemonic practices are being deeply considered by the involved stakeholders. The core philosophy behind attaching a cost to time perhaps mirrors the methods propogated in Taylorist [41] schools of thought. While we aim to re-appropriate this method in our paper in an attempt to resist against the effects of the attention economy, deep questions can and need to be asked about the existence and abolishment of these methods.

7.4 Considerations for Long-term Use

While our intention was to create an object that is designed for long-term use, naturally, some aspects of the design were still influenced by our study design and the nature of our inquiry. A truly long-term object would require additional thought to ensure that changing the roll of paper is an enjoyable seamless process that users would want to engage in rather than viewing it as a chore. All participants suggested that having the ability to trigger a print from the printer itself instead of triggering it from the browser plugin would largely improve the experience. While we were focusing on maintaining

the same interaction for both forms of reflection in conditions A and B, in hindsight, providing a print button on the object would lead to a better experience and increase the independence of the artifact. Further questions need to be asked about the ecological impact of such a device, the ideal conditions of use for such a device and the potential psychological and philosophical impact of further associating time with a cost.

7.5 Extending to Other Platforms

While we focus on YouTube for this study, what would it look like to extend this method to other platforms? Platforms oriented towards short-form content like TikTok and YouTube Shorts do not rely on descriptive titles to establish the quality of the content and the nature of the time sink is markedly different. Longer-form streaming platforms like Netflix might have easier ways to establish the quality but they do not rely on the same "attention retaining" mechanisms like YouTube as they are more concerned with recurring subscriptions than holding someone's attention purely to serve ads. All participants were asked if they see value in our intervention for other platforms. Some participants expressed how it would be interesting to see how long they spend watching ads or sponsored content vs actual content on Reddit and TikTok. This, to us, represents a curiosity towards the attention economy which strongly satisfies the goals of our exploration, but the design of the receipt and the system for these extensions remains unexplored.

7.6 Limitations of the Study

Our study was designed around qualitatively answering the research questions we set out to answer. While this was successful to some extent, truly understanding the effects of our proposed intervention requires longer-term interactions with the device and the system. All participants in some form or the other expressed that they were curious about the long-term effects of the receipts. While some participants asked if they could continue using it even after the study ended, others asked if it was a product that we plan on launching and asked if they could help build it further. One participant also offered to host the server by themselves to continue using the printer. We also limited the amount of data collected by our system to maintain participant privacy. A deeper understanding of how our intervention affects usage patterns can be gained by collecting richer data and tying it together with participant accounts.

Our participant pool is also inherently biased as it only contains participants living in a relatively high-income neighborhood in Chicago. Perceptions of materiality vary across cultures and socio-economic backgrounds and it is important to understand the bounds and effects of it. Additionally, more varied households such as family homes, co-operative living arrangements, and other arrangements where a power relationship may be involved – parent/child, landlord/tenant – can produce deeper insights about the inherent challenges with tangibility and privacy.

Another omission from our study design is the lack of a hybrid condition that contained all 3 conditions. All participants agreed that they would enjoy a hybrid condition where they were occasionally reminded by the printer automatically but they also had control over the receipts. This would retain the agency-driven, fun aspect of printing receipts by themselves but also ensures that the basic intention behind the technique is not obscured. Additionally, it could prevent users from attaching the positionality of the printer being a tool, instead of an independent object.

8 DESIGN RECOMMENDATIONS

For others interested in building household objects and material methods that help users resist against persuasive technology, we reflect on our experience and provide a set of design recommendations. While some recommendations originate from our findings, others are generated by reflecting on our design process. Additionally, some are highly specific to objects that aid with reflection and others are more generally applicable.

Agency, with some room for surprise. Specifically related to reflective methods, from our study it was evident that users enjoyed having agency over when they reflected on their screen-time. But at the same time, users also expressed that when they're not regularly reflecting out of habit, being surprised by it can nudge them towards reflecting again. As evidenced by our interviews, while having complete agency over the reflection process can be important for the user, it has the potential to lead to diminished reflection. We encourage designers to reflect on the positionality of the object with respect to the user and the goals of the system. Sacrifices might have to be made to the perception of the system in the users' eyes to achieve the goals of the system. This is a tricky balance.

Maintaining materiality. During the design and prototyping process, it is easy to obscure elements of the materiality that is tied to the cultural memory of the users by straying too far from the materiality of the object. We encourage designers to reflect on and maintain elements of the original materiality of the medium, and to ensure at every stage that the materiality is not being obscured or lost in the design. In our case, this involved rejecting extraneous but novel metadata that would be interesting to include in the receipt. When adding or removing design elements, it's important to ask whether it is adding to the materiality or taking away from it.

Re-appropriating hegemonic practices. While we found that users exhibited a distrust towards hegemonic design patterns like push notifications due to digital overload, in our design, we still re-appropriate the capitalistic practice of attaching a "cost" to time. While the ethics of this can be debated, in our design practice, it helps us maintain a balance between novelty and familiarity. We encourage designers to consider the hegemonic practices that they are re-appropriating (if any) and to reflect on whether it feeds the hegemony or subverts it in an act of resistance.

Object independence. While independence is previously established as a design criteria for research products [55], we re-emphasize its importance in this line of research. Providing domestic objects to people with the hope that they reflect on or change their habits, puts the object itself in an inherently combative stance against the user. We highly recommend that designers take any steps possible to ensure that the setup process, and day-to-day usage is as smooth as possible. We also recommend taking every opportunity to reduce the friction between the object and the user, but retaining the friction required to improve the reflection process.

Aesthetics. As the objects are installed in a user's home – although aesthetic taste is subjective – ensuring that the aesthetics are inoffensive and polished can go a long way in increasing the willingness from the user to install it and use it regularly. Designing an object with the hope that it gracefully embeds itself into the user's home is not always simple, but we recommend that designers deeply consider the aesthetic choices that they're making when building such objects, especially when the objects can have a "surveillance" aspect to them.

9 CONCLUSION

We explore how the materiality of a receipt can improve screen-time reflection on YouTube. We built and deployed a browser plugin and a printer that prints receipts for the time spent watching videos on YouTube. We evaluated our idea by deploying our object in the homes of 6 participants. We found that the materiality of the receipt improves reflection and therefore influences the quality and quantity of time spent on YouTube. We also found that users largely preferred having agency over when they reflected on their YouTube usage but not having agency sometimes lead to higher quality reflection. We concluded with a set of design recommendations for designers who would like to build domestic objects that help users resist against persuasive technology.

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