Cognitive Accessibility of Digital Payments: A Literature Review

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ABSTRACT

Given its current ubiquity in banking and other services, digital payments should be accessible to all, but neurodiverse populations encounter barriers often understudied in research and practice. A greater understanding of user needs across the neurodivergent spectrum will thus improve universal access. To characterize the cognitive accessibility of digital payments, this literature review examines 30 scholarly publications, nuancing the challenges of online banking for older adults and people with neurodiverse needs. Our findings uncover a range of potential design and support strategies, including simplifying interfaces with diversified cues, raising designer awareness and participant involvement, extending third-party support, and leveraging new technological aids. We further discuss implications for digital currency design through support for user agency, collaborative payments, contextualized inclusive approaches, and AI-powered accessible design, hopefully inspiring future research on improving web accessibility.

CCS CONCEPTS

• **Human-centered computing** → **Accessibility**.

KEYWORDS

Web accessibility, cognitive impairment, neurodiversity, mental health, older adults, universal access, online banking, digital currency, central bank digital currency (CBDC), financial technology (fintech)

*The views in this paper are the authors' and not those of the Bank of Canada.

1 INTRODUCTION

Digital payments and online banking have grown ubiquitous with increasing digital and online services and declining cash use [32], and payment access must evolve symmetrically to remove barriers to participation in this fundamental aspect of society. Academic research has highlighted accessibility issues related to financial technology (fintech) and digital currencies. Human-computer interaction (HCI) researchers have explored haptic ATM interfaces for visually impaired users [12] and augmented paper cheques for older adults [62]. Digital currencies should offer the benefits of digital payments while preserving the accessibility, privacy, and security of cash. Such universal access considerations feature prominently in research conducted by central banks (e.g., the Bank of Canada [4]), which seek to maintain users' access to central bank money, potentially by introducing Central Bank Digital Currencies (CBDCs)—banknotes in digital formats. These and other digital payment methods involve complex, interrelated factors ranging from personal and merchant device forms and interaction design to network variances and affordability; each factor entails additional decisions, compounding cognitive load and raising cognitive accessibility requirements. Greater awareness and understanding of these nuances are thus critical for researchers, designers, and decision-makers involved in developing fintech and broader web-based technologies.

Guided by the overarching research question of *how to improve the cognitive accessibility of digital payments*, this paper focuses on the fintech experiences of older adults—who might experience cognitive decline with aging—and people with neurodiverse needs, including but not limited to dementia, intellectual and developmental disabilities, and mental health. Broader populations, varying in their abilities and situational needs, can also benefit from cognitively accessible design. This ongoing literature review project characterizes the cognitive accessibility of digital payments by compiling the existing but scattered scholarly data to contextualize diverse user needs. To advance the understanding of cognitive accessibility challenges, this paper reveals emerging design approaches and support strategies, along with their implications for designing

more cognitively accessible digital currencies and user experiences. These findings can hopefully inspire interdisciplinary discussion on web accessibility in digital payments and beyond.

2 BACKGROUND

We group the universal access needs for digital payments across three dimensions: financial inclusion, digital inclusion, and accessibility. The universal access needs not only apply to small margins of people with disabilities or without internet but more broadly include 1) people affected by financial inclusion (e.g., low income, no bank account, and avoidance of bank services for trust or other reasons) [46, 50], 2) people affected by digital inclusion (e.g., no phone, no internet, and low technology literacy) [61], and 3) people with accessibility challenges with payments (e.g., older adults [35] and people with sensory, motor, or cognitive accessibility needs [38]). Universal access involves both the primary users of digital transactions (i.e., people making payments) as well as secondary ones (i.e., people supporting or associated with others making payments).

Financial inclusion refers to access to financial products and services normally offered through banks, such as accounts, transactions, payments, saving, and credit. Existing literature paints diverse customer profiles centering around different aspects of financial behaviours. For example, some online payers view paper bills as structural assurance for managing their feelings of distrust when dealing with banks and billing firms [45]; as many as 10–12% of Canadians do not file tax returns and thus lose benefits [55]; payment preferences have evolved towards digital and contactless in recent years (e.g., [70]). Prior HCI work on user challenges and successes with mobile payments in North America highlights user routines and trust mechanisms for future design [33].

Digital inclusion refers to affordable and reliable access to essential digital resources, such as devices and networks. Internet availability and web experiences are essential to digital payments. Prior work shows variances in coverage, affordability, and literacy across communities [3, 11, 58]. The interplay of public and private spaces in internet access has been noted, with online banking activities observed at public libraries [37] and public access facilities highlighted for enabling both domestic access users and those without other options to be active participants [63].

Accessibility around digital payments require design considerations for sensory, motor, and cognitive accessibility of the entire payment interaction and workflow (e.g., accessibility challenges with electronic payment terminals [25]). A range of prior research and accessibility guidelines, such as those developed by the World Wide Web Consortium (W3C) and the Web Accessibility Initiative (WAI), can guide research and practice. However, recent literature surveys stress an unbalanced representation across disabilities in HCI [14, 43], and the diversity of cognition-related accessibility needs demands a more nuanced understanding. For example, sensory changes unique to age-related cognitive changes affect technology use [23], and older adults with mild cognitive impairment are financially vulnerable due to their reduced ability to recognize scams (e.g., email phishing), follow password guidelines, and consider the implications of sharing personal information [47].

Encompassing broad areas (e.g., memory, attention, learning, and emotion), cognitive accessibility requires dedicated initiatives such

as the Cognitive and Learning Disabilities Accessibility Task Force (Coga TF)[1] by W3C and WAI. More work is underway to define cognitive accessibility and disability and investigate the implications across areas of research and practice (e.g., [13]). As cognitive accessibility is both relevant to digital payments and under-represented in research, this literature review takes the first step to fill this gap. A deepened understanding of cognitive accessibility around digital payments can better inform web accessibility research, as well as the future design of end-user devices, interfaces, and experiences for universal access to digital currencies.

3 METHODS

We adopted a standard literature review approach [28], starting with retrieving and selecting relevant sources and followed by data extraction and analysis.

3.1 Search Strategies

We developed a set of search terms around two concepts: digital payments (e.g., banking OR payment OR currency) and cognitive accessibility (e.g., cognitive OR learning OR development OR speech OR language OR "mental health"). In this initial round, we searched the ACM Digital Library[2] (a premium repository of computing research) and Scopus[3] (a mainstream scholarly database with multidisciplinary coverage). In addition to full texts in English published in or after 2010, the inclusion criteria focused on empirical findings and literature reviews, excluding research protocols and workshop proposals. As cognitive accessibility encompasses a broad space and has not been well defined in the literature, a systematic search is not feasible at the current stage. We approached this developing topic through a fair amount of manual searching and screening to ensure the breadth and inclusivity of our searches.

We conducted the database searches in mid-late November 2022, collecting 26 sources after document screening and team discussion. Our team review of candidate documents focused on applicable and transferable studies related to digital payments instead of granular or less relevant sources, but we made sure to include both banking/finance-specific studies and broader neurodiversity topics to better understand the contexts and needs. In this exploratory review, we further added three (3) sources through citation tracking from the included sources, as well as one (1) digital-divide-related source from expert recommendation.

3.2 Data Analysis

This dataset of 30 sources represents a variety of studies including literature reviews and guidelines (5), system design and evaluation (4), webpage/search log analyses (2), and empirical work (19) involving interviews, observations, workshops, surveys, and experiments. Published between 2012 and 2022, these studies were conducted by researchers mainly based in North America (15) and Europe (13), as well as Australia (1) and Brazil (1). We adopted a qualitative content analysis with a deductive, directed approach [34]. Guided by two broad concepts, *problems* and *solutions*, the first author extracted the relevant findings from each source and

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[1] https://www.w3.org/WAI/GL/task-forces/coga/
[2] https://dl.acm.org/
[3] https://www.scopus.com/

developed the initial categories, which later evolved through axial coding. The authors discussed the evolving categories and notable findings until we reached a consensus on the categories and sub-categories. Our sources encompass acquired impairments such as dementia, neurodiversity, and mental health concerns, covering a wide range of cognitive accessibility terms. For clarity, we mainly defer to the terminology used in each source.

4 PRELIMINARY FINDINGS

Our analysis reveals two categories: *banking and finance challenges* and *design and support strategies*. Interrelated in answering our research question, the first category mainly speaks to nuanced needs and challenges, and the second focuses on potential solutions.

4.1 Banking and Finance Challenges

4.1.1 Banking as a component of technology use. Researchers at W3C and WAI recognize web payments among emerging changes in the evolving web landscape, creating new accessibility challenges and requiring user-centric, needs-focused guidelines [15]. Several studies show banking as a component of information and technology use for older adults and people with disabilities. A large-scale search engine query analysis reveals baby boomers'[4] primary interest in finance with a notable number of navigational queries (e.g., "paypal") related to online banking [66]. As older adults face late-life disabilities, banking and paying bills are among the largely retained household activities [69]. Similarly, people with mild to moderate dementia use mobile phones for online shopping and banking [24] while being aware of online information eliciting distrust such as pop-ups requiring financial commitments or bank details [22].

4.1.2 Accessibility problems. Our findings highlight the need for improving the accessibility of bank and finance websites. Web Content Accessibility Guidelines (WCAG) A and AA violations are found on 100 US bank or financial institution homepages, with the top five WCAG 2.0 criteria violated being poor contrast ratio, ability to resize text without assistive technology, valid HTML markup, mechanism to bypass repeated content and menus, and text alternative for essential non-text content [67]. Other studies report that simplified plain-language online financial content (e.g., Terms and Conditions) do not increase older adults' perceptions of comprehensibility or informativeness [57] and that people with cognitive disabilities experience problems with texts (e.g., long sentences) or finding certain elements (e.g., a specific button) [26].

4.1.3 Social challenges. Multiple studies show social needs and challenges in digital payments. As participants with cognitive disabilities acknowledge, "the experience of going to a bank and getting one-to-one attention could not be replaced" [26]. Mobile technology is found to increase communication and social participation of people with disabilities—improving their confidence, security, safety, and independence—but varied due to disability types, support needs, and availability of services [19]. Digital participation is highlighted for people with intellectual disabilities, as well as risks for sharing personal data including bank account information [42]. Older adults receive help from close others (some are older adults

themselves) with online banking, but sharing credentials might risk privacy, security, and financial exploitation [40]. People with mental illnesses often experience financial vulnerability and frustration with the lack of low-cost bank products and services [30]. Their carers could effectively help with personal budgets but face fluctuating mental conditions of care recipients as well as adversarial and obstructive negotiations with practitioners and agencies [29].

4.2 Design and Support Strategies

4.2.1 Simplifying interfaces with diversified cues. Multiple studies explore ways to simplify user interfaces by providing relevant information at prominent places and avoiding distractors [8] and using clean visual elements [26]. Diversified cues help address varied needs across user groups. As older adults value both language and visual aspects (e.g., layout and colour), the interplay between language and the non-linguistic aspects is stressed [57]. An eye-tracking study investigates how people with dyslexia visually attend to search engine results and webpages [51]. For people with an intellectual disability or on the autism spectrum, three visualization elements—chart type, chart embellishment, and data continuity—can help improve data accessibility [68]. Simplicity is prioritized in exploring online banking interfaces for people with cognitive disabilities by representing money amounts through images of bills and coins, showing a single task at a time, using short sentences, and avoiding non-numeric text input requirements [26].

4.2.2 Raising awareness and involvement. The rare participation of people with cognitive disabilities in software development and evaluation is highlighted in a systematic review [8]. Strategically facilitating accessible user participation is essential in the design process to hear the voices of people with mental and cognitive needs [36]. Inclusive research can help expose misconceptions. Teenagers with autism can develop online privacy and safety literacy instead of being extremely "naive" to online risks as perceived by parents and professionals [56]. Raising professional awareness is a recurring call across studies involving designers and web/app developers. Identified barriers include a lack of empathetic understanding/awareness of accessibility concerns [17, 20, 53], organizational aid [53], and supporting tools [20]. Specialized design frameworks can help increase awareness and participant involvement while contextualizing design principles (e.g., [59]).

4.2.3 Extending third-party support. Studies around third-party payment support and financial collaboration for people with neurodiverse needs reveal nuanced contexts and evolving solutions. To help older adults with banking, over a decade, HCI researchers move from exploring cheque-based transactions [62] to explicitly recognizing "the nuanced and temporally changing role of close others" [40]. Online banking tools can enable users with cognitive impairment to pause a transaction for caregiver approval as needed [26]. The actions and attitudes of some significant others and service providers could constrain technology adoption and use. People with intellectual disabilities and high support needs might require the ongoing, essential involvement of significant others [19]. People with mental health conditions need support and intervention mechanisms to maximize their autonomy and financial health [30], as well as carefully monitored provision of personal budgets to ensure

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[4][66] adopts the US Census Bureau definition of baby boomers as those born between 1946 and 1964.

access for those with or without caregivers [29]. A new fintech tool enlists a trusted party for people with financial or mental health concerns by notifying this ally of specified transactions [5].

The third-party support could expand to broader accessibility communities. Researchers call on financial institutions to engage families and social networks of people with disabilities [67]. User-generated content in online communities (e.g., blogs, wikis, social networking sites, and discussion forums) can foster a culture of self-moderating accessibility, channeling constructively sustained efforts towards making content accessible to a broad audience [39].

4.2.4 Leveraging new technological aids. This review examines sources published between 2012 and 2022, a decade of technological evolution that continues to impact fintech. Recent studies show emerging technological support, notably AI, in banking and accessibility contexts. Older adults with low technology use find intelligent voice assistants (e.g., Amazon Echo Dot) helpful for online or local information search (e.g., the hours and location of the nearest bank branch) while raising credibility and reliability concerns [54]. People with mild to moderate dementia report high-stress interactions with voice-based systems, which might fail to understand them (possibly due to changes in their speech patterns, stutter, and greater pauses between words) [24]. More accessibility issues of conversational user interfaces include meaningful representation of conversation sequences, cognitive load, and data/operation transparency [41].

With growing AI assistance in shopping and banking, researchers investigate "machine heuristic—a rule of thumb that machines are more secure and trustworthy than humans," stressing the need to inform users of the automated and algorithmic nature, rather than human operations [60]. The flexibility of technological tools points to broader application. An NLP-based system can offer synonyms, definitions, and pictograms of complex words [2], as well as simplified texts [49], for a wide range of users with cognitive, intellectual, or language disabilities. Third-party access tools depend on emerging web services, collaboration technologies, and APIs supporting payment innovation (e.g., open banking [5]).

5 DISCUSSION

Cognitive accessibility is a significant factor in designing for digital payments where generic considerations often fall short of addressing specific pain points and nuances of payment interactions. Through this exploratory literature review, we take the first step towards painting a comprehensive picture of cognitive accessibility needs and challenges around digital payments, then explore potential avenues for better designing digital currency experiences.

5.1 Implications for Digital Currency Design

5.1.1 Promoting agency in collaborative payments. Our analysis of social challenges and third-party support reveals approaches to enabling flexible and dynamic collaboration on payments. Older adults' interest and continued capability in finance and online banking [66, 69] and their active seeking of help from close others [40] are echoed in the broader literature. Older adults with mild cognitive impairment often receive help from caregivers, including partners, children, and professionals with online services [47], and many seniors would permit their banks to contact someone trusted [27]. The

complexity of digital payments prompts user workarounds like sharing bank cards, identification numbers, and online account credentials. These mitigation strategies can be better supported through lessons from an integrated approach to support older adults' technology use and preferences (e.g.,[52]), inclusive of both in-person and remote support and a range of supporting persons/resources. The fluctuations in care recipients' financial or mental conditions (e.g., [29]) require dynamic support and customizable controls, as opposed to giving away passwords or power of attorney.

Enhancing collaborative payments heightens the need for user agency and autonomy through payment approval and consent. Enlisting trusted others can mitigate complex payment collaboration, requiring accessible design accommodations for embedding allies in the digital payment experience. Technology aids can enlist these allies through notifications, embedded help, and payment approvals. Payment approvals support autonomy better than broader power of attorney but still risk financial abuse and exploration as shown in our analysis [29, 40], calling for ways of increasing the accountability of trusted others. Building upon the understanding of extra cognitive and other workload required in digital payments [5], more work on payment notifications for people experiencing mental health issues and financial hardship further proposes the notion of financial citizenship [6].

5.1.2 Contextualizing inclusive approaches. The nuanced cognitive accessibility needs demand more contextualized design approaches. Our review shows that plain language alone might not necessarily work across contexts and user groups [57], pointing to the complexity of addressing cognitive burdens. Banking services are developing learning supports such as a specialized app that provides users with flashcards detailing step-by-step task instructions [44], while still placing the onus on users to self-train. These examples from academia and industry signal the need for visiting the system holistically to build inclusive and intuitive features beyond the general cognitive load issues. Recent work for users with autism from Brazilian HCI researchers can inspire approaches to contextualizing existing guidelines, such as a comparative analysis of guidelines [1] and a survey on the relevance, suitability, and understandability of guidelines for autism [16]. Increasing professional awareness and user participation can strengthen these approaches, along with lessons drawn from assistive technology design frameworks (e.g., the interdependence frame [7]), as well as strategies for involving stakeholders and surfacing the voices of neurodiverse populations (e.g., for people with dementia [18]).

5.1.3 Expanding AI-powered accessible design. Emerging virtual collaboration and AI-powered technologies are expanding accessibility approaches. In sensitive settings like health, recent work explores older adults' perspectives or use of voice assistants [10] for information seeking [9, 31], a social-support chatbot for online health community [65], and an AI-powered decision support system in rural clinics [64]. Such developments can inform human-AI collaboration in financial settings, including AI serving a triage role of ongoing transactions, built-in automated functions and handoff to human support, interruption and emotion change detection, and immersive Metaverse experiences (e.g., [21, 48]).

5.2 Next Steps

Moving forward, we will expand to a more systematic review approach, searching more databases and conducting a meta-analysis of the sources. In addition, a deeper dive into key HCI journals and conferences, combined with comprehensive forward and backward citation tracking, will yield more focused results and expand relevant outcomes. Critically reviewing the evolving results with expert feedback, we will deepen the focus on underrepresented sub-groups and the selected avenues that emerge in current findings (e.g., the use of new technologies such as AI). Future research can consolidate existing cognitive accessibility guidelines and frameworks across sub-groups, with refined analysis and in-depth interpretation, hopefully leading to new framework development and extending to empirical research directly involving users.

6 CONCLUSION

This literature review examines 30 scholarly publications to characterize and improve the cognitive accessibility of digital payments. Our findings reveal a range of accessibility and social challenges in online banking for older adults and people with neurodiverse needs. We uncover potential approaches and supports, including simplifying interfaces with diversified cues, raising professional awareness and participant involvement, extending third-party support, and leveraging new technological aids. We further discuss implications for digital currency design through support for user agency in collaborative payments, contextualized inclusive approaches, and extended AI-powered accessible design. We hope that this work will help inform researchers, interaction or fintech designers, and decision-makers about universal access priorities for digital currencies and broader web-based technologies.

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