Pupil Metrics in FinTech

Illuminating Human-AI Collaboration in Financial Decision-Making Through Pupillometry

Sophie J. Leonard

ADAPT Centre, School of Information and Communication Studies, University College Dublin, Belfield, Dublin 4, Ireland. sophie.leonard@ucd.ie

ORLA COONEY

ADAPT Centre, School of Information and Communication Studies, University College Dublin, Belfield, Dublin 4, Ireland. orla.cooney@ucdconnect.ie

BENJAMIN R. COWAN

ADAPT Centre, School of Information and Communication Studies, University College Dublin, Belfield, Dublin 4, Ireland. bejamin.cowan@ucd.ie

Eye-tracking methodologies offer a powerful tool for understanding cognitive and social processes in human-AI collaboration within financial technologies. By efficiently capturing fixation and gaze patterns, researchers can assess usability, attention, and decision-making in financial interfaces. Beyond usability, pupil metrics, less utilised in HCI research, can provide neurophysiological insights into the underpinnings of user cognition, namely trust, in AI-driven technologies, shedding light on collaborative facets of financial decisions. Implementing such research requires interdisciplinary expertise to ensure controlled study environments and meaningful data interpretation. Additionally, ethical considerations surrounding biometric data must be addressed to regulate its implementation. The current paper briefly outlines the potentials of pupillometry, in addition to more widely used eye-tracking metrics, in shaping the future of financial technologies, exploring trust during financial decisions, and emphasising its role in enhancing and understanding financial human-AI collaboration.

CCS CONCEPTS • HCI • FinTech

Additional Keywords and Phrases: Pupillometry, Eye-tracking, Trust

1 INTRODUCTION

In neurobehavioural research, eye movement data proves a useful metric in the exploration of cognitive resources, social processes, and even the prediction of various neurological deficits [1,2,3]. In the field of Human-Computer Interaction (HCI), eye-tracking has also shown to be an efficient means of gauging usability of applications and interfaces, providing novel insights into the allocation of attention to functional features and aspects of design [4,5]. Given the drive in understanding the unique way humans process high-stakes financial decisions, and how financial technology (FinTech) can facilitate such decisions, we argue that eye-tracking can provide an efficient and integrated means of exploring behavioural interactions with financial interfaces, allowing researchers to explore attention and user preferences, as well as the cognitive and social underpinnings of financial decisions. Below we outline the need to expand the range of metrics used when using eye tracking in FinTech interactions, and how this can lead to deeper cognitive insights into the nature of FinTech supported

decision making and social interaction. We then outline important considerations for the successful implementation of such measures within FinTech studies.

1.1 Expanding from gaze and fixation data in FinTech research

Eye-tracking metrics such as gaze and fixation data are widely used in HCI research, being seen as beneficial in providing information on attention allocation and interface usability [4,6]. As well as providing these evaluative insights, they also allow the researcher to draw cognitive inferences about user interactions with an interface, including cognitive load and hesitation about certain features [7]. For instance, researchers have used fixation count and duration to draw inferences on users' financial literacy and cognitive overload when engaging with certain features within a FinTech application, using this insight to prompt the updating of information to better suit the user's levels or literacy or confidence in the agent [8]. In sum, gaze and fixation data are a valuable set of metrics to use when designing and evaluating human-AI interactions within FinTech. Yet, rather than focusing solely on these two metrics, we argue that integrating additional eye movement metrics can also reveal neurophysiological signals, providing deeper insights into the cognitive processes underlying financial decision-making. For instance, changes in pupil size have previously been associated with levels of behavioural trust in another, which may have significant implications within FinTech. [9]. Such insights are important so as to allow a deeper understanding of the cognitive and social factors that are integral to decision making and how FinTech applications might influence these processes.

1.2 The case for pupil metrics in FinTech

To date, pupil metrics are generally less implemented in HCI research relating to collaboration and trust, though have been observed in the implementation of binary communication tools and in assessments of cognitive load [10]. The pupil serves an anatomical function in controlling how much light can enter the eye, allowing for vision and depth perception [11]. Low-level psychological research leverages pupillary changes in response to light and distance, to investigate processes like covert attention, mental representations, and the integration of pupil metrics into adaptive communication interfaces [12,13]. While pupillary changes occur in response to light sources, an array of research proposes that these changes are modulated by social processes, one of which being trust, which is considered particularly important for collaboration on financial decisions [9,14]. Social cognitive research finds that humans view partners with dilated pupils as more trustworthy, and partners with constricted pupils as less so, with their own pupils mimicking these changes when making decisions on allocating or revoking trust [15,16]. During monetary investment tasks (considered a direct way of measuring to what extent one partner trusts another), pupil metrics correspond to the levels of trust exhibited during financial decisions when the investment partner is deemed to be part of an in-group or an out-group [16]. Similar patterns of pupillary change are observed when a human partner engages with a virtual or robotic partner, with more trust, as measured via pupillary change, being ascribed to more anthropomorphic agents [17]. Integrating pupil metrics into human-AI collaboration in FinTech research and development could provide novel insights into trust dynamics in financial decision-making, among other cognitive processes. User confidence and trust in collaborative AI investment advisors could be gauged, enhancing transparency and user experience. Since pupil dilation (but not other eye-tracking measures) is found to be indicative of decision making components; option evaluation, hesitation and conclusions, pupil metrics can allow us to understand user's cognitive and emotional states during financial decisions [18]. Indeed, adaptive FinTech interfaces could utilise pupillometry to tailor interactions or adjusting information presentation based on cognitive load and trust levels. Furthermore, as pupillary responses seem to mirror social trust cues even in virtual settings, FinTech research could use pupil response to explore how assigning more human-like features and designs to AI agents influences financial trust, potentially allowing for more trustworthy and appropriate FinTech interactions. To put the above into context, if pupil metrics could signal a user's trust, hesitation, or cognitive load when reviewing investment

recommendations using an AI investment advisor - whereby changes in pupil dilation indicate hesitation or mistrust - the system could adapt by simplifying complex data or information, or offering alternative investment avenues. Since pupillary responses are purported to mirror social trust cues, integrating these metrics could also inform the design of such technology, optimizing their appearance and interaction style to enhance perceived trustworthiness.

2 Methodological Considerations

2.1 Controlled testing

While reliable gaze and fixation data can be obtained in a variety of ecological settings with relatively little need for stringent experimental controls, the added neurophysiological insights gained from pupillometry is accompanied by the need for considerably more controlled testing. Sensitivity to certain environmental factors such as lighting and excessive movement mean that extensive validation testing may be required before relying on pupillary changes as a definitive metric for specific cognitive or social processes. [11]

2.2 Ethical data regulation

Eye movement data can reveal information about the user's cognitive and emotional state, particularly prevalent when faced with high-stakes financial decisions. This raises questions about user autonomy, especially in cases where an interface may actively influence behavioural or social processes via eye movements, as has been demonstrated in previous psychological research [9]. As is the case with many forms of psychological or physiological metrics, misuse of pupil data could lead to privacy breaches and the potential for manipulation. Pupillometry as a marker of hesitation or trust in an AI advisor could lead to exploitation from platforms, nudging users towards decisions which are financially beneficial for the platform rather than the user. This is why emphasis on transparency, informed consent and stringent data regulation are of the utmost importance in the discussion surrounding application of these methodologies in FinTech. Discussions surrounding ethical frameworks and transparent policies will be essential in ensuring eye-tracking data as a reliable tool in facilitating FinTech based human-AI collaboration, without breaching privacy, autonomy, or reinforcing bias in any aspect of financial decision-making. More generally, consideration must also be given to the use and storage of personal biometric data in this way to prevent misuse.

3 Conclusion

The utilisation of eye movement data can enable unique and versatile insight into the behavioural and physiological underpinnings of human-AI collaboration during financial decision making. Although fixation and gaze data are commonly used in HCI work, the incorporation of pupil metrics is less observed. We argue that these metrics may be highly valuable, providing neurophysiological information on social and trust behaviour - a particularly important construct in the exploration of financial HCI - in addition to other cognitive processes. With controlled validation testing and consideration for ethical and regulatory procedures regarding the use of biometric data, eye-tracking allows for the collection of multi-faceted user data, facilitating understanding of

financial decision processes, personalisation of financial technologies, and overall human-computer financial collaboration.

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