Contemporary self-reflective practices: A large-scale survey

James Tyler [*], Marc-Olivier Boldi, Mauro Cherubini

Université de Lausanne, CH-1015 Lausanne, Vaud, Switzerland

ARTICLE INFO

ABSTRACT

Although self-reflection is a topic that appears in Human-Computer Interaction, the empirical data on the subject can often be dated, fragmented and focused on particular use cases. Our work sought to capture data that would help us better understand the current use of technologies to support self-reflection in the broader population. We did this through a large-scale online survey with a representative sample of internet users in the United Kingdom ($N = 998$) and a smaller series of follow-up interviews ($N = 20$). We found that, regardless of recent stress, those with high scores on a scale that measured self-reflection maintained a wider variety of self-reflective activities in recent months. Men reported more access and use of technology for self-reflective activity than women, but women's self-reflection scores were usually higher. We noted that high self-reflectors appear more spontaneous and experimental, using heuristics to mitigate common barriers or adapt their practice to stressors. These individuals appear to favour analogue objects to facilitate reflective practice, utilising technology in more strategic and selective ways.

1. Introduction

Self-reflection is a complicated psychological process people experience in different frequencies and amounts. It can be a valuable part of many health interventions to make sense of past experiences or organise new information (Hébert, 2015; Schön, 1992). However, as we continuously evaluate our experiences and surroundings, it can also have compounding effects that need to be considered (Kinsella, 2010; Takano & Tanno, 2009). Overall, our starting point and theoretical perspective throughout this work were self-reflection is a *particular* form of self-focused attention, directed at *oneself* or *our relationships to other things*. Though it may occur in different contexts and potentially influence our well-being, encouraging it may not always be advisable. This last point is because of its potential to spin off in problematic ways (e.g., rumination, obsessive or compulsive thinking) that may require the intervention of psychological services (Yip, 2006). A limited number of professionals can supervise meaningful redirection of introspection, and demand has been rising with the incidence of mental health disorders (World Health Organization (WHO), 2019; Davis & N. D. S. Correspondent, 2021).

Unfortunately, this often means there is a discrepancy between the need and availability of psychological treatments. Different factors may deepen this issue, including restricted budgets for the services themselves (Mahomed, 2020), improvements in public awareness (Bethune, 2019) and even aspects of modern life we cannot avoid (e.g. social media, changes in working patterns or conditions) (Gao et al., 2020). Professional stewardship may be necessary to facilitate *productive* self-reflection (especially in a healthcare setting). Though specialists are not telling their patients what to do or think *explicitly*, they help them to safely reach insights *themselves* which may allow the disentanglement, appreciation and restructuring of cognition. Whether done through interpersonal interactions exclusively or in combination with medication, progress and recovery often hinge on replacing behaviours with healthier approaches. Successful habituation will often come down to a person attaining sufficient *competency* and *motivation* to persist with the alternatives (gleaned through their intervention) in day-to-day life. It is then easier to understand why digital alternatives are appealing when they may be a cost-effective way of providing persistently accessible support, particular in a world where the pace and complexity of normal life appear to be increasing (Davidson, 2012). Applications such as Day One,[1] reflectly[2] or stoic[3] market themselves as productive ways to consider life from different perspectives and are already popular. These options will often quote the influence of scientific studies, but the

---

* Corresponding author.
  E-mail addresses: james.tyler@unil.ch (J. Tyler), marc-olivier.boldi@unil.ch (M.-O. Boldi), mauro.cherubini@unil.ch (M. Cherubini).

[1] See https://dayoneapp.com, last accessed December 2021.
[2] See https://reflectly.app, last accessed December 2021.
[3] See https://stoicroutine.com, last accessed December 2021.

available work often concerns *specific* use cases. They may not scale to a general population, involve technology, or rely on varieties and paradigms that are no longer commonplace (e.g., earlier 'non-smart' mobile phones (Lindström et al., 2006)). These approaches could miss essential details, like tactility, flexibility or personalisation - things which appear to make their analogue counterparts useful *and* compelling (Ayobi et al., 2018). In short, the conception of self-reflection in HCI may not be as mature as it could be. It would be enriching to gather further data - especially on what or why digital supports already work well for some and not everyone, when or where we can anticipate problems.

Our motivation was to build a better understanding of *current* technological use with respect to self-reflection. To distinguish between what is *popular* or *fashionable* and begin to take apart where technology is helping or hindering this activity. Given its importance to our well-being and resilience (Crane et al., 2018), we think it is important to know where it might be undermining healthy behaviours (new *or* existing). Offering insights to the community on how to improve digital supports. Importantly, this cross-section view of attitudes and technology was not limited to a small group or use case - it needed to capture a *general population*. We developed multiple perspectives at this level to understand how the environment, tools and mannerisms vary. We took steps to appreciate *what* people were using, *how* they were reflecting and *why* it might be working for them (or not). As many works on self-reflection (or even technology-assisted self-reflection) pre-date significant developments in personal and mobile devices, we felt it crucial to understand how technology is already situated - intentionally or not. Because self-reflection is often personal, our data collection focused on appreciating *conditions* that appeared to be common. Rather than building arguments that certain activities are *responsible*. Therefore, we structured our research questions around capturing (in a general population) the *distribution and variety* of different aspects (RQ1), what may be contributing to the differences in these aspects of reflection (RQ2). Specifically, the *attitudinal* differences (RQ2.1.) which *activities*, *objects* or *routines* were most (RQ2.2.) or least (RQ2.3.) common. Lastly, we looked for factors that could become candidates for future research to mitigate or improve a future generation of digital supports (RQ3). In summary, our research questions were as follows:

RQ1. How does self-reflection *vary?* (e.g. incidence, ability).

RQ2. What may be *influencing* sustained self-reflection?

    RQ2.1. Which are the most or least dominant *attitudes?*
    RQ2.2. Which activities, objects and routines *are used more?*
    RQ2.3. Which activities, objects and routines *are used less?*

RQ3. What *obstacles/pain points* could be addressed?

Our study found that although there were differences in technology use across different factors (e.g., gender, reflective ability or recent stress), analogue approaches to self-reflection took priority. Technology's role was often *complementary*. There were some technologies that nearly every respondent had access to but had not used (or considered) for self-reflective activities. Though all respondents experienced difficulties, our interviews revealed that competent reflectors found ways to maintain their practices with strategies or heuristics. These mitigated the most common obstacles (e.g., associating self-reflection with more reliable conditions and contexts *instead* of a routine time or schedule). The primary contribution of our work is *empirical* data on all these aspects - the incidence and attitudes toward self-reflection (or its related artefacts) especially. In addition, our data treats self-reflection as the central point (rather than a by-product). We believe this focus allows our results to form a foundation for technologies that could play a better role in enhancing *meaningful* self-reflection, self-knowledge and insight.

In the rest of this paper, we will discuss work that targeted (or contributed to) the topic of self-reflection so far, namely in the areas of *well-being, education* and *performance*. We will then detail our

experimental procedure and results before discussing the practical implications for researchers in similar or adjacent fields. Crucially, this data is a *contemporary* snapshot at a scale under-represented in current research. Being so close to well-being, conceptualisations of interactive systems to support personal insight need data situated in everyday circumstances - even if this prioritises non-technological aspects.

2. Related work

While developing self-reflection is sometimes an intention of interactive systems, it is often a secondary consideration or effect (Baumer et al., 2014). For example, reflection sometimes occurs concerning a significant life event (called 'life-changing events' or 'LCEs') as a tool that can help us process or integrate the changes we are experiencing (Massimi & Neustaedter, 2014). Research like this can neglect to expand upon the subject of reflection, assume it is occurring because of a degree of feedback, or focus entirely on different outcomes (Baumer et al., 2014). With its potential to influence human behaviour, appreciating how technology *already* facilitates this activity for most people may be invaluable to the systems which rely on it.

Preceding studies on self-reflection appear in many domains *outside* of HCI, usually involving clinical psychology or neuroscience at some level (de Jong et al., 2019; Lysaker & Klion, 2017). Of relevance to this work, many studies underline the utility of self-reflection or examine its efficacy in certain use cases. Namely, it has been studied extensively within the areas of *well-being* (1), *education* (2) and *performance* (3). While some use technology to elicit self-reflection (Lomicka & Ducate, 2021) (Terpstra et al., 2019), and ground their efforts in sound behavioural theory (Lie et al., 2018) (Saksono et al., 2020); it is often for a specific goal (e.g., improving exam results, beating a personal best). These works demonstrate at least that self-reflection *is* an important topic to understand *because* it may influence the outcomes which are important to other objectives in HCI. However, studies will often fall short on detailing how this activity factors into the daily lives of *most* people or how it is generally perceived.

Before we describe the areas above, it seems that current work on self-reflection is fragmented - particularly within Human-Computer Interaction. Preceding work may be vigorous and invaluable but often refers to *aspects* and *effects*. To the best of our knowledge, a recent picture of technology *within* self-reflective activity has yet to emerge at this scale. We believe that developing public *needs* warrants the collection of more data that could help realise efficacious and appropriate supports.

2.1. Defining 'self-reflection'

An immediate issue is that self-reflection is a broad and ambiguous concept; Baumer et al. found in a corpus of papers from Human-Computer Interaction (HCI) that precise definitions of self-reflection were rare. He found that of the 28 papers which *did* include definitions, the majority (20) drew from the work of Donald Schön in particular (Baumer et al., 2014). For Schön, there is a distinction between 'reflection-*on*-action' and 'reflection-*in*-action' (Schon, 1984). In this case, self-reflection is characterised as a focused attention on something that has either been experienced *already* (*on*) or is being so *currently* (*in*). Later work will sometimes expand this pair with an additional type, 'reflection-*for*-action', where the focus is instead on aspects anticipated or planned in the future (Grushka et al., 2005; Killion & Todnem, 1991; Olteanu, 2017). Schön's work on self-reflection derives from some of the earliest writing on reflective practice by John Dewey. The reflection provided by Dewey describes that it is "active, persistent and careful consideration" of the support for our beliefs and knowledge - something that may lead to new conclusions or insights (Dewey, 1997). However, Dewey was influential in the work of many others. Multiple schools of thought and models have emerged, each with different emphases or the inclusion of synonymous aspects (Borton, 1970; Brookfield, 1998; Gibbs & G. B. F. E. Unit, 1988; Johnson & Raye,

1981; Kolb & Fry, 1974).

Though the picture provided by Schön and others is invaluable, it was the limited number of definitions seen in HCI that Baumer believed may hold it back. They may paint a picture of self-reflection which is too rigid, broad or *neutral*. For example, authors in other fields have also examined important distinctions between self-reflection and *reflection*, self-reflection versus *rumination* (Takano & Tanno, 2009; Trapnell & Campbell, 1999). They show that self-focused attention is rarely passive, universally positive or negative - it can be, at times, adaptive or *maladaptive*. This detail is related to a close relationship between meta-cognition and our self-regulating ability, meaning these terms will often be adjacent in reflection studies. Meta-cognition is important to regulating our behaviour and being aware of our thinking, and *why* it is that way can subsequently help us to intercede or re-direct our energies.

2.2. Well-being, education and performance

2.2.1. Well-being

The first area, (*well-being*), is what comes to mind for most when they discuss *self-reflection*. Reflection can be helpful for assessing life satisfaction and interpersonal relationships (Rank & Gray, 2017; Rober, 1999), it has also been studied as an aspect of developing psychological resilience (Crane et al., 2018). In psychology, self-reflection is often a *therapeutic* mechanism used to evaluate thoughts, feelings or behaviours. Life experiences and stressors may be *interpreted* different ways (Carver & Scheier, 1998). How we address (or re-address) them can strengthen or weaken our ability to manage or respond adequately (Falon et al., 2021; Falon et al., 2021). It can be an individual process, but it can also be a collaborative process performed with others (Berry et al., 2021). Crucially, self-reflection may be essential for purposeful changes in behaviour. It can help to determine if additional adjustment or a new strategy is needed to attain a desirable outcome (Grant, 2001). Meta-cognitive knowledge and meta-cognitive regulation are different aspects of this process, accounting for what is known about one (or others) thinking or influences (Schraw & Moshman, 1995). These have been explored in psychological disorders such as anxiety (Wells, 1995) and aspects that impact the quality of life, like memory encoding or reality monitoring (Johnson & Raye, 1981; Strack & Förster, 1998).

It is not to say that self-reflection alone can remediate psychological issues. Instead, it is part of a lattice people can use to appreciate themselves and facilitate improvement. Grant explored definitions of such *psychological mindedness* and noted a difference between preparedness and motivation. Namely, where efficacy depends on a person's ability to appreciate themselves from different perspectives *as well as* their motivation to seek out these new perspectives and engage in the process (Grant, 2001). For psychological therapy, reflection is helpful to patients and professionals alike (Bennett-Levy et al., 2001). Reflective action can accrue important glimpses into someone's inner state that subsequently inform the clinical approach. As such, considerable work examines best practices to *capture* or *measure* the extent of reflection or model the process. Systems have emerged to measure different aspects of self-reflection (e.g., reflective ability, psychological mindedness or private self-consciousness). Still, an issue can be the complexities of the topic and the variety of definitions being used (Conte & Ratto, 1997).

More widely, *wellness* trends in popular culture often position self-awareness as a desirable virtue, but researchers have examined the potentially harmful aspects as well (Joireman et al., 2002). Notably, the distinction between rumination and reflection has been a focus of authors such as Trapnell and Campbell (Trapnell & Campbell, 1999), addressing what is sometimes known as *the self-absorption paradox*. This issue reports that higher levels of self-awareness may be associated with increased levels of psychological distress and psychological well-being *simultaneously*. They suggest psychological distress emerges from ruminative aspects of self-consciousness, and well-being comes from reflective contemplation. This juxtaposition may be a warning that reflection is powerful in either direction. It requires competency and even

supervision to prevent maladaptive behaviours from developing.

2.2.2. Education

In the *education* setting, meta-cognition through self-reflection may help students to assess their progress accurately or take an objective perspective (Choi et al., 2017; Kilgour et al., 2015; Mlinar Reljić et al., 2019) and it is also adjacent to important critical thinking skills (Beveren et al., 2018). These processes can inform a cycle of behavioural change that is closer to *personal-development* or *coaching* than the therapies we mentioned earlier. However, it is still essential for optimal pedagogical results and fruitful cooperative learning. Individual reflection can contribute to the cumulative effort of a larger group through the regulation of personal learning, co-learning, and cooperation (Pedrosa et al., 2019). Studies have examined the extent to which self-reflection impacts the learning processes of students in different domains (Campbell et al., 2021; Izu & Alexander, 2018; Lousberg et al., 2020), the teaching practices of educators (Wosnitza et al., 2018) as well as the influences it may have on social issues within the academic environment (Civitillo et al., 2019; Kishimoto, 2018).

Particularly in recent months, the need to reinforce autonomous learning practices has grown due to the COVID-19 pandemic. As every level of education adopted a remote or hybrid teaching model, the channels for educators to monitor student progression are fewer. In addition to the well-being issues involved in this public health crisis, the need for adequate self-regulation and the responsibility to communicate difficulties has increased for students (Gaeta et al., 2021; Holzer et al., 2021). Although it is possible to create digital learning spaces, evidence suggests it may be harder for virtual learning to promote spontaneous creativity and social sharing, which may catalyse introspection (Lowenthal et al., 2020).

Although educational research often includes self-reflection, it is usually examined as an influencing *factor*, not the central aspect (Hollingsworth & Clarke, 2017). These works often focus on improving technological adoption or how it compares with a traditional approach - the performance of *a* technology *against* the psychological process is of most concern. Details on the process or how it interfaces with the more significant technological landscape are often limited. Lastly, it is worth mentioning in this part that learning and collaborative reflection are not exclusive to the school or university setting. Other researchers such as Michael Prilla have examined ways to support these processes in the *workplace*, and many of the studies mentioned here are relevant to working practices as well (Prilla et al., 2012).

2.2.3. Performance

Similarly to its use in education, self-reflection has also been a phenomenon of interest for athletic *performance*. Here, a *coaching* or *personal development* mindset is also the most common. Some will be familiar with works associating visualisation techniques with performance differences in professional athletes (Campos et al., 2015; Jose & Joseph, 2018), mindfulness-based approaches to improve recovery (; Hägglund et al., 2019) or post-event reflection and assessment (Chow & Luzzeri, 2019). Reflective measurements have also been crucial to appreciate the needs of those transitioning into athletic retirement (Stellefson et al., 2020). Although performance and education share a similar objective, there are subtle differences. Reflection may influence self-image and motivation within sports to afford the athlete additional endurance or the resources to *complete* or *extend* training efforts (McCormick et al., 2019) and, in contrast, students gather comprehension that is *sufficient* or *qualifying*. Athletes may train extensively to maximise their performance in a brief window. Students invest in skills they will build upon for the rest of their careers.

We know that the mind-body relationship may play an essential role in physical performance (Hanrahan et al., 2009; Jonker et al., 2012). Psychological well-being is often a desirable foundation for an optimal and sustainable effort like education. Still, athletes face attrition that is *both* physical and mental. The scale of their goals and failures means

professional athletes have a very different relationship to setbacks (Conroy & Elliot, 2004). Not every student is concerned with beating their peers, but it is the central objective for many athletic careers. Athletes pursue best-in-class results as the measure of their success. They often flirt with the boundaries of human capabilities. Only a handful of individuals will manage to breach these thresholds, so many studies are concerned with preparing or rehabilitating athletes who suffer under the tremendous burden of these ambitions.

This detail relates to another aspect of self-reflection apparent in all examples. While reflection can be an introspective activity, it often involves a degree of external focus or comparison. We continuously construct aspects of identity and our understanding from observations of ourselves, the world around us or how we compare to others. Dissonance can emerge between actual and desired results, and perceptual discrepancies can manifest into threats to psychological well-being. Self-reflection can be a tool to process important events, mitigate reactionary psychological responses and remain sustainably focused on an objective.

2.3. Technologies and self-reflection

Researchers such as Calvo and Peters have promoted the idea that technology can play a positive role in psychological well-being, even augment it (Calvo & Peters, 2014). Their conviction has been supported and explored with important peers in behavioural psychology as well (Peters et al., 2018). Technology research has often explored essential aspects of awareness and self-reflection, especially as capturing personal information has become easier over generations of personal devices. Digital tools have played a transformative role in many industries; technology adoption and a growing number of *digital natives* have allowed fields to flourish considerably. In particular, *personal informatics*, which sometimes appears in parallel to the *quantified self* movement, has been a progenitor of self-reporting and self-tracking technologies. Many have already found their way into daily use (Elsden et al., 2016; Epstein et al., 2015). Elsden argues that in recent years, these technologies have matured. He suggests their utility might relate to people's desire *to account for one's life*, or *author a unique perspective* (Elsden et al., 2016). However, what is of interest within the computing space is how resistance can develop toward these digital trends. In HCI, we may often discuss *non-users* of technology (Satchell & Dourish, 2009) but we believe this term does not always sufficiently distinguish those who are inactive through *circumstance* from those who *abstain* (Cherubini et al., 2021). This phenomenon is visible in certain self-reflective activities like journaling, where some prefer a paper-based and *analogue* practice over a digital counterpart. We know that people attribute different values to artefacts they have fabricated themselves either partially or entirely (Norton et al., 2012). Personalisation like this has also been a subject within HCI; Ayobi investigated the customisation strategies in a prevalent system of paper journaling (*Bullet Journaling*) (Ayobi et al., 2018). He extended these principles into an application for users experiencing multiple sclerosis to record their symptoms or experiences (Ayobi et al., 2020). This work capitalised on the modular nature of the original analogue practice, resulting in a more meaningful system for the user.

In healthcare especially, although it can seem intuitive to replicate the terminology and structure of *treatments* into applications, it can lead to issues that may undermine sustained use. Users of healthcare applications, particularly with chronic conditions, often report discomfort with the clinical aspects of their situation 'creeping' into their regular life - a process known as *medicalisation*. Although clinical elements are helpful to physicians, who deal with these terms, they can be uncomfortable or jarring reminders for patients on an ongoing basis (Ancker et al., 2015). It can be helpful for researchers to consider human issues like these whilst developing new technologies, mainly if they are for use in influencing behaviour. One approach is to assess interventions using a particular behavioural theory lens. Our work subscribes to the model of behavioural change described by Ryan and Deci (*Self-Determination Theory (or 'SDT')*). Their work suggests that human motivation is driven by three *basic psychological needs* (Ryan & Deci, 2000). It contends that satisfying these needs (or failing to) can alter the likelihood that behaviour becomes driven and *self-sustaining* through intrinsic motivation. SDT is essential to self-reflection, not just as a tool to appreciate needs-satisfaction and frustration but also because it is a behaviour *itself*, which will be subject to the same principles. It is also a theory with an established presence in HCI. Other researchers have used it to focus on improving the satisfaction of these needs or critique potential failure points in existing applications (Peters et al., 2018; Villalobos-Zúñiga & Cherubini, 2020).

Broadly, we can see from personal-informatics that autonomous data capture may be conducive to self-reflection and *sense-making* (Puussaar et al., 2017; Rapp & Tirassa, 2017). That is, in combination, how we attribute meaning to things or understand our collective experiences. This process can be through a *data-driven* approach of surfacing insights for users with their personal information (Potapov et al., 2021; Rapp & Tirassa, 2017). This approach is often a crucial stage for many different models (Bentvelzen et al., 2021; Epstein et al., 2015; Li et al., 2010; Rooksby et al., 2014). It is progress in this area (and others like it) that implementations of health or fitness trackers *have* experienced a wider acceptance. HCI has indeed gone to some lengths to understand analogue practices (Tholander & Normark, 2020) or investigate ways of modernising them (Terzimehić et al., 2021). Nevertheless, we believe we could extend current understanding by examining analogue, digital, and *hybrid* approaches. Linking to our goals for this study, collecting these perspectives may reveal deeper *best practices* for digital supports and facilitators. Whether existing applications or services are informed or *inspired* by research is not always tangible, nor are all levels of ability visible and catered for (RQ1, RQ2). This study partly intends to address this issue by collecting data on the current *status quo* (RQ2.1, RQ2.2). We believe that the efficacy of some digital approaches may lag far behind *appeal*. Others (which may be promising to explore) could be held back by different factors (RQ2.3, RQ3). Indeed, we have seen that research into self-reflection is a mixture of old and recent cases that frequently examine particular *niches* with a narrow focus. Any broader treatise on self-reflection appears to predate significant technological developments that may be important to consider. Tools and services for this purpose could emerge from an impoverished position until we know more about the contemporary perspective.

3. Methodology

Our study utilized a mixed methods approach in two stages. Firstly, we deployed a large-scale survey on the Prolific research platform,[4] specifically on a representative sample of internet users in the United Kingdom. Questions were included for quantitative and qualitative perspectives on participants - specifically on their reflective *activities*, associated *objects* or *routines*. In the second part, we invited a subset of participants back to undergo a follow-up interview over Zoom. These interviews allowed more nuanced discussions and a chance for researchers to observe attitudinal differences up close. We chose interviewees (see Table 1) using categories that emerged from the combination of two scales covered in the following parts. An important note before continuing is that many aspects of this study needed careful consideration due to the nature of using self-reflection as a subject of study. Before, we considered the challenges presented by earlier work and sought to design our experiment to mitigate as many issues as possible. Some of these steps were practical, whereas others require us to make a statement on what exactly can be measured or stated. We believe that although there is much work on the subject of self-reflection, it is and will continue to be difficult to encapsulate empirically into factual statements of things that will or will not improve someone's ability. Each

---

[4] See https://prolific.co/, last accessed December 2021.

Table 1

Interviewee characteristics.

P#	Age	Gender	Ethnicity	Education	Stress (SRSS)	Reflection (SRIS-SR)	Group
P1	34	Male	Black	Graduate degree	406	61	H-SRSS /w H-SRIS
P2	40	Female	Black	Undergraduate degree	347	48	H-SRSS /w L-SRIS
P3	51	Male	Asian	Undergraduate degree	424	57	H-SRSS /w H-SRIS
P4	27	Female	Asian	Technical/community college	449	67	H-SRSS /w H-SRIS
P5	47	Female	Asian	Undergraduate degree	403	72	H-SRSS /w H-SRIS
P6	33	Male	White	Graduate degree	377	59	H-SRSS /w H-SRIS
P7	37	Male	White	Graduate degree	352	69	H-SRSS /w H-SRIS
P8	50	Female	White	Technical/community college	313	62	H-SRSS /w H-SRIS
P9	44	Female	White	Technical/community college	346	66	H-SRSS /w H-SRIS
P10	61	Male	White	Technical/community college	329	46	H-SRSS /w L-SRIS
P11	41	Female	Asian	Undergraduate degree	93	42	L-SRSS /w L-SRIS
P12	64	Male	White	Graduate degree	58	22	L-SRSS /w L-SRIS
P13	37	Female	Asian	Undergraduate degree	73	41	L-SRSS /w L-SRIS
P14	61	Male	White	Undergraduate degree	69	38	L-SRSS /w L-SRIS
P15	62	Male	White	Undergraduate degree	91	31	L-SRSS /w L-SRIS
P16	39	Female	White	Graduate degree	24	70	L-SRSS /w H-SRIS
P17	42	Male	Asian	Undergraduate degree	117	49	L-SRSS /w L-SRIS
P18	53	Male	Black	Undergraduate degree	63	58	L-SRSS /w H-SRIS
P19	21	Female	Asian	High school diploma/A-levels	96	61	L-SRSS /w H-SRIS
P20	–	Female	White	Graduate degree	64	51	L-SRSS /w H-SRIS

individual is unique, and while it is possible to appreciate more or less self-reflective traits, it is not advisable to say that *doing meditation* or similar *makes* someone self-reflective. We built much of the stages in our experiment with the objective of a final *holsitic* picture of the *conditions* or *environment* that appear to make it more likely to occur or be done in a *consistent* way. Next, we will discuss the design of these stages in more detail before moving to our results. Our complete interview protocol and survey questions are also in our Open Science Foundation repository.[5]

3.1. Participants

We chose the United Kingdom for the deployment of this study for several reasons. First, as the first author of this study originates from the UK, we felt this would facilitate a more nuanced understanding of the cultural and contextual backdrop. This strength would also improve the likelihood of noting colloquialisms in responses during analysis. This familiarity also extended to the technological landscape, including how digitised critical public services were and their impact on daily life. Additionally, as the Prolific platform originates from the UK, we expected its user base to be the most active and comprehensive in this region.

A feature of the Prolific platform is that researchers can recruit a representative sample for a specified region. Prolific uses its demographic data on each user to direct surveys where their qualities are still needed to complete a sample (Prolific, 2021). Prolific uses sex, age, and ethnic group data collated by the UK Office of National Statistics during the last public census in 2011 (U. O. for National Statistics, 2011). We used this facility to collect our survey participants and verified that the respondent demographics were accurate to the original census data. The survey respondents were 18 to 89 (M = 47.11, SD = 15.46), with 513 males and 487 females. Demographic characteristics aligned with expectations for a representative sample of the UK, though there were slight differences in the sex and age groups. This detail is because children are *included* in the original census data, but Prolific *prohibits* users under 18.

3.2. Materials

3.2.1. Survey

The instrument was designed to last approximately 20 min and

included 42 questions across several topics.[6] It included two different scales - the *Self-Reflection and Insight Scale* (SRIS) developed by Grant et al. (Grant et al., 2002) and the *Social Readjustment Rating Scale* (SRRS) of Holmes and Rahe (Holmes & Rahe, 1967). As we have mentioned previously, we considered the level of detail and provided ways for participants to add more information with open-ended questions. For example, while we included lists of activities, objects and routines, these were intentionally non-exhaustive (e.g. not listing individual apps or techniques). Participants would have the opportunity to mention more detailed specifics, and we did not want to overwhelm them with choices that would undermine the efficacy of the survey itself.

We used wording in our survey questions that would be approachable to most people, partly drawn from participant work descriptions described in the earlier studies. To build a list of self-reflective *activities*, we amalgamated suggestions from across the web and those appearing in earlier studies. We ran these lists by our colleagues to ensure that the options were easy to understand, distinguished enough from one another and provided as much coverage as possible. For *objects* and *routines*, we adapted similar questions on household items and lifestyles that are common in public censuses and marketing surveys.

We briefly asked participants at the beginning to indicate which region of the United Kingdom they resided in and the highest level of education they had completed. We did not need to ask any further demographic questions as this data is provided automatically by the Prolific platform. The remainder of the survey combined multiple-choice questions for quantitative data and free-form fields for qualitative perspectives. The survey followed a specific order, but multiple-choice answers were random. In addition to the main sections of the study, the two different scales book-ended the main questions. These were to assist with categorizing participants into and identifying candidates suitable for a follow-up interview.

Although these scales are not infallible, they have established utility in Psychology and HCI. We placed the stress scale (SRRS) at the end of our survey because it may have distracted participants during the other sections had it appeared earlier. The scale includes a list of challenging or disruptive events. If survey respondents were experiencing any of these, it might have coloured their responses.

3.2.1.1. Entrance questions. After acquiring the participant's consent

---

and asking for additional demographic details, participants completed the SRIS. The scale is a series of statements in which participants indicate how they agree (or disagree) with its applicability to themselves. It uses a Likert-type scale of six points, ranging from 1 (Strongly Disagree) to 6 (Strongly Agree). Descriptions in the Self-Reflection and Insight Scale include things such as *"It is important for me to evaluate the things that I do"* and *"I have a definite need to understand the way that my mind works"*. While the SRIS has been validated on several occasions and there may be consensus on its reliability, the experimental settings were often quite different from one another (e.g., different language versions, groups of nurses and students rather than representative population samples). In light of this, these studies' exact reliability scores may be misleading but we can report the figures of the coefficient alpha included in the original study as.91 for the SRIS-SR, and.87 for the SRIS-IS (Grant et al., 2002). As we have mentioned earlier, measuring self-reflection *exactly* may be problematic for many reasons. In the context of the experiment, the purpose of this scale was as a *baseline* in which we could apply *rough* filtering to the large amount of data we were expecting. Our observations would become more polished through a holistic approach to analysis that includes qualitative steps described shortly and an aggregated approach toward statistical analysis. It looks at relationships between as many factors as possible that may create ideal *conditions*, not individual *causes* for these numbers to change.

3.2.1.2. Activities, objects and routines. The central sections of the survey involved a series of questions to determine participants exposure to self-reflective *activities*, associated *objects* and *routines*. For the most part, they were exclusively multiple-choice though there was sometimes an open-ended field to add more detail, and each section ended with an open-ended question we will detail. In the *Activities* section, we asked participants to indicate which they had heard of from a list of reflective activities. We then asked if they had done any of these from those they selected in the past four months. Finally, for any that made it this far (i. e., they had heard of them and done them recently), how long had they been doing these - with options from 1 month – 3+ years. This line of questioning was to establish any differences in the *repute, popularity* and *incidence* of particular activities. It is worth mentioning at this point that the goal of this study was not to find *direct* associations with these elements and the reflection scale scoring. It is difficult to know *exactly* what is *producing* improvements in self-reflective ability. Instead, our motivation was to understand which elements may be contributing to a *condition* or *environment* where self-reflection is more likely to occur. Measuring self-reflection is difficult because it is often a deeply personal/individual experience - as we have discussed earlier, many things can be overlapping (e.g. self-expression).

In the second section, we asked participants about *Objects* they may use to facilitate or drive self-reflection. Crucially, there were two lists of artefacts, one with *digital* and another with *analogue*. Similarly to the first section, our questions work down from asking which objects they had *access* to and, of these, the ones they would use for the reflective activity. The lists included things usually used to develop personal insight (e.g., paper notebooks, activity trackers). It also had more atypical household items that could serve a function in the process (e.g., sensory aids like incense or essential oils, tablets or video game consoles). We asked participants if they had (or would consider) the purchase of an object *explicitly* for reflection (e.g., a tablet to keep a digital journal). We provided a free-form field to allow them to articulate an example in more detail. These questions were essential to understanding the tools most have at their disposal, how technology was acceptable or accessible for these activities, and if this varied across groups.

The last of these sections covered the *Routines* of participants. This part focused on what time they had available, allocation, and how it was reliably accessible. First, we asked when they would most likely have the time to engage in a reflective activity on a typical day. Then, how often these times occurred in a typical week and how long the periods

typically lasted. While perceived vs actual free time would certainly differ, we wanted to understand how this contributed to reflective scores. For example, those who scored highly on the reflection scale (SRIS) might only be reaping the rewards of a more flexible schedule.

All three sections concluded by asking how important this aspect seemed to them. They indicated their answers using a 7-point Likert-type scale (Largely Unimportant - Largely Important). These questions highlighted potential attitudinal differences across the range of reflection scale (SRIS) scores and different configurations of reflective practice.

3.2.1.3. Exit questions. In the final section, we asked participants to complete the Social Readjustment Rating Scale (SRRS) mentioned earlier. This scale lists 43 stressful or significant life events, and a participant indicates which of these they have experienced in the preceding 12 months. Each has different weights, and the final scores are the sum of the selected items. This scale intends to indicate the likelihood of a person experiencing (or may experience) a health breakdown due to recent events. Therefore, if a participant has a score of 300 or more, the chances of experiencing illness relating to these stressors increase (Holmes & Rahe, 1967). This measure was used in addition to the reflection scale to help us differentiate respondents and improve the contextual perspective. In contrast to the SRIS, which does not appear to have been validated using a population sample, the SRRS has been used many times since it was first introduced in the 1960s. In one study, using a general population, the reported Cronbach's alpha was.85 (Gerst et al., 1978).

Given the age of the SRRS scale, we included another question with additional life-changing events (e.g., being affected by *'non-consensual pornography'* or *'gender transition'*). These examples were things that were less pronounced or recognised when Holmes and Rahe developed their scale. Choosing any of these did not count toward the stress scale scoring they had completed and was only there for additional context. This scale has also been adapted successfully in HCI by Haimson for similar reasons (Haimson et al., 2021). This question also included a free-form field if participants desired to indicate something unlisted. We asked which types of support they consulted during these events in the final questions. Before asking about consent to a follow-up interview, we included a free-form question about aspects that regularly interfered with their self-reflection and how they felt about the concept more generally. We felt these questions were most appropriate at the end to capture participant thinking which may have evolved over the survey.

3.2.2. Interview protocol

We developed an interview protocol with questions to provoke further reflection and insight on specific aspects of the survey.[7] The design of the interviews was semi-structured, to be led by no more than two researchers. An introductory period explained the interview process and the researcher's roles and fielded any participant questions before starting. Some questions were included at the start to help participants relax and to break the ice. We asked participants if they were comfortable with us recording the session and told them that they could take a break or stop at any point.

3.2.2.1. Reflection. In the first part of the interview, we asked participants to elaborate on their reflective nature. This dialogue included asking what this concept meant to them, whether they considered themselves to be and under what circumstances it was most likely. We asked about different sources of reflection and how their behaviour or attitude changed toward obstacles. This part of the discussion extended the atmosphere of the ice-breaker, with participants being encouraged

---

[7] The interview protocol is available on the Open Science Foundation repository at https://osf.io/r6f8v/?view_only=0c55cfe93b8045179732feafc6835d03, last accessed May 2022.

to reminisce and speak freely. This section also helped establish how introverted or extroverted participants seemed and their intrinsic or extrinsic influences. We learned about how reflection was most likely to feel for them and when it occurred, their typical responses to life stressors or how they felt about these activities. This part allowed us to collect pointers on their psycho-social nature and aspects of their environment, which could potentially support (or hinder) reflection.

3.2.2.2. Self-management. In this section, we began to explore how reflection influenced participants' day-to-day behaviour. We asked how they organized themselves, used tools, mitigated stress or sought advice. We were particularly interested in understanding more about how our participants kept track of or remembered essential details in their lives and the extent they looked backwards or forwards. This line of questioning extended to planning styles and their attitude toward integrating behaviours. This section was also important as a place where we began to ask participants how technology played a role in their day-to-day life - whether they relied on artefacts such as a smartphone for task management or a calendar.

3.2.2.3. Technology. Extending the introduction of technological aspects, we used the last section to ask the participant more general questions about their attitudes toward technology. We asked how they felt about technology's role in their lives and society - what problems they might have been concerned about or encountered. We wanted to learn more about the advantages they found in technology, what aspects they would change, and their overall sentiment. This direction encapsulated discussion of how they had or considered technology as part of reflection and any final thoughts on the activities they had tried (or tried and *failed*) to pick up in the past. This part was a more candid discussion on whether technology felt appropriate for a reflective activity. Typically after asking participants if they had any further questions or thoughts, we ended with a brief description of our study and how their results would be helpful.

These interviews did not establish if participants were more inclined toward extroversion or introversion. Nor their hesitance around technology. There are already measures for these, and we preferred to capture a more holistic image of different groups. Interviews were better opportunities to observe how participants occupied their spaces, spoke about their lives or presented themselves and their thoughts. We felt that coding these interviews would teach us more about these individuals' relationship *with* self-reflection than isolated measurements on speculative factors in the context of exploratory work.

3.3. Procedure

3.3.1.1. Data collection. Participants received a 5 GBP incentive for completing the survey. Design features of the platform also ensured safeguarding and anonymity for participants with strict policies on how and where we could contact or pay them. After finalising the survey questions, it was implemented on the Qualitrics platform and tied to a Prolific study. Participants' eligibility for incentive payments was handled automatically by URL handlers provided on both platforms when arriving at the survey. Before launch, the survey underwent several checks for survey flow and cognitive issues; three attention checks were also included in the survey to improve data quality.

Once we published the study, the deployment was staggered to address errors before allowing it to run unattended until completion. The Prolific platform recorded which participants needed to complete a representative sample and alerted users who were still required. After verifying the integrity of the deployment, it took several days to accrue all 1000 participants and examine responses to approve or reject incentives. Participants took approximately seventeen and a half minutes

to complete the survey, with eight participants spending more than an hour. The study was closed after collecting a representative sample ($N = 1000$). We took quality assurance steps to ensure the data was validated and cleaned before adding new columns for the calculated scores of each respondent on the SRIS and SRRS scales. This summation was necessary as a first step in choosing individuals for a follow-up interview. All respondents were classified into four quadrant groups - permutations of their scale scores (e.g., High Stress *with* High Self-Reflection, High Stress *with* Low Self-Reflection etc.). In total, 1001 people completed the survey, and after the steps listed above, we had 998 completed.

We examined the participant's SRRS scores against their SRIS-SR score - this is the Self-Reflection aspect of the SRIS, which is a combination of two sub-scales: *Need for Self-Reflection* and *Engagement in Self-Reflection.* We chose to use the SRIS-SR scale rather than *both* of the components because the other scale, SRIS-IS, represents the extent to which respondents have *clarity* about their thoughts/feelings. As we were examining a wide variety of people at different life stages and levels of maturity, it would have been problematic to mix combined scores of people who were perhaps older and less insightful with those who were younger and more insightful. We distinguished these different characteristics more clearly by considering the SRIS-SR and SRIS-IN scores independently. Finally, while many studies report the mean score of these scales, they are often limited to narrow groups (e.g. students, nurses). As our survey was targeting a *population sample*, we decided it was not appropriate to use these means as a threshold for groups as it was not a guarantee that the characteristics of the narrow groups would translate to the broader public. We defined the mean SRIS-SR seen in our data as the threshold between *High* or *Low* self-reflection. For the threshold of the stress scores, the SRSS scale is not a measure of how *stressful* an individual is in character. Instead, it represents the sum of recent stressful events that are *likely* to impact daily life. We were most concerned with learning about the characteristics of reflectors that maintain their practices *in-spite of* exceptional levels of stress, we used a threshold of 300 with this scale. The SRRS describes this as the point from which individuals are 80 % more likely to experience a major health breakdown in the preceding two years. We could have set this threshold lower, but we decided that the COVID-19 situation presented a potential problem. Many of the situations listed in the SRRS are *typically* infrequent; however, during the pandemic, almost everyone is likely to have experienced a portion of these because of the realities of the health crisis (e.g. *Changes in…* recreation activities, social activities, the number of family reunions). A threshold of 300 gives us a better picture of those amid *significant* upheavals, and we could focus our analysis on objects, routines and activities that remain beneficial at the extremity.

Participants were made aware of follow-up interviews in the study description before they signed up for the survey on Prolific and could give their consent to the final question. We used the scales described to group the survey participants, and we offered 20 of these a further 30 GBP incentive for an interview (i.e., 5 GBP for the survey +30 GBP for the follow-up interview). Interviews lasted around 1 h on Zoom, and of the 998 participants, 741 agreed to contact about a follow-up interview (74 %). After, we verified all of the automatic transcriptions from the interviews (provided by a Zoom feature) for accuracy. Only two interviews needed manual transcription because of a recording issue and a strong regional accent.

3.3.1.2. Qualitative analysis. We manually examined patterns in participant responses to the open-ended questions of the survey and the interview transcripts using thematic analysis - following the reflexive approach of Braun and Clarke (Braun & Clarke, 2006). In brief, this approach uses six steps: steps one and two involved the two researchers familiarising themselves with the data that had been collected and extracting initial codes from highlighted passages. Codes can be qualities or descriptions, such as if a participant emphasises something *directly*. Steps three and four involve discussing these codes and

searching for themes encapsulating them. In the case of our survey, we used a random subset (approximately 10 % of participants) to generate initial codes and then check the rest of the responses for how frequently they appeared or whether there was anything new. We used a similar process with interview transcripts, but we generated codes and themes using all the transcripts because there were fewer. We repeated this part until new themes or codes stopped emerging, and there was a consensus on the codebook. Details were also shared with other group members at regular intervals to ensure that the thematic analysis procedure was respected and to gather additional feedback and perspectives. The last two steps in Braun and Clarkes' process involved researchers writing up the findings after concluding refinements.

3.3.1.3. Quantitative analysis. Given the scale of our representative sample, a quantitative analysis of the survey data underwent more detailed steps, which included measures to verify its integrity and completeness. In the first analysis stage, we collected our preliminary observations by comparing answers to different pairs of questions. Researchers kept track of these using a spreadsheet, where it was possible to observe methodically which were complete and where they to find the associated results.

We gave the data to another collaborator in the university who was familiar with the study and had a greater level of experience with statistical methods to conduct a more profound analysis. This step allowed us to examine the relationships between the self-reflection and stress scales with other features using logistic regressions. We examined four different groups in two different configurations. The first set of four utilized the SRIS-SR scale (combining the *Engagement in Self-Reflection* and *Need for Self-Reflection* sub-scales), whereas the second group of four used the SRIS-IS. We will focus on the results emerging from the SRIS-SR predominantly in the next section for the reasons mentioned earlier. However, it felt appropriate to examine this data because it was already a part of the complete SRIS. The other variables used in the analysis were:

- The *total number of activities* that participants reported *doing* for different lengths of time (e.g. more than three years - less than one month).
- The *total number of activities* that respondents had *heard of* (but were not necessarily doing).
- The *total number of objects* that participants reported as being *used* for reflective activity and the same for how many objects were *accessible*.
- The ratio of *digital* versus *analogue* objects reported as being *used*, as well as another ratio for the *accessible* objects.
- The *availability of instances* during a typical week where the respondent reported having time to self-reflect.
- The *amount of time* respondents felt they had for activities in each of these instances.
- Respondent's *age, sex* and *employment status* were used as control variables.

We performed logistic regressions to understand how covariates related to the groups. We might have examined the interactions between pairs of survey items, but as we have discussed earlier - an objective of this work is to provide a *holistic* picture. Our concern was to find common *conditions* amongst different groups rather than make claims about the efficacy of specific items being *responsible* for productive self-reflection - something that may be highly individual. By approaching quantitative analysis in this way, our feeling was that we would have a better picture of how different aspects interacted *in aggregate* or became qualities that made the occurrence of productive or *genuine* self-reflection *more likely*. In addition, because of imbalances in the group sizes, we approached statistical analysis with a different approach to dividing the data, ensuring less distortion than strictly comparing the four quadrants we will describe in the first part of the results section. We

first divided the data into sub-groups - those associated with a high-stress score (equal to or over 300) or a low-stress score (under 300). We completed two analyses for each sub-group to relate the covariates to a self-reflection (SRIS-SR) or insight score (SRIS-IS) that was either low or high. We removed by step-wise selection method based on the AIC unimportant covariates first, and the resulting model was then analysed to see which variables appeared to be significant. Additionally, we used the generalized variance inflation factors (GVIF) to inspect the collinearities between the variables to see if others could replace some variables and to avoid over-interpretation of the non-significance of variables.

Finally, the quantitative analysis included some comparisons over different scores. These started with the participants' stress scores (SRRS), self-reflection (SRIS-SR) and insight scores (SRIS-IS) and then across particular groups (e.g. sex, location, above or below thresholds for stress and reflection). We made these comparisons using a *t*-test and a non-parametric test (Wilcoxon-Mann-Whitney test) for confirmation purposes (contrary to *p*-value hacking). We applied multiple comparisons for each set of comparisons between groups (like Bonferroni's correction) to obtain adjusted *p*-values.

4. Results

This part will outline the patterns and qualities observed in our sample. In each sub-section, we will begin by sharing the quantitative findings from our surface-level analysis alongside the codes or themes captured via the qualitative analysis of interviews and open-ended survey questions. In the final parts, we will outline the results of a more in-depth statistical modelling of the data and briefly acknowledge the notable influences of the COVID-19 health crisis. For our research questions, these results inform an understanding of how observable aspects of self-reflection vary (RQ1), detail on how certain qualities may move with these variations (RQ2) such as *attitudes* (RQ2.1), the access or use of *activities*, *objects*, and *routines* (RQ2.2, RQ2.3). We believe this puts the research on this topic in a position to improve technological supports for self-reflection - through an understanding of where they may be failing specifically and where people encounter problems, making it a habit more broadly in the current state of the world (RQ3).

4.1. Group characteristics

After grouping participants (see Fig. 1), we found that the mean age ranged from 34.77 in the *High Self-Reflection (SRIS-SR) with High Stress (SRRS)* group (SD = 15.46) and 50.85 in the *Low Self-Reflection with Low Stress* group (SD = 15.46). The smallest individual group was *Low Self-Reflection with High Stress* with only 19 participants, and the largest was *High Self-Reflection with Low Stress)* at 506. It is worth mentioning again that the role of the SRIS-SR scale was not able to make *exact* statements about which factors influence these scores. Instead, our objective for this study was to build a holistic picture of the *conditions* or *environment* where it would appear that differences are more likely to differ.

Self-reflection scores (SRIS-SR) ranged from a minimum of 18 in the *Low Self-Reflection with Low Stress* group and a maximum of 72 in both the *Low Stress* and *High Stress* with *High Self-Reflection* groups. People whom we classified as experiencing *High Stress* using the SRRS scale also achieved larger self-reflection scores on average (M = 55.50, SD = 11.64) than their counterparts with *Low Stress* (M = 50.27, SD = 11.64). This 5.23 point difference was small but significant nonetheless ($t(80) = 4.03$, $p < .01$). Indeed, given the range of SRIS-SR scores in our sample (18–72), this represents a 9,69 % increase. The average self-reflection score across the entire sample (and subsequently, the threshold for our *High Self-Reflection* groups) rounded to 50.63 (SD = 11.64).

Across genders, average self-reflection (SRIS-SR) scores were higher for females (M = 52.12, SD = 11.28) than males (M = 49.20, SD = 11.91) and this 0.65 point difference was significant ($t(968) = 3.92$, $p <$
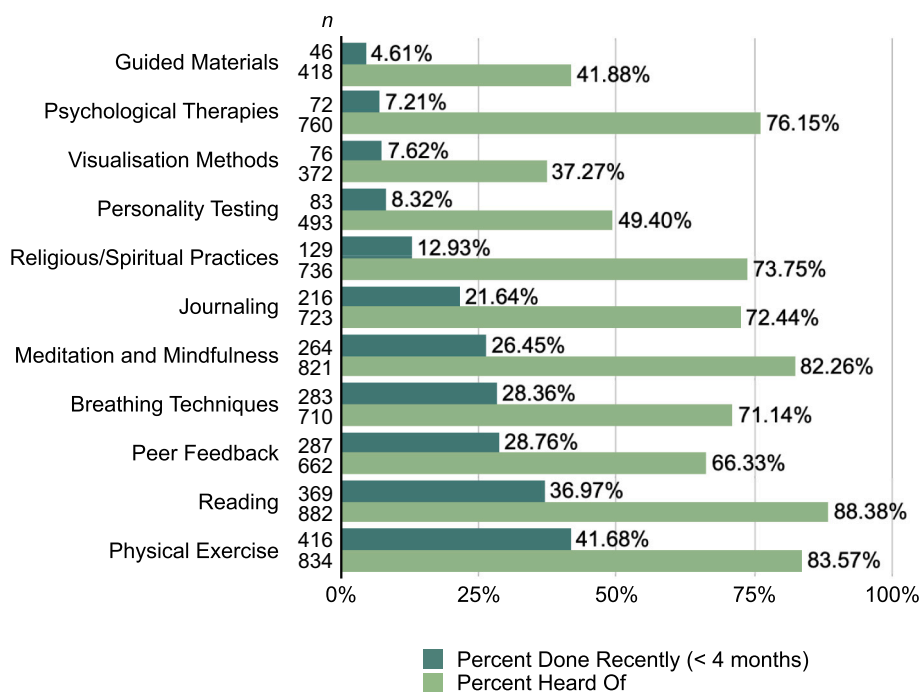
Fig. 1. Characteristics of groups which were formed using respondents *Stress* (SRRS) and *Self-Reflection* (SRIS-SR) scorings.

.001). There was also a 14 point difference between the average stress scores (SRRS) of male (M = 133, SD = 99) and female (M = 147, SD = 102) participants which was not significant (t(973) = 2.22, p 0.26). Nor was the 0.65 point difference between male (M = 34.63, SD = 6.67) and female (M = 33.98, SD = 6.96) insight (SRIS-IS) scores (t(973) = −1.48, p 0.14). The events on the SRRS scale have established weights, so it is possible to give some practical perspective to these 14 and 0.65-point differences. For example, a *Change in eating habits* is worth 15 points, whereas *Vacation, Christmas,* and *Minor violations of the law* are all worth <14.

Regarding the highest educational level, our respondents reported achieving, in all groups, the majority held an undergraduate degree. However, those with a high self-reflection score had a greater incidence of post-graduate attainment than lower self-reflection groups. The following most common qualification after an undergraduate degree differed slightly - in the high SRIS-SR groups, this was a graduate degree (e.g., MA, MSc) and a technical or community college qualification for those with lower self-reflection scores. As you will also see, there was a great difference between the number of people in certain groups - something which we expected would dictate the manner of our statistical analysis. Examining the interactions as individual permutations in the default groupings would likely involve extensive work and distortions from imbalances. Instead, we focused on a picture of how factors interacted with one another in aggregate to arrive at *conditions* in which self-reflection seems to be more likely.

4.2. 'Activities', 'objects' and 'routines'

Questions in our survey on the *activities, objects* and *routines* participants associated with their self-reflection helped us to build a more holistic picture. In addition to learning about how evenly self-reflection is occurring in a large population (RQ1), we wanted to shed light on factors and attributes that could influence a person's ability (RQ2, RQ2.1, RQ3) or provide them with a measure of assistance (RQ2.2,

RQ2.3).

4.2.1. Activities

Though the number they had done in recent months (< 4 months) was low (M = 2.26, SD = 1.78), most respondents were aware of more than half the activities we listed (M = 7.44, SD = 2.78). Female participants had heard of more self-reflective activities on average (M = 7.94, SD = 2.60) than males (M = 6.96, SD = 2.90) and although this difference was significant (t(957) = 5.57, p < .0001), in practical terms, this only meant that females were usually aware of one more activity (0.98). The difference between males (M = 2.03, SD = 1.72) and females (M = 2.51, SD = 1.81) in the total number of activities they had *done* across all time scales was also significant (t(967) = 3.27, p < .01) but a had a small delta in practice (0.48). The same was true of a narrower period (< 4 months) where the statistical difference was also significant (t(973) = 4.22, p < .001) but the *actual* gap between males (M = 2.01, SD = 1.71) and females (M = 2.48, SD = 1.79) was negligible (0.47).

In Fig. 2, we can see that even less popular activities (e.g., *'Guided Materials'* and *'Visualisation Techniques'*) were high in public awareness. Nevertheless, there was always a large delta between reported awareness and engagement, regardless of activity. This discrepancy varied, indicating that some activities may be *popular* or well known but do not translate into routine engagement as intuitively as others.

Without considering self-reflection scores, there was no significant difference between the number of activities that respondents of the survey reported knowing. With low stress, those with higher self-reflection scores did more activities (M = 2.81, SD = 1.81) across any duration than those with lower self-reflection scores (M = 1.48, SD = 1.78). The difference was significant (t(887) = 11.54, p < .001) and meant that the high self-reflectors had normally reported at least one more activity (1.33). Looking at the last four months exclusively, high self-reflectors with low stress also did more (M = 2.79, SD = 1.76) than low self-reflectors (M = 1.47, SD = 1.76). The difference was similar in statistical significance (t(899) = 12.87, p < .001) and practical

Fig. 2. Participant's awareness (*Heard Of*) and recent engagement (*Done Recently*) with different reflective activities.

dissimilarity (1.32). Although these differences may seem *practically* small, people can only maintain a small number of activities, to begin with (if at all) - any increase is a notable distinction.

Those who were experiencing *High Stress* and had self-reflection (SRIS-SR) scores that were high were also doing more (M = 3.55, SD = 1.78) across every duration than low self-reflectors (M = 1.74, SD = 1.78). This represents a difference of nearly two additional activities (1.81) and was significant ($t(65) = 3.88$, $p < .01$). Even when we narrowed our focus, high self-reflectors in the *past 4 months* were still doing more activities (M = 3.55, SD = 1.76) than low self-reflectors (M = 1.74, SD = 1.76) if they were also experiencing high stress. The actual (1.81) and statistical difference were almost identical $t(57) = 5.06$, $p < .001$). Again, the practical differences may seem inconsequential, but any additional activity has a corresponding impact on time and energy. Though the impacts of different activities may vary, high self-reflectors have a clear investment in surplus or diversity.

Participants were more likely to report doing certain activities for several years. However, the examples of *Peer Feedback* or *Physical Exercise* were not associated with any additional likelihood of having a better self-reflection score. On the other hand, when it was *rare* an activity that had lasted many years, it may be related to other factors. We noticed that *Psychological Therapies* were associated with higher self-reflection scores, but this activity occurs typically over a finite period (e.g., a weekly program across 12 weeks). In the case of *Reading*, the number of people who reported doing this activity for more than three years was higher in the high self-reflection groups (28.65 % vs 10.38 % for those in low self-reflection).

Open-ended responses to survey questions corroborated our interview observations, where most people *felt* that physical exercise, particularly in nature, was especially conducive to self-reflection. Research into such phenomena as *'nature'* or *'forest baths'* has already explored this area somewhat but whether the amenability of this environment is due to a physiological response to the natural setting or the absence of typical stressors is not clear (Lee et al., 2011; Wen et al., 2019). It may be likely that both are contributory. Activities that participants described as more encouraging their self-reflection in interviews were sometimes atypical. If an everyday task was sufficiently repetitive or mundane, their minds could wander into it. One participant

discussed her fondness for reflecting on her life whilst *"people watching"* in a cafe or restaurant, and another talked about feeling more reflective while browsing social media. A final consideration was people that may or may not be part of the activity.

Interestingly, regardless of how introverted or extroverted a person seemed, reflection was something where most people favoured privacy. The only noticeable difference was how likely it was that sharing the reflections took place with others *after*. During our interviews, some participants expressed concern about being judged - for taking time for themselves that might appear selfish or self-interested.

In this sense, activities were often the hardest to discuss with participants during the interviews. Many participants found it hard to describe the internal experiences of these practices or could necessarily point to clear aspects that they found the most helpful. The nature and perception of practice was also a common topic. Notably, female participants appeared to be the most comfortable describing the subjective qualities of their self-reflection. Male participants appeared to be more pragmatic about the benefits (e.g. helping them to think about situations with *work*, or how to resolve *problems*). They would sometimes express discomfort with the emotional nature of some activities. Female participants also appeared to utilize self-reflection in practical ways. However, they accepted their activities more potently as part of their holistic view of themselves and their identity.

When discussing how technology played a role in activities, interviewees used a variety of applications. Some applications were 'starting points for practices, and it was not uncommon for participants to mention several for the same activity (e.g. one participant used a dedicated application for *guided* meditations but also utilized the timer app on their phone). Qualitatively, interviewees would also outline a 'journey' they had taken to find an application that helped them establish activities. In most cases, they had heard about these apps through word of mouth or because they appeared on their device's application store.

While applications were a common talking point during the interviews, another technological approach that was also common was using online video - with YouTube being the most common resource. In particular, several people found new activities through YouTube videos that provided them with an overview or an introduction. Some also

tended to *refer* platforms as a means to troubleshoot specific issues they encountered with their activities. For example, some individuals used the search functionality and recommendations to find new routines for exercise or guided meditation. In *journalling*, videos or other forms of social media were a way interviewees found examples of what others were doing.

When mentioning activities introduced via another person, interviewees mentioned an *affinity* or *comradeship* to the individual. Often, what had drawn them into the practice was that they felt the person had similar *values* or *mindset* to themselves. An interviewee mentioned that a YouTuber's descriptions of her journalling habits felt very 'honest', making it far more approachable for her to try because she could expect inevitable setbacks or frustrations as 'normal'. It was rare for participants to describe introductions to activities through courses or training. However, a few mentioned that they had to do some workplace orientations for things such as stress management.

Another aspect of activities that participants described in detail was the extent their practice involved an active or passive use of technology. For example, when describing their 'journey' to find a practical application, many participants came to a similar conclusion - even though the activity had been different. In one case, an interviewee tried to capture their thoughts more often; another was undergoing cognitive behavioural treatment for anxiety. Both had found interactive apps that allowed them to complete exercises on the screen, but they found it hard not to be distracted by other features of their devices. Eventually, they found apps that used *guided audio* instead, which allowed them to put the device to one side and do the activities with fewer distractions. We also noted similar use of *videos* for meditation and exercise. In one case, a survey respondent preferred exposing themselves to 'self-help' materials over more traditional forms of entertainment.

[Male, 45]: "I really enjoy watching and listening to self-help stuff on YouTube. Particularly Buddhism lectures by Alan Watts. I find it more useful and enjoyable than watching TV."

4.2.2. Objects

The *accessibility* and *use* of certain objects for self-reflective activity varies in consistency (see Figs. 3 and 4). For example, although more than half had access to a printer ($n = 694$, 69.54 %), usage was far less common ($n = 188$, 18.84 %). When it came to technological artefacts, almost everyone had access to a smartphone ($n = 949$, 95.09 %) or a personal computer ($n = 926$, 92.79 %), and almost two-thirds had access to a tablet ($n = 636$, 63.73 %). While more than half were using smartphones ($n = 607$, 60.82 %) or personal computers ($n = 562$, 56.31

%) for self-reflection, only a third of participants were using their tablets as well ($n = 336$, 33.67 %).

The difference between the *total* number of objects (or devices) that men (M = 4.37) and women (M = 5.51) reported *using* for self-reflection was significant ($t(968) = 5.37$, $p < .0001$). There was also a significant difference in their *access* to these artefacts ($t(974) = 3.82$, $p < .01$), with more available to women (M = 10.26) than men (M = 9.49) as well. Although the difference was statistically significant, it may be more difficult to ascertain if the practical difference of around one more reflective tool is meaningful. The literal number of these items does not capture the *extent* they are being used, and the combination of *specific* objects may also be deep or nuanced.

We can say that analogue artefacts had *totals* for access and usage that were lower than their digital counterparts (except for common materials for writing or drawing). Looking at individual access and use as a *ratio* however, only *access* to digital supports (M = -0.05, SD = 0.23) was higher - analogue tools had the greatest reported *use* (M = 0.02, SD = 0.22). When we examined these ratios with respect to gender, there were significant differences in *access* ($t(968) = 7.24$, $p < .0001$) and *use* ($t(973) = 7.20$, $p < .0001$) as well. Although male (M = -0.10) and female (M = -0.00) *access* ratios were on the side of digital artefacts (i.e. negative), females leaned *slightly* more toward analogue. For *use*, this tendency between males (M = -0.03) and females (M = 0.07) was more visible. In both cases, the delta of 0.10 only represents around one object difference in practice (our ratio was between -1 to $+1$, with 11 objects each for digital and analogue).

We saw a significant difference ($t(75) = 4.44$, $p < .001$) in the number of devices that individuals were using for self-reflection - those experiencing a higher level of stress were using more devices (M = 6.76, SD = 3.36) than lower stress individuals (M = 4.81, SD = 3.36). There was also a significant difference in the number devices *accessible* to high (M = 11.21, SD = 3.19) and low (M = 9.75, SD = 3.19) stress individuals ($t(77) = 3.74$, $p < .01$). In *both*, device access (+1.46) and use (+1.95), the highest number was with those who had a *high* stress score.

When we also included self-reflection scores, those with a high self-reflection score and low stress were using a significantly higher ($t(885) = 5.21$, $p < .001$) number of objects or devices on average (M = 5.32, SD = 3.36) than counterparts with low self-reflection (M = 4.29, SD = 3.36). High self-reflectors with low stress also had significantly ($t(900) = 3.23$, $p < .01$) more devices *accessible* to them for practice (M = 10.06, SD = 3.19) than the low self-reflectors (M = 9.39, SD = 3.19). In practical terms this was a practical difference of 1.03 in *use* and 0.67 in *access*.

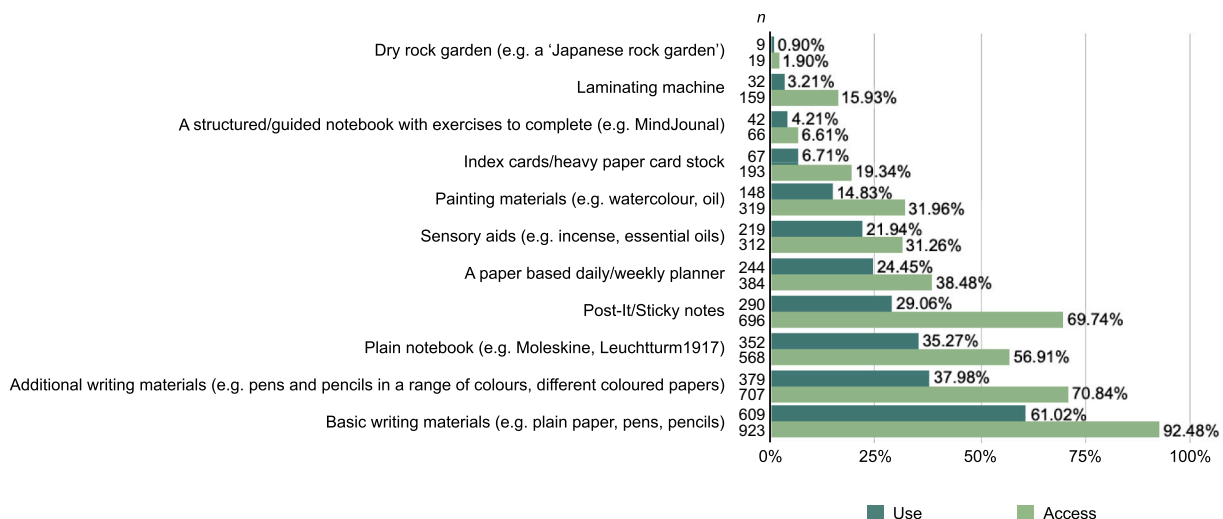It is again worth stressing that we can only understand so much from

Fig. 3. Utilisation (*Use*) versus accessibility (*Access*) of analogue objects/tools supporting self-reflection.
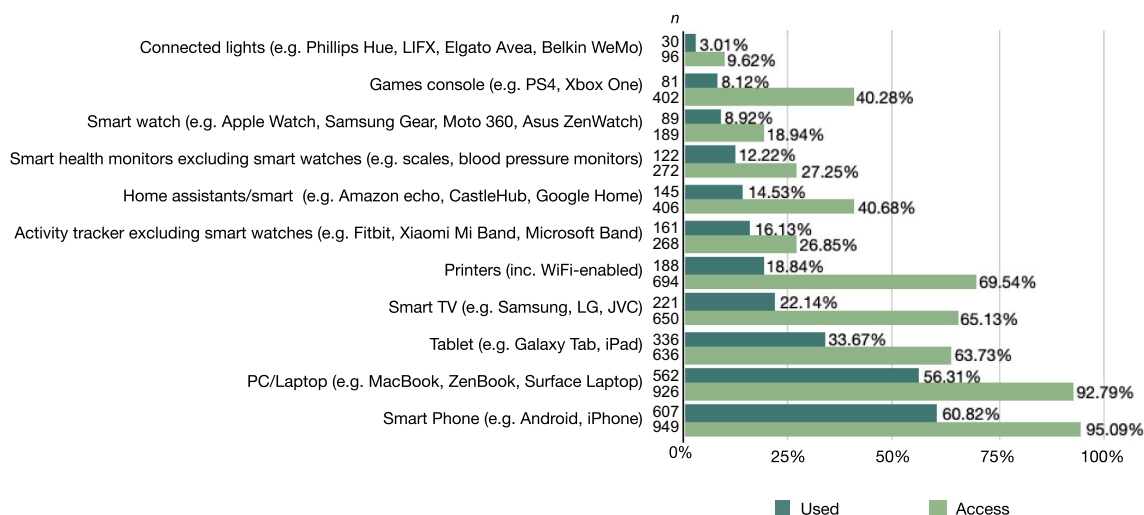
Fig. 4. Utilisation (*Use*) versus accessibility (*Access*) of digital objects/tools supporting self-reflection.

these observations numerically speaking. The nature and extent of use, and object combinations, are factors to consider. What is at least apparent is that consistent statistical significance differences exist. Similar to activities, we must consider tiny differences cautiously - a smartphone or journal may only be *one* artefact. However, their impact could be consequential for self-reflection alongside different factors.

For example, the ratio of digital to analogue devices accessible to high reflectors experiencing low stress was more toward analogue (M = -0.03, SD = 0.23) than low self-reflectors (M = -0.09, SD = 0.23). As we have mentioned earlier, the practical difference is small but it significant none the less ($t(921) = 4.46$, $p < .001$). Concerning the devices they were *using* for self-reflection, high reflection individuals who were experiencing low stress were far more positive and analogue (M = 0.04, SD = 0.22) than low self-reflectors as well (M = -0.01, SD = 0.22). Again this difference was practically small (+0.05) and although it was statistically significant ($t(927) = 3.09$, $p < .05$) we should consider the component aspects that might be contributory.

Objects could be reflective or evocative in practical and sensory ways. In the case of mindfulness, some participants discussed using candles and incense to focus their concentration. Sensory triggers within their day-to-day lives were also mentioned - for example, a familiar smell being a conduit to look back on a particular memory. The idea of objects facilitating self-reflection felt abstract to many participants. However, once we discussed this for a short period, people gave examples where a particular object facilitated their practice or triggers that provided sentimental reminders of a person or a meaningful life event (e. g. photo albums, baby clothes, items they had inherited or gifted). These often became a means to alter their perspective through retrospective thought or comparison. P7, in our interviews, discussed how handling his newly born son was a straight access point to thought experiments and reflective experiences. He considered what it must have been like for his parents when he was born, how they had raised him and where he would do the same or make different choices. These frequent interactions with his newborn were, to him, opportunities to use reflection and re-invest in himself.

[P7 (Male, 37)]: "It makes me analyze mistakes better and to constantly improve myself. This type of activity has now become a constant in my life."

Many of the digital supports people mentioned were apps they had downloaded to their devices. These included general purpose applications for keeping a regular diary (e.g. Day One, Grid Diary) or more specific applications for a particular activity (e.g. Insight Timer for meditation) and those that accepted materials they had downloaded

elsewhere (e.g. using PDFs in Notability or GoodNotes to keep a digital Bullet Journal). Often in our interviews, the applications and materials people acquired were deeply intertwined with their values. For example, they could be principled about the extent of their technology use in day-to-day life, and descriptions of analogue approaches to self-reflection often took on 'romantic' or 'nostalgic' qualities. P9, in our interviews, expressed a cyclical return to analogue tools because it felt easier to keep track of and immediate.

[P9 (Female, 44)]: "I always came back to paper and pen. Because, I don't know why, I just felt safer writing everything down. I can lose things if it is on technology, I wouldn't be able to go straight into it.

Other concerns were the *quality* or *cost* of the digital alternatives, and most had discovered these applications through social media, peer recommendation or searching application stores.

In our follow-up interviews, high-reflection participants often described technology as a helpful tool for migrating their thoughts. By this, we mean reflection was serendipitous, and technology was, more often than not, the most accessible place to capture thoughts. Later they would transfer their notes to a more central location, such as a paper calendar or notebook, which they preferred for its *physical* properties. Participants liked that they could *"thumb through"* notebooks at their own pace, open journals to random pages to prompt themselves and *"time travel"* through their own experiences. Analogue supports were also used frequently as cues, placed in areas where they were likely to encounter or see them regularly or at essential times (e.g., first thing in the morning or last thing at night). At times, we found technology played a role as a collection tool and (similar to random pages from a book) could fuel spontaneous reflection and problem-solving. Often there was less concern for the completeness or presentation of these collections and for them being a place they could reach for something already identified as stimulating, meaningful or thought-provoking.

Of note is that many people encountered issues with specific tools fitting into their lives. This issue was not only because of time or resource requirements but also because of design. In our follow-up interviews, several people working on-call or on a shift pattern that often varied commented that their energy level and motivation were far too unpredictable, although they might have had time. P18 (Male, 53), in our interviews, articulated a feeling that supports may often *assume* regularity in life that is not the case. For example, a suggestion in a book he read was to make his reflection routine consistent by setting aside the *same* time to it every day. In reality, his work did not allow this because the shifts were never something that was fixed or predictable—trying to *make time* before or after work was often impractical because other,

more fundamental tasks demanded his limited attention and energy.

> [P18 (Male, 53)]: "You get home tired, right, try to get everything organized. Washing dishes and that. But then it is time to go to bed, so when do I do the exercise?"

In recent years, some applications (which were 'pay to own' with a one-time fee historically) have switched to a subscription model, and there were participants who had encountered this with some of their favourite apps (e.g. Day One, Fantastical). Firstly, this could feel unfair because they had '*already paid*', and although these apps may find ways to keep aspects free, reminders to sign up for the subscription service could feel 'manipulative' or become sources of dissatisfaction that had not been there before. Ultimately, this appeared most egregious if the functionality remained largely the same or there were now arbitrary limits without adjacent improvements. Furthermore, when it came to digital support, many participants commented that it is hard to use these tools because they are too close to other aspects of their devices. They might receive notifications or alerts from other applications or never use them in the first place because there was *"always something more interesting"* or distracting. This detail might explain why analogue tools continue to maintain power and effectiveness. It is easier to remain focused on the reflective activity when there is no opportunity to swipe into a game or 'quickly Google something.'

Although objects did not rank as highly as activities or routines, some relished certain items for their capacity to unlock their reflective natures. These included a *curated collection of music*, certain pieces of *stationery* or objects that reminded them of times, places or people. A typical description was that these artefacts often made the participant *"feel good"*, either through their use or being in their presence. When discussing technologies that could be co-opted in reflection (e.g. keeping a journal using a tablet and a stylus), there was hesitance toward the idea of purchasing *"gadgets"* to do something that they could *just as quickly do on paper"*. This point is not to say that we did not observe digital tools. In several cases, digital approaches to self-reflection were a secondary discovery after purchasing a device for another purpose (e.g. a student who initially bought a tablet to take class notes and found a journalling application). It was apparent that some did not wish to appear *materialistic* by attributing value or meaning to objects in ways that might be looked down upon, even if they seemed potent or valuable. For example, this could be because the objects represented a considerable expense on themselves or because the items seemed indulgent or non-essential (e.g. an expensive pen or notebook, upgrading their device).

Another aspect that appeared to influence technological involvement in self-reflective activity was whether the devices were personal or not. Some mentioned that, although they were the devices they interacted with the most (or the most available), using work-assigned tools did not feel appropriate. This aspect is worth considering because, in parallel to this, further participants commented on a desire to *not* use technology to reflect because they spent most of their working days using it. When they came home, interacting with '*another screen*' was the last thing they wanted to do. Here we saw that work responsibilities might monopolize an immaterial capacity in some situations. Both examples show that despite technological access, feelings of *appropriateness* and *desirability* may mediate use.

4.2.3. Routines

We asked in the survey *how important* it was in each section to pick the right *activity*, *object* or *routine* with respect to self-reflection using a 7-point Likert-type scale (Largely Unimportant - Largely Important). When looking at which respondents choose 'Largely Important' for each, we found:

- 19.44 % (194) said that the right *routine*.
- 15.03 % (150) the right *activities*.

- 9.72 % (97), for the right *objects*.

Even when we aggregated the other possible responses (e.g. 'Slightly' to 'Largely Important'), the rankings did not change. However, the conviction is more noticeable when looking at the difference between those who scored higher or lower on the SRIS-SR scale. Of the 555 who scored highly on the SRIS-SR (equal or higher than 50.63), 25.77 % (143 of 555) felt that routines were 'Largely Important' whereas, for the 443 below the threshold (<50.63), only 11.51 % (51 of 443) gave routines the same importance.

Participants expressed that they were most comfortable or naturally orientated toward self-reflective action late at night or in the early morning. Typically, these periods occurred every day or between 3 and 4 times per week, lasting 1 to 3 h or 30 min to an hour (see Fig. 5). These routines were often rooted in moments where they could relish time away from others or the responsibilities that generally occupied their time.

> [Female, 60]: "I do Pilates to have time to myself, since my husband retired two years ago it is nice to do something on my own."

In some cases, participants discussed self-reflection that occurred in conjunction with other non-reflective activities. For example, they might drift into such thought patterns whilst engaging in a passive or repetitive activity. Something mundane enough to allow their minds to wander.

None of the participants described self-reflection as an activity under duress or forcing themselves to do so. Some of our interviewees elaborated on the distress that could sometimes occur when they felt reflective. High and low self-reflection groups differed in their tendency to describe these spaces as activities they could lose themselves *in* or as a means to escape *from* something. By this, we mean that the routine of self-reflection could be an activity that was a safe space to explore ideas (which included negative or challenging experiences) or a 'sanctuary' that a participant went to great lengths to ensure remained pleasant. In the high self-reflection groups, interviewees seemed more tolerant of negative aspects during reflection and were often part of the process. Higher self-reflection individuals often described a desire to be immersed in the activity, regardless of the content. In contrast, lower self-reflection groups preferred to feel protected in a similar space.

Another aspect of routines was *serendipitous* experimentation. High self-reflection individuals appear to identify opportunities for controlled experiments more regularly. Chances to try new experiences or provoke their thinking in novel environments seemed appealing to them. There was a greater tendency to be sceptical or defensive toward these unknowns in the low self-reflection groups. Those with high self-reflection scores regularly describe practices that emerge from these chance encounters and opportunities in our interviews. For example, P18 (Male, 53) began an exercise class because a friend had invited him to try it. Specific spaces could often be classified or labelled where a participant went to *think*. It did not need to be a related (or conducive) space to reflect; the participant had simply decided it would be a place to do so. This act could be a way to remove themselves from situations, occupy their minds with something else or create distance between them and
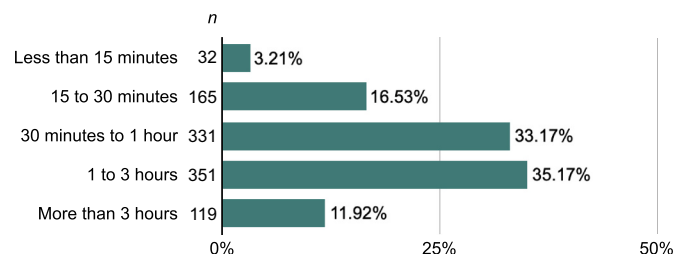
Fig. 5. Duration for instances of self-reflective activity.

their stressors.

> [P17 (Male, 42)]: "With worries and stress coming in, I will go for my daily walk. Then it has gone. People say to me, 'What do you do when you go for a walk?' and I say, to be honest, I'm just listening sometimes. Just birds singing. Sometimes that's all I want to hear."

This behaviour is especially noteworthy in cases where the participant's schedule was irregular. A participant who was often unable to maintain a regular practice recommended by a self-help book began to use specific frames of time instead (e.g., the taxi ride to his job), even though this occurred at different times throughout the week. Those who had high self-reflection scores and were on-call or working 'shifts' that could change week-to-week had more success in maintaining their practices when the act was contextual like this. One interviewee, an on-call replacement teacher, paired self-reflection with their exercise routine and moved directly into it after a workout. Criticisms of particular tools (digital and analogue) were when they seemed imprudent to specific lifestyles or when lifestyles changed significantly to make them impractical. Participants with new families and students who had just started university commented that specific applications they had relied on previously had fallen out of use. It could be because they no longer had the time, their energy levels throughout the day had changed, or they felt their life had changed in ways that altered the need for self-reflection altogether. One survey respondent found that when she considered the content of old diaries, having children affected her needs and personality changes.

> [Female, 66]: "I began re-reading diaries from my youth in lockdown and found them entertaining (though mostly dull) and I could recall a lot, particularly how I felt about the events and the people. I was SO critical at times. I think I have mellowed a lot since having kids."

When examining our participant's strategies to ensure that their reflection occurred, we found that high reflection individuals often utilized *heuristics*. Qualitative responses and interviewees described some of the barriers or failure points were practice issues the person could not overlook, like the neatness of their handwriting or spelling mistakes. For example, one of our survey respondents attributed the *completeness* of his diary as a sign that his commitment may have been inadequate.

> [Male, 67]: "I have in the past tried to keep a diary but after a few weeks, I started to miss the odd day and then this became a number of days. I think it is a lack of commitment, if I had managed to keep it up for a month or more, I would probably have continued."

In those who scored highly on the SRIS-SR scale, there were often cases where the participant had created a 'workaround' for common issues or some attitude that put them back into a feeling of control much sooner. High reflection individuals appeared more accepting of fluctuations in their motivation and often mentioned moving to another activity if the efficacy seemed faulty; almost none described a single practice they had done every day without fail. They may spend more time in one, then move to another if the appeal drops and only return if the 'spark' comes back. Several participants who kept a journal commented that sometimes they would try something different or start a new journal altogether. P19, in our interviews, addressed mistakes by applying a sticker or painting over the errors she did not like to see - attributing it as *part of* the journalling experience.

> [P19 (Female, 21)]: "It is a pleasurable experience for me too, like, making it look pretty. I am journaling, but I am also making it an art project at the same time, so I have my little stickers and stuff."

It is also worth noting that the participants who held the most rigid definitions of self-reflection were least forgiving to many of the issues

mentioned - sometimes common or *unavoidable*. High-reflection individuals appear to identify strategies that allow them to 'keep moving' or remember the product of their self-reflection emerges cumulatively.

For technology, some interviewees expressed frustration at how technology contributes to the formation of unhelpful behaviours. Some variations expressed the same sentiment: technology could rob them of their time or attention. This point is hardly a new observation, but a number of these individuals quoted this as a specific reason they actively *avoided* technological approaches to self-reflection because the accessibility of other apps or services was a distraction they could not 'trust themselves to avoid. Otherwise, participants mentioned technologies such as task management systems and habit tracking applications as tools that helped people self-reflect routinely. However, their commonality was no more significant in high self-reflection groups. Those who did succeed appeared to favour less complicated systems or the most intuitive for their needs. Applications included MinimaList, Things and Todoist but the most common approach that appeared was to write things down in the Notes or Reminders apps that came preloaded on their devices.

4.3. 'Attitudes', 'barriers' and 'motivations'

The open-ended questions of our survey and our interviews offered further detail on our participants' relationships with self-reflection. These resources helped us to expand upon *attitudinal* differences, especially (RQ2.1) or factors that may be influencing their practices (RQ2, RQ3). It was a chance for our respondents (or interviewees) to elaborate more candidly on the artefacts they had encountered or used (RQ2.2, RQ2.3) - what was *motivating* or acting as *barriers* to their self-reflection.

4.3.1. Attitudes
On the concept of self-reflection more broadly, we grouped responses around two codes for their valency toward it (*caution* or *enthusiasm*) and three more indicating a temporal orientation toward its utility. These were that reflection was *retroactive* (it helped them looking back), *proactive* (planning or looking to the future) or *active* (it helped them appreciating things in the present). We found that most people showed caution toward reflection (30.7 %, 304 cases) though enthusiasm was not far behind (29.7 %, 294). When it came to orientation, most found reflection useful for the present (14.2 %, 141) or the past (10.6 %, 105) and only 8.4 % (83 cases) said they found reflection valuable when looking toward the future.

4.3.1.1. Caution. Those who seemed cautious about reflection expressed a need to regulate the activity. It was often through a phrase that was similar or the same as "too much reflection can be a bad thing". The 'bad things' they alluded to were either ruminative or detrimental thinking (e.g., obsessing over something) or that introspection could lead to 'naval gazing', where someone becomes overly concerned with their own experiences and those around them. In one interview, P16 (Female, 39) alluded to the possible dangers for someone who lacked experience.

> [P16 (Female, 39)]: "It can simplify your life, but if you are just a person who just has basic knowledge, it can make your life difficult."

4.3.1.2. Enthusiasm. Enthusiasm was easiest to identify because respondents often spoke prescriptively of reflection. They felt that "everyone could benefit" from these activities, which were generally grounded in benefits they had experienced personally *or* a perceived deficiency in society (e.g., society would be better if more people did it). A phrase we encountered several times was that they wished they "had been taught about this in school" or similar.

4.3.1.3. Active. When people spoke about self-reflection in the *present*

tense, they often referred to reflection as a tool that helped them appreciate more detail in the world around them. It might also be that reflection allowed them to notice others in a different light. Participants spoke about seeing their partners' or loved ones' behaviours in a more rational, balanced or inverse way. They realized that things they had previously discounted were aspects of their life that needed change.

4.3.1.4. Retroactive. Self-reflection as retroactive was when respondents considered their personal history differently because of their reflection. Some mentioned looking back at their childhood as better or worse than they had previously given credit. Alternatively, an event that had created an issue for them in later life had been perceived as more significant than it was. Those who were open about mental health issues such as panic disorder or anxiety commented on how they were reevaluating events in their life now and appreciating the times when they had misinterpreted threats in the past.

4.3.1.5. Proactive. When people spoke about self-reflection in a proactive or future-orientated way, it was often for ambition but, more generally, about achieving *consistency* or *security*. Retroactive and proactive comments were often partners with one another, with a respondent wishing to feel prepared for the future or approach a situation they had encountered previously in a new way - one that was healthier or more constructive. While we encountered the parlance and rhetoric of 'self-help' or 'personal development' in many places, it was noticeable in these cases.

4.3.2. Barriers

Aspects most challenging or disruptive were that respondents found reflection *distressing or uncomfortable*, that they had *hesitancy or uncertainty* toward it, difficulty with *self-regulation and self-management*, external *dependencies or responsibilities* or a degree of *apathy or passivity* about the activity. We found external dependencies to be the most common interference to practice (45.3 %, 443 cases), closely followed by issues relating to self-management (36.0 %, 352). Hesitance accounted for the fewest number of cases (5.3 %, 52), and apathy (11.8 %, 116) or discomfort were similarly low (10.2 %, 100).

4.3.2.1. Dependencies or responsibilities. External dependencies often interfere with self-reflective practice, including taking care of elderly or sick relatives and obligations associated with work and child care.

4.3.2.2. Self-regulation and self-management. The character of self-management issues was by an acknowledgement that although they had time, resources or inclination, some struggled to capitalize on them or had the feeling that they were undermining their opportunities. Some participants were very self-aware of their self-management issues and felt reflection was crucial for recognizing non-productive habits. P5 (Female, 47) articulated that this often felt like an obstacle to their ambitions in life and that 'figuring out' these nuances could help them avoid repeated mistakes.

[P5 (Female, 47)]: "If you do not self-reflect, I feel like you will never learn, and then a similar situation will happen, and you will get the same results. So if you want anything for the future, you have to change how you act."

4.3.2.3. Apathy or passivity. Apathy was seen in some respondents who simply had no interest or desire to engage in an introspective activity. These individuals were usually quite blunt though the apathy might centre around the practice *or* themselves. Either they would be unlikely to find the helpful activity or, as a subject of introspection, they did not feel like they were interesting enough.

4.3.2.4. Distressing or uncomfortable. Discomfort differed from apathy because it seems in these responses that reflective activity *was* productive but that the person found outcomes or aspects too overwhelming. In particular, these responses mentioned that reflective activity made them feel "too sad" or "worse". They did not enjoy how they felt and ceased the practice. In some cases, people mentioned that particular practices feel anxious or panicked. Activities involving prolonged periods of silence or focus (e.g., meditation) or because the thinking that an activity produced became a trigger for many other things.

4.3.2.5. Hesitancy or uncertainty. Hesitance was in responses that alluded to feeling uncertain or unsure, being unsure where to start with a particular practice or concerns about whether they were doing things 'the right way'. Other people were interested in pursuing a practice, but we are not sure if they would be able to have the time.

4.3.3. Motivation

When asked about their motivations for trying (or considering) a reflective practice; our coding revealed that respondents were trying to *maintain or protect*, to *reduce or relieve*, *increase or improve*, seeking to *process or understand* or *alter perspective*. We found that ordering descended through increasing or improving some aspect of their lives (49 %, 289 cases), finding a different perspective (33.7 %, 199), reducing or relieving the issues (21.9 %, 129) and then finally, understanding (18.3 %, 108) and maintaining (4.9 %, 29).

4.3.3.1. Increase or improve. Instances of this code were when respondents talked about self-reflection as something they were hoping would lead to something better. Improvements to their psychological well-being (e.g., 'calmer') but could include better performance in other activities (e.g., 'being more productive at work') or strengthening social skills (e.g., 'more confident about meeting new people'). This code was when the desire for improvement was explicit toward 'adding' something they felt was missing currently.

4.3.3.2. Alter perspective. Respondents sometimes mentioned a desire to seek perspective changes afforded by self-reflective activity. Whether this was to 'see the situation differently' or 'think about it from a different perspective', these and similar phrases were when it seemed that the comment was signalling an intentional *pursuit* for an altered point of view. Typically this was about events but could also be about social interactions or 'getting unstuck' when thinking about a problem. A number of our participants commented on the utility of social networks and video streaming sites to collect a wide variety of perspectives on a topic; P19 (Female, 21) highlighted that although they were gathering such opinions from 'strangers', she found them to be invaluable.

[P19 (Female, 21)]: "These days with the Internet, I think advice from strangers is not as weird as you would think. A lot is going on right, and people share advice."

4.3.3.3. Reduce or relieve. As this code may appear similar to *Increase or Improve*, we made a point to only code explicit descriptions. While it is proper to add or improve something may also see a reduction of something else (e.g., improving a relationship by having *less* arguments), we wanted to code according to the *exact* language respondents had chosen. The focuses of these comments were often similar, but the language, as directed toward themselves, was noticeably more critical (e.g. I *should* have done/be doing something). An example below was taken from an open-ended response to the survey.

[Female, 55]: "I have been feeling stressed about my partner's recent health decline, and my sister has suggested journaling to cope with it. I've not heeded her advice though, I should probably do so."

4.3.3.4. Process or understand. Some respondents referred to self-reflection as an activity that helped them make sense of things. Self-reflection is a means to grasp a situation of themselves or the larger world. Understanding of why they *'reacted that way'* or insight toward making an important decision (e.g., *'deciding what I want to do'*). In these cases, this code was applicable when a description inferred that the reflection produced critical awareness of something else.

4.3.3.5. Maintain or protect. The code we observed the least was perhaps the most interesting because it was often easy to recognize. Some participants expressed a desire for self-reflection to be means of maintaining themselves. Like some of the other codes, people might mention psychological issues as a reason for pursuing the activity, but their goal did not appear to be one that altered the status quo. Instead, this code was often attributable to the respondent desiring some stability or resilience. In contrast to the others, they were not trying to improve or reduce something to reach this equilibrium.

In the codes above, it is essential to note that those with high self-reflection scores, regardless of their stress score, differed in their presentation and attitudes. This difference might not have been in ways one would expect; these groups were not always more optimistic about the idea of self-reflection or spending *all* of their time engrossed in the activity. Still, self-reflection was a more integrated force in their lives.

4.4. Statistical modelling

Logistic regressions of the survey data to relate covariates used two sub-groups with two different analyses (see Fig. 6). The sub-groups were dependant on whether the respondent's stress scale (SRRS) scoring was *high* or *low*; the analyses looked at differences across scores of the self-reflection (SRIS-SR) or insight (SRIS-IS) sub-scales of the SRIS. It was necessary to refactor the grouping in this way for the statistical modelling as, in the original four groupings, there was a large imbalance between the number of participants with high and low stress. Additionally, in keeping with the philosophy we mentioned earlier, our goal was not to single out specific factors responsible for increasing or decreasing reflective scores. Instead, we believed that examining the relationships between different factors *in aggregate* would be the most valuable and appropriate to the holistic picture we wanted to construct.

All respondents groups used thresholds of 300 (for stress) and the practical means for the SRIS-SR (50.63) and SRIS-IS (34.26) sub-scales. In the following part, we will discuss our findings for *insight* or *self-reflection* at each tier of stress. While there was already a pre-defined threshold for high stress, established by Holmes and Rahe (Holmes & Rahe, 1967), the SRIS sub-scales are much simply a numerical scale. While we initially thought it might be possible to use the means of prior studies that have used it, we could not find an example of the SRIS being used at this scale or with a comparable population. It was likely that narrower demographics in these cases would make these inappropriate as the threshold for our sample, encompassing a representative UK population sample.

The complete output of our statistical modelling and the R code associated with it can also be found in our Open Science Foundation repository.[8] Overviews can also be found in in Fig. 6 and Table 2.

4.4.1. Low stress (SRRS < 300)

4.4.1.1. Self-reflection and low-stress. It was found that for those experiencing low stress, the total number of activities a respondent reported doing recently (*Activities: Last 4 Months*) was a predictor of their *SRIS-SR* score ($\beta = 0.40, p \leq 0.001$). Those who were doing *more* recent activities

tended to have a larger SRIS-SR result (indicating greater *engagement* and *need* for self-reflection) than their counterparts.

We found that *Age* predicted *SRIS-SR* scores as well. Though the significance of this finding was lower than the one we had seen for recent activities ($\beta = -0.01, p \leq 0.01$), in low-stress individuals, those who had high scores on the self-reflection sub-scale of the SRIS tended to be younger.

Finally, the least powerful result (that was still significant) in this analysis was *Part-Time* employment was a predictor of *SRIS-SR* ($\beta = -0.69, p \leq 0.05$). If someone reported themselves as in part-time employment, the likelihood of their SRIS-SR sub-scale score being higher also increased.

4.4.1.2. Insight and low-stress. The number of devices an individual reported *using* was a predictor of their SRIS-IS result ($\beta = -0.04, p \leq 0.05$) in cases of *Low Stress*. Those who achieved a higher score on the SRIS sub-scale for *Insight* reported using fewer objects/devices in reflective practice.

A finding with larger a significance value was that a respondents *age* was also a predictor of their insight sub-scale result as well ($\beta = 0.02, p \leq 0.05$). In contrast to *self-reflection* and *low stress*, insight scores had a tendency to be higher for those who were older.

4.4.2. High stress (SRRS ≥ 300)

4.4.2.1. Self-reflection and high-stress. As we saw in *Low Stress*, the number of recent activities (*Activities: Last 4 Months* was also a predictor of SRIS-SR scores in the *High Stress* sub-group as well ($\beta = 0.55, p \leq 0.05$). Again, the *Age* of participants was a predictor of SRIS-SR scores in the *High Stress* sub-group too ($\beta = -0.05, p \leq 0.05$).

In addition, we found that the number of activities participants knew about (*Activities: Heard Of*) was a predictor of SRIS-SR sub-scale scores. This was in in the *High Stress* sub-group ($\beta = -0.27, p \leq 0.05$), where those who knew of more self-reflective activities tended to toward higher results on the SRIS-SR sub-scale compared to their peers.

4.4.2.2. Insight and high-stress. When it came to *Insight* for those with a *High Stress* score, we also found that the number of devices/objects seems to relate to the outcome of the SRIS-IS sub-scale. In this case however, the total number of devices that people had *access* to was a predictor of a respondent's *Insight* score ($\beta = 0.20, p \leq 0.05$).

We found that those who had more devices/objects at their disposal (*Devices: Access*) had a more chance that their SRIS-IS (*Insight*) result would be higher. Note that this does not indicate that higher insight scores were associated with *using* more devices. Instead, individuals had a wider variety of artefacts which they *might* use in such an activity.

4.5. COVID-19

It was not this paper's goal to examine the pandemic's influence, but the impact it has had on day-to-day lives *and* the role technology has played makes some findings worth highlighting. Given that the SRRS scale relates to life events occurring in the past 12 months, using it in our study meant that it encapsulated several waves of quarantine measures, vaccine development and deployment.

As such, we expected that all participant stress scores would have a common sub-set of pandemic events augmenting them (e.g. *Major change social activities*, *Major business readjustment*). This issue is why our threshold for the SRRS scale was at a much higher point. Had this been lower, there may have been more people in our'High Stress' groupings, but it would be a population that was experiencing exceptional circumstances *as well as* exceptional stress.

Setting a higher bar for stress was by no means a perfect solution. However, it made us feel more confident that such individuals were experiencing appreciably amplified stressors. Otherwise, many people
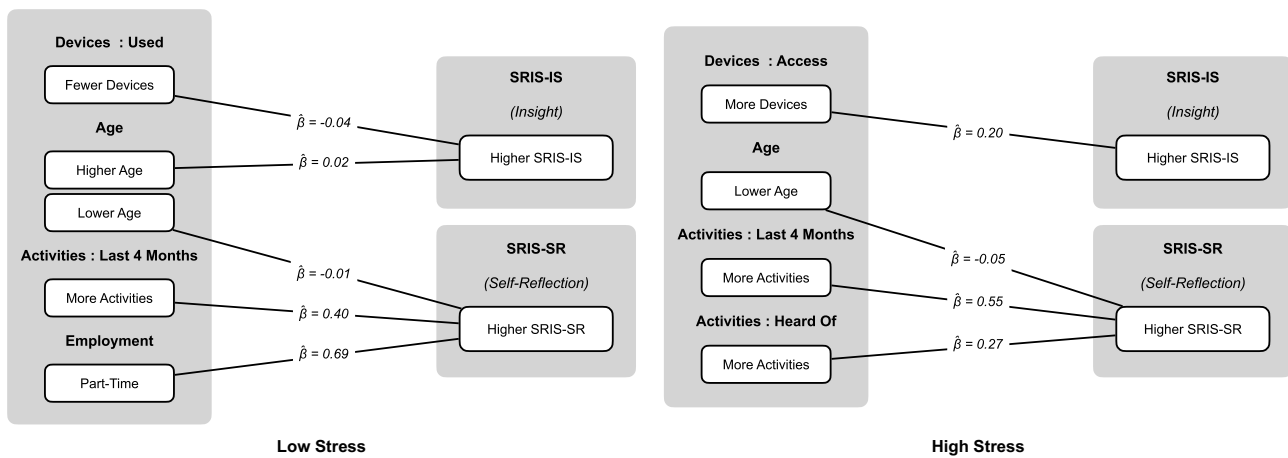

Fig. 6. Relationships between the SRIS-IS *(Insight)* or SRIS-SR *(Self-Reflection)* sub-scales and different variables for respondents with *Low* (Top) or *High* (Bottom) SRRS scores (i.e. *Stress*).

Table 2
Logistic regression results for the covariates of SRRS scores *(Stress)* and SRIS-IS *(Insight)* or *(Self-Reflection)* sub-scale scores.

Coefficient	Estimate	Std. Error	z-value	p-value
Self-Reflection and Low Stress				
(Intercept)	−0.31	0.37	−0.84	0.39
Activities: Last 4 Months	0.40	0.09	4.20	<0.001
Age	−0.01	0.01	−3.02	<0.01
Employment: Part-Time	0.69	0.28	2.43	<0.05
Insight and Low Stress				
(Intercept)	−1.35	0.31	−4.25	<0.001
Age	0.02	0.01	6.19	<0.001
Devices: Used	−0.04	0.02	−1.96	<0.05
Self-Reflection and High Stress				
(Intercept)	−0.85	1.58	−0.54	0.58
Activities: Last 4 Months	0.55	0.26	2.11	<0.05
Activities: Heard Of	0.27	0.13	2.01	<0.05
Age	−0.05	0.02	−2.08	<0.05
Insight and High Stress				
(Intercept)	−2.48	1.10	−2.24	<0.05
Devices: Accesible	0.20	0.09	2.22	<0.05

would have been 'buffeted' into this zone because of 'background stress' common to everyone and too early to appreciate fully. The conditions in that Holmes and Rahe developed their scale were quite different, and it is unclear whether it is entirely scalable in this kind of crisis without testing.

Although we used caution when categorizing participants because of the pandemic - certain details were hard to ignore. In the survey, key-words associated with the health crisis appeared multiple times in our open-ended questions. There were 80 (8.19 %) cases which included the word 'lockdown', 88 with 'COVID' (9.01 %) and 97 for 'pandemic' (9.93 %). A separate code for instances where the situation had been attributed *directly* as a reason for starting a reflective activity occurs six times (0.61 %).

In particular, the health crisis amplified aspects that might not have been at the front of people's minds another time. Notably, technology's role meant some participants had used tools in new ways or challenged them to reconsider their roles in life. We would be interested to see if a replication study would notice differences on the other side of the crisis and whether the quality of life improvements that specific tools have brought do indeed persist. We would argue that such a study is meaningful because the COVID-19 situation has had advantages for digital literacy and competency.

At times, it has forced people to leave their technological comfort zone (e.g., new tools, new strategies for communication or collaboration). Some interviewees told us it was unlikely they would have

encountered or sought these changes autonomously, but the situation demanded it. An important reason was quality of life improvements, like *staying in touch with loved ones* or *improving their 'working from home' experience.* When we asked participants how they felt about technology at the societal level, some used it as a backdrop for their points - that it had allowed many aspects of life to continue or that it exacerbated and created new problems.

Finally, on this point, technology during the pandemic seems to have been a tool *and* a topic for reflection itself. One participant, quarantined during the swine flu (H1N1) outbreak of 2009, commented how much more helpful technology had been in this most recent crisis. Many older participants expressed gratitude for the accessibility of digital media (e. g., photos and videos) during this time as a means to revisit uplifting memories and continue participating in the creation of new ones. Some commented that they had also seen loved ones and colleagues in a new level of detail because it was difficult to hide the realities of *"home life"* over video calls. This pandemic phenomenon triggers self-reflection and empathy via comparison, encouraging personal evaluations of self or environment through glimpses afforded by an exceptional situation.

5. Discussion

The following section will discuss different aspects of our results and how they link back to our research questions. While it may be difficult to know *which* specific tools or techniques are *responsible* for productive and consistent self-reflection, we found that most people characterised existing supports are rigid and *non-adaptive* (RQ3). We also found from persistent self-reflectors that *education* and *flexibility* might influence their efficaciousness and versatility when it comes to their self-reflective practices (RQ1, RQ2). It may help improve digital support if they do more to recommend and explain self-reflective practices in ways that improve *self-assessment* or *acceptance* - particularly if it benefits the users' sense of *competency* (RQ2.1, RQ2.3). It may also be worth exploring different models of interaction or readily available technologies that appear to be underutilised thus far (RQ2.2, RQ3). We will discuss these predominate aspects in more detail below before ending with a general description of the *limitations* that may have impacted our work.

5.1. Adaptation

We found that self-reflective ability was not the only aspect to vary within the population for our research questions. The *style and amount of the activity* needed to support well-being or autonomy (RQ1, RQ2) also appeared to be heterogeneous. Our statistical analysis indicated differences in *frequency*, *duration* or *variety* of practice, but even for those with

similar abilities, they could need more or less. Up or down-regulation can occur to meet needs and stressors, but individuals with lower reflective scores do not appear to do this as intuitively as their high reflection counterparts. With this knowledge, it would be essential to understand in future work whether this regulation is directed more by particular contexts or circumstances or at individual attributes. If the latter is true, high self-reflectors could offer examples of adaptations appropriate to specific profiles and ways to motivate or nurture more vulnerable or inexperienced.

We cannot state that the relationship between higher reflective scores and educational attainment is casual. Nor is it possible to be sure that the increased number of reflective objects in use (digital or not) is a reason for higher reflective ability (RQ2.2, RQ2.3). The implication we can establish at this stage is that those with a high reflection score do appear differentiated from those who scored lower in these respects. Part of our goal in this study was to begin *shedding light* on these perspectives and forge a path toward a more rigorous understanding. It was essential to establish where these differences might be visible in the *current* context, and capturing these indications will allow for a more targeted investigation in future. It raises questions on what behavioural triggers lead high reflectors to alter their approaches in response to stressors. Skills that may be transmissible through education and guidance digital support could provide.

It is apparent that for a technological system to support the reflective ability of an individual, it needs to be adaptive to change (RQ3). As people encounter stressors and life events, a system that does not anticipate or compensate may struggle, even undermining behavioural persistence. For example, someone expecting a child may go from a modality where time is more available to one in which it is scarce. Suppose a system continued to suggest reflective activities that were difficult or impossible within the new situation. In that case, it might actively undermine the user's sense of *autonomy* and *competency* (Ryan & Deci, 2000). From the self-determination theory perspective, we know this is highly detrimental to success in behavioural change. This aspect has also been a finding of this work. textcolorblueMany tools or services people have used for self-reflection fail through insurmountable changes in their environment and practical or personal resources (RQ2.3, RQ3). This issue implies that one strategy to avoid these failures is to focus on recommending activities that are less susceptible to changes, simplifying them, or assisting the user with moving to more appropriate alternatives. It also seems that although some activities are common and *can* be reflective in some ways, they may not always produce a constructive or productive kind of self-reflection. For example, although *peer feedback* and *exercise* were popular, these activities may not be as effective at synthesising new perspectives. textcolorblueActivities like these might be better at reinforcing an *existing* perspective and offer a limited number of alternatives.

We can see from our results that some activities are more resilient than others; some were consistently popular across stress levels *and* more frequently associated with extended practices that went back years (RQ2). What contributes to the success of these particular activities may be that they only rely on factors or resources that are continuously available despite dramatic changes. An individual may need to invest practical resources such as money and time to travel to or pay for an activity (e.g., a meditation studio or therapist). They may also need to possess a minimum level of physical or cognitive function (RQ3). Whilst some of these elements can be refactored (e.g., a person who cannot go to a Yoga class could follow on YouTube), physiological and psychological fluctuations are more likely to require a more radical adaptation - perhaps an entirely new activity. Some things may be harder (or impossible) to replace if access becomes a problem - if someone loses mobility due to an accident or ageing, access becomes restricted due to hospitalisation (or a global pandemic).

We suggest that, to support self-reflective action, a digital support *needs* an adaptive component that tries to understand users in a *holistic* way. Similar to the adaptive difficulty commonplace in video games,

adaptive qualities may be critical to initial adoption *and* consistency. Particularly for a sense of *competency*, and the *attitude* people have toward these practices. Given the prevalence of archetypes, expectations and variety in people's descriptions of self-reflection, it would stand to reason that elements of this adaption would benefit from transparency. To explain *why* recommendations have changed, emphasising the normality of fluctuations in practice (and in life) are essential opportunities to seed approaches to thinking constructively. This approach is especially relevant to the context of longer-term, day-to-day support described in our introductory section. Our work has shown that nearly everyone is open to new approaches, but those with lower self-reflective ability could be held back by rigid assessments and attitudes (RQ2.1).

In simpler terms, holistic adaptations would be across at least two dimensions - the recommended activities or exercises and their form or complexity. Qualitative observations included people who could no longer do certain activities that once supported them because of changes they could not adapt to or avoid (RQ3). In summary, a system designed to encourage or support reflection would need to have a choice of activities or exercises a user is most likely to be motivated by *and* ways they can modify in response to changes in the user's need or ability. Ideally, this would include assistance and counselling if they need to move to a *different* activity altogether *as well as* to reinforce a healthier beginners mindset at the start. textcolorblueThese recommendations' form and delivery should emphasise how self-reflection can ebb and flow between activities.

Our work has shown that although we might expect the inflexibility of support to be a failure point for *some* groups, it also seems to be the case for *most*. The implication is that enhanced adaptation might be helpful to all - not just those experiencing a chronic issue. Self-determination theory suggests that this choice and flexibility would likely encourage *autonomy* whereas education or counselling may be inoculating for *competency* and *relatedness*. Everyone can encounter aspects of life that can be disabling, physical or perceptual.

5.2. Education

Another aspect our open-ended questions revealed and corroborated in follow-up interviews is that there are appreciable differences in the expected outcomes of reflection across groups. This factor may have implications for adherence to the activity and may play a role in self-reflection evolving into maladaptive perspectives or rumination. textcolorblueTo begin with, people have varied *definitions* of self-reflection, a phenomenon we also mentioned earlier as an issue for researchers as well (Baumer et al., 2014). Whereas some appeared to consider it a mechanism for embracing the world or events around them *as is*, others expected it to be transactional - to add or remove (RQ2.1). This quality is vital because digital support may need to consider how these archetypes influence the user and whether precise steering or education is appropriate to achieve a healthier perspective of self-reflective activity.

Given the growing prevalence of reflective applications and services and their proximity to the 'self-help' industry, we think further scrutiny of their design choices is warranted. We mean that designs targeting 'engagement' or 'length of use may be problematic if it is an isolated metric. Engagement alone does not indicate that the self-reflection occurring is not ruminative or detrimental, as we have mentioned before; feedback may not be enough to indicate that self-reflection has occurred either (Baumer et al., 2014). This aspect may not be considered enough in these apps or services, and it would be interesting to extend our research into a taxonomy of safeguards that have (or have not) been placed in these services so far. This factor will introduce another dimension to the requirements we envision for adaptive support - awareness of when behaviour can take on negative sentiment. textcolorblueThese issues should be important to researchers at a stage where more companies focus on preventative and personalised health care. We believe that technologies *do* have the potential to play intermediary roles between individuals and their care providers, but it will be vital to

develop responsibly. Our work shows that certain factors make reflective thought easier or harder for certain people; we must understand how different factors can develop or immunise against harmful tendencies. Gender differences and education are just two factors that may contribute to different perspectives of self-reflection. These differences could warrant alternative approaches to the function and presentation of digital support.

We see the same potential recognised by Calvo and Peters; the transformative effects technology may yet bring to human-potential (Calvo & Peters, 2014). Technological supports that provide meta-cognitive education to maintain well-being could be tremendously influential. We noticed that participants who *had* received some form of psychological counselling would frequently examine their thinking with language or strategies that bore the hallmarks of therapeutic techniques (e.g., Cognitive Behavioural Therapy, Mindfulness-Based Stress Reduction). This detail again highlights that those developing digital products and services for self-reflection should know that not all reflection is *good thinking* - that cognitive awareness varies considerably. There also appears to be evidence that people will naturally up or down-regulate their reflection as their practice improves, reiterating that the *quantity* of self-reflection is not a substitute for *quality*. Again, through the lens of SDT, users guided toward *quality* self-reflection, counselled on its nuances, may be more likely to feel that their *autonomy* is supported. Their sense of *competency* is likely to improve over time, culminating in feelings that the practice is essential to their well-being (*relatedness*). Needs satisfaction across these aspects nurtures *intrinsic* motivation, improving the likelihood that any associated behaviours become continuous and *consistent* overall.

5.3. Flexibility

Based on what we have seen, technological access and use do not appear to be associated with a significant *increase* in reflective ability or the number of activities a person maintains (RQ2.2, RQ2.3). However, we did observe several ways that technological use *supported* reflection in more pragmatic ways that complemented activities or reduced interference to adherence. We noted instances where the inflexibility of particular tools (digital and analogue) contributed to why these approaches may have failed to be adopted (RQ3). We understand that an implication drawn from these points is that a digitally exclusive approach to an app or service for self-reflection may create more obstacles to long-term adherence. Firstly, although some (e.g., male users) seem to be more accepting of digital tools, there is usually a stronger *preference* or *comfort* associated with analogue tools regardless (RQ2, RQ2.1). Male participants had greater access to technology, but, like their female peers, they still preferred an analogue approach (RQ2.1, RQ2.2). Whether this has more to do with kinesthetic and practical qualities or the analogue tool untethered from the digital world is one question that warrants further scrutiny. The other implication is that *hybrid* approaches may offer a 'middle path' that can reap benefits from both sides *and* be more flexible to changing needs.

An implication is that digital supports, particularly those on smartphones and tablets, might struggle to be effective within a chaotic environment of *other applications and features*. It may make sense that support emphasises a more *minimal* approach to direct interactivity or make a point of prompting users to mitigate the chances they will be distracted. In practice, an application of this nature might recommend activities but instruct users to complete them *away* from the device or turn off features like notifications for a brief period. Some of our interviewees also mentioned applications that gave them audio instructions (e.g., guided meditation), which allowed them to place the phone nearby and not become distracted by its other features. Although this example is a passive form of guidance, we could also envision a more interactive approach, where reflective questions or prompts can be aloud and capture user responses with speech recognition. textcolorblueEven if the recognition quality is not perfect, it might be possible to

ascertain *sentiment* in aggregate.

Another possibility is that the support acts as an activity repository, generating recommendations as printable materials. The user could complete these at their own pace, and the device would not be required. Users could scan completed worksheets, storing them for serendipitous exploration and retrospection. A more advanced possibility might be that these scans could be analysed for signals to improve the subsequent recommendations or prompts.

The use of heuristics by high self-reflection groups suggests digital supports should understand flexibility and adaptation as *distinct* issues. What we mean by this is that an adaptation is more rooted in what changes the system can make to improve *relevance* to the user; flexibility may be the extent users will need to depart from their intuitions to complete the activity with *ease*. This aspect includes whether the user can be spontaneous and experimental in ways that bolster their sense of *autonomy*. It should be that if an interface is too aggressively adaptive, the user could feel the process is transparently manipulative (undermining *autonomy*). If it is too flexible, they may lack the structure to ascertain their *competency*. Striking the right balance will be essential to an overall feeling of *relatedness* toward the practices a system recommends. Lastly, we believe that given the *uniqueness* of individual needs and ability we have seen in self-reflection, any social features need careful consideration. Social comparison *may* be helpful to give people ideas on ways to experiment with their agency. However, it may also undermine *competency* if people become focused on trends or archetypes of 'good' practice that emerge in group sharing (Ayobi et al., 2018).

5.4. Limitations

Given self-reflection is often a *personal* experience, it presents several challenges as a research topic. As we found in prior work and from our participants, the *definition* of what constitutes self-reflection (or act thereof) can vary. In turn, *measuring* the incidence of such activity can be difficult. Our survey description and content included definitions and examples of what self-reflection meant in context. We also included open-ended questions inviting participants to use their own words to articulate their understanding. Here are qualitative analysis helped us find discrepancies, activities we had not listed and different points of view - which would have made the survey exhaustively to list. The framing provided by our grouping also supported these codes and themes - even if it was difficult to know what self-reflection *means* to each individual or where improvements *originate*. Using these scales helped silhouette important conditions that may contribute to their likelihood.

Our study involved a representative sample from the U.K. while aspects may generalise to other countries, socioeconomic differences are likely to introduce nuances. We have seen that educational achievement and stress appear to have a *relationship* with reflective ability. However, we cannot state a causal direction (e.g., because someone is of lower socioeconomic status, they are more or less likely to reflect vs because someone reflects they are more or less likely to be of lower socioeconomic status). Socioeconomic status can manifest as an issue in many ways - the availability of higher quality technologies is one factor that may relate to disposable income. This measure may influence which technological support a person will try or the quality of that experience with a *new* technology.

Additionally, although this is a representative sample of the population, with it being an online survey, it may not include the perspectives of those who do not (or cannot) access the internet. As follow-up interviews were over Zoom because of COVID, this format may have influenced that experience for some. It was easier to collect qualitative data from those who were *happy to share*. However, those who were quieter or less openly reflective may have been affected by the nature of the interaction *as well* as personality differences.

6. Conclusion

We designed this study to address shortcomings in how we understand reflective practice in the *modern* era and the role technology *already* plays in the lives of different reflectors (RQ1, RQ2.3). To the best of our knowledge, this is the first empirical study focused exclusively on reflective practice *itself* and technological use), *in the contemporary setting* and at the scale of a *general population*. We also believe this is the first use of SRIS using a general population sample to the best of our knowledge. We have found that although people have access to many technologies that *could* be invaluable gateways or tools, actual *usage* is relatively limited (RQ2.2, RQ2.3). This detail does not seem to change substantially across individual competency. However, it *does* appear that committed reflectors are more cognisant and strategic about the role technology plays in their practice (RQ2, RQ2.1). It seems capable reflectors capitalize on the benefits of technology in ways that may mitigate common barriers to practice (RQ2.1, RQ3). Additionally, competent reflectors appear to contract or expand their technological use in response to stressful events in their life (RQ2, RQ2.2). Their gender or education also relates to their attitudes (RQ1, RQ2, RQ2.1).

HCI researchers should take these observations seriously because a technology-centred approach may not be optimal or intuitive enough for most (RQ3). Based on our findings, it may also be that analogue approaches or components are *preferred*. Because competent reflectors seem to have found ways to leverage digital tools to complement their analogue approaches, we intend to examine this further (RQ2). Digital and analogue components could be a holistic pair, a hybrid approach that multiplies the strengths of one another, constituting the *'best of both worlds'*. It may be challenging to know what aspects are *directly* responsible for improvements in self-reflective ability (and it seems likely to be highly individual). However, we believe that our work helps toward understanding aspects that may help to create *conditions* where it is more likely to occur.

Before now, we did not have information that allowed us to understand the incidence or characteristics of digital tools being used for self-reflection in the general population, indications of their influence or efficaciousness. We believe our work adds objectivity by widening the perspective (RQ1) and appreciating differences in needs or application (RQ2, RQ2.1). Especially how access and use of *activities*, *objects*, or *routines* vary (RQ2.2, RQ2.3) or which formulations appear to work better for some (RQ2.1, RQ3). We believe that reflection is undeveloped in technical domains, which is troubling given that it is important to many of the behaviours they attempt to change. Self-reflection is challenging, and our research contributes to a clearer picture of important aspects to manage or consider. Self-reflection is a highly individual experience, and it isn't easy to prescribe *specific* activities or universally productive steps. Nevertheless, we believe researchers can approach agreement on aspects that foster the *conditions* where the likelihood improves and reinforce other forms of support. In a world where technological entrenchment is difficult to ignore, updating perspectives may help digital supports become equally useful and considered for ordinary or vulnerable individuals.

Declaration of competing interest

Data availability

Data will be made available on request.

References

Ancker, J. S., Witteman, H. O., Hafeez, B., Provencher, T., Van de Graaf, M., & Wei, E. (2015). "You get reminded you're a sick person": Personal data tracking and patients with multiple chronic conditions. *Journal of Medical Internet Research, 17*(8), Article e202. https://doi.org/10.2196/jmir.4209

Ayobi, A., Marshall, P., & Cox, A. L. (2020). Trackly: A customisable and pictorial self-tracking app to support agency in multiple sclerosis self-care. In *Proceedings of the 2020 CHI conference on human factors in computing systems* (pp. 1–15). Association for Computing Machinery.

Ayobi, A., Sonne, T., Marshall, P., & Cox, A. L. (2018). Flexible and mindful self-tracking: Design implications from paper bullet journals. In *Proceedings of the 2018 CHI conference on human factors in computing systems, CHI '18* (pp. 1–14). Association for Computing Machinery. https://doi.org/10.1145/3173574.3173602.

Baumer, E. P., Khovanskaya, V., Matthews, M., Reynolds, L., Sosik, V. S., & Gay, G. (2014). Reviewing reflection: On the use of reflection in interactive system design. In *Proceedings of the 2014 conference on designing interactive systems, DIS '14* (pp. 93–102). Association for Computing Machinery. https://doi.org/10.1145/2598510.2598598.

Bennett-Levy, J., Turner, F., Beaty, T., Smith, M., Paterson, B., & Farmer, S. (2001). The value of self-practice of cognitive therapy techniques and self-reflection in the training of cognitive therapists. *Behavioural and Cognitive Psychotherapy, 29*(2), 203–220. https://doi.org/10.1017/S1352465801002077

Bentvelzen, M., Niess, J., & Woźniak, P. W. (2021). The technology-mediated reflection model: Barriers and assistance in data-driven reflection. In *Proceedings of the 2021 CHI conference on human factors in computing systems, CHI '21* (pp. 1–12). Association for Computing Machinery. https://doi.org/10.1145/3411764.3445505.

Berry, A. B., Lim, C. Y., Liang, C. A., Hartzler, A. L., Hirsch, T., Ferguson, D. M., Bermet, Z. A., & Ralston, J. D. (2021). Supporting collaborative reflection on personal values and health. *Proceedings of the ACM on Human-Computer Interaction, 5* (299), 1–299. https://doi.org/10.1145/3476040, 39.

Bethune, S. (2019). Survey: Americans becoming more open about mental health. https://www.apa.org/news/press/releases/2019/05/mental-health-survey.

Beveren, L. V., Roets, G., Buysse, A., & Rutten, K. (2018). We all reflect, but why? A systematic review of the purposes of reflection in higher education in social and behavioral sciences. *Educational Research Review, 24*, 1–9. https://doi.org/10.1016/j.edurev.2018.01.002

Borton, T. (1970). *Reach, touch, and teach: Student concerns and process education.* Graw Hill.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brookfield, S. (1998). Critically reflective practice. *Journal of Continuing Education in the Health Professions, 18*(4), 197–205. https://doi.org/10.1002/chp.1340180402

Calvo, R. A., & Peters, D. (2014). *Positive computing: Technology for wellbeing and human potential.* MIT Press.

Campbell, R. C., Nguyen, N. T. T., Kim, J.-H., Duke, L. A., Taraban, R., & Reible, D. D. (2021). *Visual thinking strategies (VTS) for promoting reflection in engineering education: Graduate student perceptions.*

Campos, G. G., Moral, P. V., Zagalaz, J. C., & Ortega, F. Z. (2015). *Visualisation and goal-setting in footballers.*

Carver, C. S., & Scheier, M. F. (1998). *On the self-regulation of behavior, on the self-regulation of behavior.* Cambridge University Press. https://doi.org/10.1017/CBO9781139174794

Cherubini, M., Reut, L., Tyler, J., & Ortlieb, M. (2021). Inattentive, imprudent and inapt: Discovering inadequacies of ICT during life-changing events through the lens of non-users. *Behaviour & Information Technology, 40*(15), 1643–1670. https://doi.org/10.1080/0144929X.2020.1772879

Choi, J., Walters, A., & Hoge, P. (2017). Self-reflection and math performance in an online learning environment. *Online Learning Journal, 21*(4).

Chow, G. M., & Luzzeri, M. (2019). Post-event reflection: A tool to facilitate self-awareness, self-monitoring, and self-regulation in athletes. *Journal of Sport Psychology in Action, 10*(2), 106–118. https://doi.org/10.1080/21520704.2018.1555565

Civitillo, S., Juang, L. P., Badra, M., & Schachner, M. K. (2019). The interplay between culturally responsive teaching, cultural diversity beliefs, and self-reflection: A multiple case study. *Teaching and Teacher Education, 77*, 341–351. https://doi.org/10.1016/j.tate.2018.11.002

Conroy, D. E., & Elliot, A. J. (2004). Fear of failure and achievement goals in sport: Addressing the issue of the chicken and the egg. *Anxiety, Stress, & Coping, 17*(3), 271–285. https://doi.org/10.1080/1061580042000191642

Conte, H. R., & Ratto, R. (1997). Self-report measures of psychological mindedness. In , *The LEA series in personality and clinical psychologyPsychological mindedness: A contemporary understanding* (pp. 1–26). Lawrence Erlbaum Associates Publishers.

Crane, M. F., Searle, B. J., Kangas, M., & Nwiran, Y. (2018). How resilience is strengthened by exposure to stressors: the systematic self-reflection model of resilience strengthening. *Anxiety, Stress, & Coping, 32*(1), 1–17.

Davidson, A. (2012). *Making choices in the age of information overload.* URL. The New York Times https://www.nytimes.com/2012/05/20/magazine/making-choices-in-the-age-of-information-overload.html.

Davis, N., & N. D. S. Correspondent. (2021). *Covid crisis dramatically worsened global mental health, study finds.* URL. The Guardian https://www.theguardian.com/world/2021/oct/08/covid-crisis-dramatically-worsened-global-mental-health-study-finds.

de Jong, S., van Donkersgoed, R. J. M., Timmerman, M. E., Rot, M. A. H., Wunderink, L., Arends, J., … Pijnenborg, G. H. M. (2019). Metacognitive reflection and insight therapy (MERIT) for patients with schizophrenia. *Psychological Medicine, 49*(2), 303–313. https://doi.org/10.1017/S0033291718000855. arXiv:29692285.

Dewey, J. (1997). *How we think, revised ed. edition edition.* Dover Publications.

Elsden, C., Durrant, A. C., & Kirk, D. S. (2016). It's just my history isn't it?: Understanding smart journaling practices. In *Proceedings of the 2016 CHI conference on human factors in computing systems, ACM* (pp. 2819–2831). https://doi.org/10.1145/2858036.2858103

Epstein, D. A., Ping, A., Fogarty, J., & Munson, S. A. (2015). A lived informatics model of personal informatics. In *Proceedings of the 2015 ACM international joint conference on pervasive and ubiquitous computing - UbiComp '15* (pp. 731–742). ACM Press. https://doi.org/10.1145/2750858.2804250.

Falon, S. L., Kangas, M., & Crane, M. F. (2021). The coping insights involved in strengthening resilience: The self-reflection and coping insight framework. *Anxiety, Stress, & Coping, 34*(6), 734–750. https://doi.org/10.1080/10615806.2021.1910676

Falon, S. L., Karin, E., Boga, D., Gucciardi, D. F., Griffin, B., & Crane, M. F. (2021). A clustered-randomized controlled trial of a self-reflection resilience-strengthening intervention and novel mediators. *Journal of Occupational Health Psychology, 26*(1), 1–19. https://doi.org/10.1037/ocp0000268

Gaeta, M. L., Gaeta, L., & Rodriguez, M. D. S. (2021). The impact of COVID-19 home confinement on Mexican University Students: Emotions, coping strategies, and self-regulated learning. *Frontiers in Psychology, 12*.

Gao, J., Zheng, P., Jia, Y., Chen, H., Mao, Y., Chen, S., Wang, Y., Fu, H., & Dai, J. (2020). Mental health problems and social media exposure during COVID-19 outbreak. *PLOS ONE, 15*(4), Article e0231924. https://doi.org/10.1371/journal.pone.0231924

Gerst, M. S., Grant, I., Yager, J., & Sweetwood, H. (1978). The reliability of the social readjustment rating scale: Moderate and long-term stability. *Journal of Psychosomatic Research, 22*(6), 519–523. https://doi.org/10.1016/0022-3999(78)90008-9

Gibbs, G., & G. B. F. E. Unit. (1988). *Learning by doing: A guide to teaching and learning methods, FEU.* arXiv:z2CxAAAACAAJ.

Grant, A. M. (2001). Rethinking psychological mindedness: Metacognition, self-reflection, and insight. *Behaviour Change, 18*(1), 8–17. https://doi.org/10.1375/bech.18.1.8

Grant, A. M., Franklin, J., & Langford, P. (2002). The self-reflection and insight scale: A new measure of private self-consciousness. *Social Behavior and Personality: An International Journal, 30*(8), 821–835. https://doi.org/10.2224/sbp.2002.30.8.821

Grushka, K., McLeod, J. H., & Reynolds, R. (2005). Reflecting upon reflection: Theory and practice in one australian university teacher education program. *Reflective Practice, 6*(2), 239–246. https://doi.org/10.1080/14623940500106187

Hägglund, K., Kenttä, G., Thelwell, R., & Wagstaff, C. R. D. (2019). Is there an upside of vulnerability in sport? A mindfulness approach applied in the pursuit of psychological strength. *Journal of Sport Psychology in Action, 10*(4), 220–226. https://doi.org/10.1080/21520704.2018.1549642

Haimson, O. L., Carter, A. J., Corvite, S., Wheeler, B., Wang, L., Liu, T., & Lige, A. (2021). The major life events taxonomy: Social readjustment, social media information sharing, and online network separation during times of life transition. *Journal of the Association for Information Science and Technology, 72*(7), 933–947. https://doi.org/10.1002/asi.24455

Hanrahan, S. J., Pedro, R., & Cerin, E. (2009). Structured self-reflection as a tool to enhance perceived performance and maintain effort in adult recreational salsa dancers. *The Sport Psychologist, 23*(2), 151–169. https://doi.org/10.1123/tsp.23.2.151

Hébert, C. (2015). Knowing and/or experiencing: A critical examination of the reflective models of John Dewey and Donald Schön. *Reflective Practice, 16*(3), 361–371. https://doi.org/10.1080/14623943.2015.1023281

Hollingsworth, H., & Clarke, D. (2017). Video as a tool for focusing teacher self-reflection: Supporting and provoking teacher learning. *Journal of Mathematics Teacher Education, 20*(5), 457–475. https://doi.org/10.1007/s10857-017-9380-4

Holmes, T. H., & Rahe, R. H. (1967). The social readjustment rating scale. *Journal of Psychosomatic Research, 11*(2), 213–218. https://doi.org/10.1016/0022-3999(67)90010-4

Holzer, J., Lüftenegger, M., Korlat, S., Pelikan, E., Salmela-Aro, K., Spiel, C., & Schober, B. (2021). *Higher education in times of COVID-19: University students' basic need satisfaction, self-regulated learning, and well-being, AERA open. 7.* https://doi.org/10.1177/23328584211003164

Izu, C., & Alexander, B. (2018). Using unstructured practice plus reflection to develop programming/problem-solving fluency. In *Proceedings of the 20th Australasian computing education conference, ACE '18* (pp. 25–34). Association for Computing Machinery. https://doi.org/10.1145/3160489.3160496, 39.

Johnson, M. K., & Raye, C. L. (1981). Reality monitoring. *Psychological Review, 88*(1), 67–85. https://doi.org/10.1037/0033-295X.88.1.67

Joireman, J. A., III, L. P., & Hammersla, J. (2002). Empathy and the self-absorption paradox: Support for the distinction between self-rumination and self-reflection. *Self and Identity, 1*(1), 53–65. https://doi.org/10.1080/152988602317232803

Jonker, L., Elferink-Gemser, M. T., de Roos, I. M., & Visscher, C. (2012). The role of reflection in sport expertise. *The Sport Psychologist, 26*(2), 224–242. https://doi.org/10.1123/tsp.26.2.224

Jose, J., & Joseph, M. M. (2018). Imagery: It's effects and benefits on sports performance and psychological variables: A review study. *International Journal of Physiology, Nutrition and Physical Education, 3*(2), 190–193.

Kilgour, P., Reynaud, D., Northcote, M., & Shields, M. (2015). Role-playing as a tool to facilitate learning, self reflection and social awareness in teacher education. *International Journal of Innovative Interdisciplinary Research, 2—4*, 8–20.

Killion, J. P., & Todnem, G. R. (1991). A process for personal theory building. *Educational Leadership, 48*(6), 14–16.

Kinsella, E. A. (2010). The art of reflective practice in health and social care: Reflections on the legacy of Donald Schön. *Reflective Practice, 11*(4), 565–575. https://doi.org/10.1080/14623943.2010.506260

Kishimoto, K. (2018). Anti-racist pedagogy: From faculty's self-reflection to organizing within and beyond the classroom. *Race Ethnicity and Education, 21*(4), 540–554. https://doi.org/10.1080/13613324.2016.1248824

Kolb, D. A., & Fry, R. E. (1974). *Toward an applied theory of experiential learning.* M.I.T. Alfred P. Sloan School of Management.

Lee, J., Park, B. J., Tsunetsugu, Y., Ohira, T., Kagawa, T., & Miyazaki, Y. (2011). Effect of forest bathing on physiological and psychological responses in young japanese male subjects. *Public Health, 125*(2), 93–100. https://doi.org/10.1016/j.puhe.2010.09.005

Li, I., Dey, A., & Forlizzi, J. (2010). A stage-based model of personal informatics systems. In *Proceedings of the 28th international conference on human factors in computing systems - CHI '10* (p. 557). ACM Press. https://doi.org/10.1145/1753326.1753409.

Lie, S. S., Karlsen, B., Niemiec, C. P., Graue, M., & Oftedal, B. (2018). Written reflection in an eHealth intervention for adults with type 2 diabetes mellitus: A qualitative study. *Patient Preference and Adherence, 12*, 311–320. https://doi.org/10.2147/PPA.S154612. arXiv:29535506.

Lindström, M., Ståhl, A., Höök, K., Sundström, P., Laaksolathi, J., Combetto, M., Taylor, A., & Bresin, R. (2006). Affective diary: designing for bodily expressiveness and self-reflection. In *CHI '06 Extended Abstracts on Human Factors in Computing Systems, CHI EA '06* (pp. 1037–1042). Association for Computing Machinery. https://doi.org/10.1145/1125451.1125649.

Lomicka, L., & Ducate, L. (2021). Using technology, reflection, and noticing to promote intercultural learning during short-term study abroad. *Computer Assisted Language Learning, 34*(1–2), 35–65. https://doi.org/10.1080/09588221.2019.1640746

Lousberg, L., Rooij, R., Jansen, S., van Dooren, E., Heintz, J., & van der Zaag, E. (2020). Reflection in design education. *International Journal of Technology and Design Education, 30*(5), 885–897. https://doi.org/10.1007/s10798-019-09532-6

Lowenthal, P., Borup, J., West, R., & Archambault, L. (2020). Thinking beyond zoom: Using asynchronous video to maintain connection and engagement during the COVID-19 pandemic. *Journal of Technology and Teacher Education, 28*(2), 383–391.

Lysaker, P. H., & Klion, R. E. (2017). *Recovery, meaning-making, and severe mental illness: A comprehensive guide to metacognitive reflection and insight therapy* (1st ed.). Routledge.

Mahomed, F. (2020). Addressing the problem of severe underinvestment in mental health and well-being from a human rights perspective. *Health and Human Rights, 22* (1), 35–49. arXiv:32669787.

Massimi, M., & Neustaedter, C. (2014). Moving from talking heads to newlyweds: Exploring video chat use during major life events. In *Proceedings of the 2014 Conference on Designing Interactive Systems, DIS '14* (pp. 43–52). Association for Computing Machinery. https://doi.org/10.1145/2598510.2598570.

McCormick, A., Meijen, C., Anstiss, P. A., & Jones, H. S. (2019). Self-regulation in endurance sports: Theory, research, and practice. *International Review of Sport and Exercise Psychology, 12*(1), 235–264. https://doi.org/10.1080/1750984X.2018.1469161

Mlinar Reljić, N., Pajnkihar, M., & Fekonja, Z. (2019). Self-reflection during first clinical practice: The experiences of nursing students. *Nurse Education Today, 72*, 61–66. https://doi.org/10.1016/j.nedt.2018.10.019

Norton, M. I., Mochon, D., & Ariely, D. (2012). The IKEA effect: When labor leads to love. *Journal of Consumer Psychology, 22*(3), 453–460. https://doi.org/10.1016/j.jcps.2011.08.002

Olteanu, C. (2017). Reflection-for-action and the choice or design of examples in the teaching of mathematics. *Mathematics Education Research Journal, 29*(3), 349–367. https://doi.org/10.1007/s13394-017-0211-9

Pedrosa, D., Cravino, J., Morgado, L., & Barreira, C. (2019). Co-regulated learning in computer programming: Students co-reflection about learning strategies adopted during an assignment. In M. Tsitouridou, J. A. Diniz, & T. A. Mikropoulos (Eds.), *Technology and innovation in learning, teaching and education, communications in computer and information science* (pp. 13–28). Springer International Publishing. https://doi.org/10.1007/978-3-030-20954-4_2.

Peters, D., Calvo, R. A., & Ryan, R. M. (2018). Designing for motivation, engagement and wellbeing in digital experience. *Frontiers in Psychology, 9*.

Potapov, K., Vasalou, A., Lee, V., & Marshall, P. (2021). What do teens make of personal informatics? Young people's responses to self-tracking practices for self-determined motives. In *Proceedings of the 2021 CHI conference on human factors in computing systems, CHI '21* (pp. 1–10). Association for Computing Machinery. https://doi.org/10.1145/3411764.3445239.

Prilla, M., Degeling, M., & Herrmann, T. (2012). Collaborative reflection at work: Supporting informal learning at a healthcare workplace. In *Proceedings of the 17th ACM international conference on supporting group work, GROUP '12* (pp. 55–64). Association for Computing Machinery. https://doi.org/10.1145/2389176.2389185.

Prolific. (2021). Representative samples on prolific. https://researcher-help.prolific.co/hc/en-gb/articles/360019236753-Representative-Samples-on-Prolific.

Puussaar, A., Clear, A. K., & Wright, P. (2017). Enhancing personal informatics through social sensemaking. In *Proceedings of the 2017 CHI conference on human factors in computing systems, CHI '17* (pp. 6936–6942). Association for Computing Machinery. https://doi.org/10.1145/3025453.3025804.

Rank, J., & Gray, D. E. (2017). The role of coaching for relationship satisfaction, self-reflection, and self-esteem: Coachees' self-presentation ability as a moderator. *Consulting Psychology Journal: Practice and Research, 69*(3), 187–208. https://doi.org/10.1037/cpb0000082

Rapp, A., & Tirassa, M. (2017). Know thyself: A theory of the self for personal informatics. *Human-Computer Interaction, 32*(5–6), 335–380. https://doi.org/10.1080/07370024.2017.1285704

Rober, P. (1999). The therapist's inner conversation in family therapy practice: Some ideas about the self of the therapist, therapeutic impasse, and the process of reflection. *Family Process, 38*(2), 209–228. https://doi.org/10.1111/j.1545-5300.1999.00209.x. arXiv:10407721.

Rooksby, J., Rost, M., Morrison, A., & Chalmers, M. (2014). Personal tracking as lived informatics. In *Proceedings of the SIGCHI conference on human factors in computing systems, ACM* (pp. 1163–1172). https://doi.org/10.1145/2556288.2557039

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55* (1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Saksono, H., Castaneda-Sceppa, C., Hoffman, J., Morris, V., El-Nasr, M. S., & Parker, A. G. (2020). Storywell: Designing for family fitness app motivation by using social rewards and reflection. In *Proceedings of the 2020 CHI conference on human factors in computing systems* (pp. 1–13). Association for Computing Machinery.

Satchell, C., & Dourish, P. (2009). Beyond the user: Use and non-use in HCI. In *Proceedings of the 21st annual conference of the Australian computer-human interaction special interest group: Design: Open 24/7, OZCHI '09* (pp. 9–16). Association for Computing Machinery. https://doi.org/10.1145/1738826.1738829.

Schon, D. A. (1984). *The reflective practitioner: How professionals think in action* (1st ed.). Basic Books.

Schön, D. A. (1992). Designing as reflective conversation with the materials of a design situation. *Knowledge-Based Systems, 5*(1), 3–14. https://doi.org/10.1016/0950-7051 (92)90020-G

Schraw, G., & Moshman, D. (1995). Metacognitive theories. *Educational Psychology Review, 7*(4), 351–371. https://doi.org/10.1007/BF02212307

Stellefson, M., Bopp, T., Odio, M., Wang, M. Q., & Zhang, L. (2020). Development of the life after sports transition (LAST) online course for collegiate student-athletes: Pretest-posttest study. *Journal of Athlete Development and Experience, 2*(2). https://doi.org/10.25035/jade.02.02.04

Strack, F., & Förster, J. (1998). Self-reflection and recognition: The role of metacognitive knowledge in the attribution of recollective experience. *Personality and Social Psychology Review, 2*(2), 111–123. https://doi.org/10.1207/s15327957pspr0202_4

Takano, K., & Tanno, Y. (2009). Self-rumination, self-reflection, and depression: Self-rumination counteracts the adaptive effect of self-reflection. *Behaviour Research and Therapy, 47*(3), 260–264. https://doi.org/10.1016/j.brat.2008.12.008

Terpstra, A., Schouten, A. P., De Rooij, A., & Leenes, R. E. (2019). Improving privacy choice through design: How designing for reflection could support privacy self-management. *First Monday*. https://doi.org/10.5210/fm.v24i7.9358

Terzimehić, N., Schött, S. Y., Bemmann, F., & Buschek, D. (2021). MEMEories: Internet memes as means for daily journaling. In *Designing interactive systems conference 2021* (pp. 538–548). Association for Computing Machinery.

Tholander, J., & Normark, M. (2020). Crafting personal information - resistance, imperfection, and self-creation in bullet journaling. In *Proceedings of the 2020 CHI conference on human factors in computing systems* (pp. 1–13). Association for Computing Machinery.

Trapnell, P. D., & Campbell, J. D. (1999). Private self-consciousness and the five-factor model of personality: Distinguishing rumination from reflection. *Journal of Personality and Social Psychology, 76*(2), 284–304. https://doi.org/10.1037/0022-3514.76.2.284

U. O. for National Statistics. (2011). Ct0570 2011 census - sex by age by imd2004 by ethnic group. https://www.ons.gov.uk/peoplepopulationandcommunity/culturali dentity/ethnicity/adhocs/005378ct05702011censussexbyagebyimd2004byethni cgroup.

Villalobos-Zúñiga, G., & Cherubini, M. (2020). Apps that motivate: A taxonomy of app features based on self-determination theory. *International Journal of Human-Computer Studies, 140*, Article 102449. https://doi.org/10.1016/j.ijhcs.2020.102449

Wells, A. (1995). Meta-cognition and worry: A cognitive model of generalized anxiety disorder. *Behavioural and Cognitive Psychotherapy, 23*(3), 301–320. https://doi.org/10.1017/S1352465800015897

Wen, Y., Yan, Q., Pan, Y., Gu, X., & Liu, Y. (2019). Medical empirical research on forest bathing (Shinrin-yoku): A systematic review. *Environmental Health and Preventive Medicine, 24*(1), 70. https://doi.org/10.1186/s12199-019-0822-8

World Health Organization (WHO). (2019). Mental health. URL https://www.who.int/h ealth-topics/mental-health.

Wosnitza, M., Delzepich, R., Schwarze, J., O'Donnell, M., Faust, V., & Camilleri, V. (2018). Enhancing teacher resilience: From self-reflection to professional development. In M. Wosnitza, F. Peixoto, S. Beltman, & C. F. Mansfield (Eds.), *Resilience in education: Concepts, contexts and connections* (pp. 275–288). Springer International Publishing. https://doi.org/10.1007/978-3-319-76690-4_16.

Yip, K.-S. (2006). Self-reflection in reflective practice: A note of caution. *The British Journal of Social Work, 36*(5), 777–788. https://doi.org/10.1093/bjsw/bch323