Age-Related Differences on Mind Wandering While Using Technology: A Proposal for an Experimental Study

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Abstract Mind wandering (MW) is a mental activity in which our thoughts drift away and turn into internal notions and feelings. Research suggests that individuals spend up to one half of their waking hours thinking about task-unrelated things. Being the opposite of goal-directed thinking, empirical evidence suggests that MW can forester creativity and problem solving. However, and despite growing efforts to understand the role of MW in technology-related settings, the role of individual differences remains unclear. We address this gap by proposing a research model that seeks to shed further light on age-related differences in MW while using different types of technology (i.e., hedonic and utilitarian systems). Thereby, we provide a point of departure for further research on how individual characteristics influence MW while using technology.

Keywords Mind wandering · Technology use · Age · Hedonic and utilitarian systems

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1 Introduction

Mind wandering (MW) is one of the most ubiquitous mental activities [1] and happens up to 50% of our waking time [2]. MW occurs when the mind stops being focused on the present and instead starts pondering about task-unrelated things [3]. Literature has shown that MW can be related to both negative job-output (e.g., reduced performance) and positive job-output (e.g., increased creativity) [4, 5]. Due to its complexity, the investigation of MW is important to further understand how it affects human behavior.

Since MW is a ubiquitous experience, it is most likely that our minds frequently wander when using technology. In fact, there is initial evidence that the degree of MW varies among different types of systems, i.e., hedonic and utilitarian systems [6]. Hedonic systems aim to provide self-fulfilling value, while utilitarian systems aim to provide instrumental value [7]. Sullivan et al. [3] suggest that MW, while using technology, has a notable impact on creativity [8]. To this end, we argue that MW is increasingly important in the context of technology use but needs further clarification.

Despite valuable first efforts to understand MW as a subject of information system (IS) research, little is known about individual differences in terms of MW and technology use so far. This gap is critical because literature on MW has stressed the role of individual differences [9–11]. Moreover, research concerning technology-related phenomena put further emphasis on them [12–14]. Studies demonstrate that older people's minds wander less in their daily life compared to younger people [9, 15], because cognitive abilities decrease with age [16–18]. As cognitive ability influences how technology is used [19], it is important to understand how IS artifacts need to be adapted to support human computer interaction.

Our paper aims to investigate the relationship between MW and age by raising the following research question: *Is there an age-related difference on MW while using different types of systems (* i.e., *hedonic, utilitarian)?* We contribute to a more holistic understanding of how humans of different ages use technology when their minds trail off.

2 Theoretical Background

Christoff et al. [18, p. 719] define MW as "a mental state, or a sequence of mental states, that arises relatively freely due to an absence of strong constraints on the contents of each state and on the transitions from one mental state to another". Psychology and neuroscience research demonstrates that MW predominately occurs in non-demanding circumstances and during task-free activity, e.g., during reading or driving [20–22].

MW has been associated with negative and positive consequences: Since thoughts wander from topic to topic, MW induces a lack of awareness and is seen as a cause of poor performance, errors, disruption, disengagement, and carelessness [4, 23, 24].

Moreover, MW is perceived as adverse, as it is enhanced by stress, unhappiness, and substance abuse [25–27]. However, besides its negative effects, studies suggest that MW offers unique benefits [1]. MW can lead to an increased ability to solve problems and positive predicts creative performance [3, 5, 11]. Moreover, MW is useful as it provides mental breaks to reduce boredom from monotonous activities [11].

In general, two types of MW can be distinguished: Deliberate and spontaneous MW [28]. This differentiation goes back to Giambra [20, 29]. Deliberate MW is characterized by intentional internal thoughts such as planning the weekend while driving to work. In contrast, spontaneous MW is unintentional, for example, when drifting away during a conversation [28]. Agnoli et al. [5] demonstrate that this distinction has indeed an effect as deliberate MW is a positive predictor of creative performance, whereas spontaneous MW is a negative predictor of creative performance. Moreover, MW can occur both as a state in specific situations or as trait in everyday life [30].

IS researchers acknowledge the relevance of MW [3, 6, 31, 32]. Sullivan, Davis and Koh [3] showed that MW while using technology influences creativity and knowledge retention. The authors came up with a domain-specific definition for technology-related MW: "task unrelated thought which occurs spontaneously, and the content is related to the aspects of computer systems" [3, p. 4]. Moreover, it has been shown that using different types of IS (i.e., hedonic, or utilitarian systems) relates to the degree of MW [6]. The use of hedonic systems indicates a higher level of MW compared to the use of utilitarian systems. Despite growing efforts to investigate MW in IS research, several questions remain unanswered. Most notably, the influence of individual characteristics on MW while using technology have not been investigated so far.

This gap is critical because individuals differ in the frequently and intentionality of their MW [9–11]. For example, Maillet et al. [9] assessed age-related differences in (1) MW frequency, (2) the relationship between affect and MW and (3) content of MW. The authors suggest that older people wander less in their daily life compared to younger people. Moreover, the authors showed that older people report their off-task thoughts were more "pleasant, interesting, and clear", while the thoughts of younger people were more "dreamlike, novel, strange, and racing" [9, p. 643]. Moreover, it has been shown that impairments can affect individuals MW. For instance, attention deficit and hyperactivity disorder symptomatology positively correlate with spontaneous MW frequency and lack of awareness of MW engagement [10, 33]. Christian et al. [34] suggest that individuals' gender and culture has an impact on the visual perspective while MW. They found out that females and residents from western nations most frequently adopted a first-person point of view, whereas a third-person perspective was more common among residents from eastern countries. Taken together, individual characteristics such as age, gender, origin, or impairments should be considered when studying MW in technology-related settings.

In this study we focus on age-related difference on MW while using different types of systems. Age should be investigated because perceptual (e.g., vision, auditory), cognitive (e.g., memory capacity, attentional control) and psychomotor (e.g., fine motoric, coordination) abilities decline with age [19]. Research has shown that these abilities influence the degree of MW (e.g., [9, 15]). Moreover, these abilities are powerful predictors of technology use [19]. Therefore, age-related changes in ability must be considered, e.g., when designing IS [19]. For example, as demographic change leads to an aging workforce, this critical aspect should be considered when introducing new IS in workplaces.

3 Research Model

According to literature, our research model distinguishes between hedonic and utilitarian systems [6]. Hedonic systems are systems that "aim to provide self-fulfilling rather than instrumental value to the user, are strongly connected to home and leisure activities, focus on the fun-aspect of using information systems and encourage prolonged rather than productive use" [7, p. 695]. Utilitarian systems "provide value that is external to the interaction between the user and system (e.g., improved performance)" [35, p. 445]. Based on this distinction, we propose a research model that investigates whether the relationship between the underlying system and the degree of MW is moderated by age (Fig. 1).

Research suggests that the use of hedonic systems differs from the use of utilitarian systems. For example, Lowry et al. [36] showed that cognitive absorption is stronger in a hedonistic context than in a utilitarian context. This may be explained by the fact that there are different motivational factors when it comes to hedonic (e.g., enjoyment) or utilitarian systems (e.g., job relevance). In line with [6], we argue that the use of hedonic systems leads to a higher degree of MW since users are primarily interested in enjoying a system instead of following instrumental goals. Hedonic usage is an effortless activity, which facilitates MW [6]. In this line, we propose our first hypothesis:

H1: The use of hedonic systems results in a higher degree of MW than utilitarian systems.

An important finding on cognitive aging is that older people have lower working memory capacity than younger people. (e.g., [19, 37]). Literature emphasized that older people have less capacity in working memory to attend to a task, leaving them with less residual capacity for MW [9, 15].

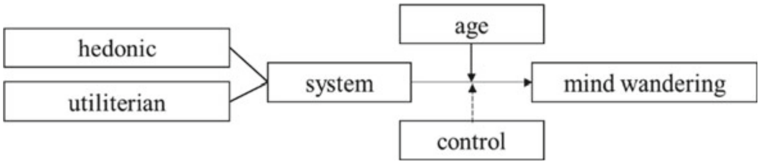

Fig. 1 Proposed research model

Utilitarian systems are mostly employed provide users value and improve productivity [7, 38]. In contrast, hedonic systems are mainly used in homes or leisure environments and are employed for pleasure and relaxation [7, 38, 39]. Thus, we argue that utilitarian systems require a higher working memory capacity than hedonic systems. Combining the above arguments, we propose our second hypothesis:

H2a: The thoughts of older individuals wander less than those of younger individuals while using utilitarian systems.
H2b: The thoughts of older and younger individuals wander in the same degree while using hedonic systems.

Moreover, we consider additional demographic variables (e.g., gender) to control for randomness or biases.

4 Methodology

Experimental design. Based on our research model (c.f. Fig. 1), we use a between-subject design to manipulate the system type (hedonic/utilitarian). Building up on the work of [15], who investigated the age-related differences between young and older adults on MW in a non-technology context, we acquire data from young-young adults (20–30 years old), young adults (31–64 years old), young–old adults (65–74 years old), and old–old adults (75–85 years old). Since we investigate MW in a technology context, we assume that the investigation of MW requires some degree of habitudinal use of technology because otherwise, when individuals use technology for the first time, the demands are too high to let the mind wander [40]. In other words, habitudinal use of technology was expected to lead to some degree of cognitive ease, which is a prerequisite for MW [41]. Consequently, we only collect data from individuals who indicate that they use their smartphones on a daily basis. Moreover, we ask the participants to use their own smartphones as users perceive their own devices as easier to use and more intuitive [42, 43].

Measurement Instruments. Since MW is an "internal mental experience" it can be measured by self-reports [11, p. 489]. We use established measurement scales for MW on seven-point Likert-Scales. To investigate the psychometric attributes of MW, we select four items from existing multi-measure scales [6, 32].

Experimental Procedure. The experimental procedure will be carried out in four phases: First, participants will be welcomed and informed about the general setting. Second, the participants will be asked to accomplish one of two tasks on their smartphone (approximately 5 min), which are briefly described below. Third, they will be asked to complete a questionnaire assessing their self-reported degree of MW, along with demographic questions. Fourth, they will be thanked and debriefed.

Task 1 ("Facebook"): A common type of hedonic systems relates to social media use. Therefore, we will ask the participants to do tasks on Facebook including navigate through commercials, comments, and postings.

Task 2 ("Email"): A common type of utilitarian technology is writing email. We will ask the participants to write an email to make a hotel reservation.

5 Outlook and Contribution

Our research will contribute to theory, practice, and design alike: From a theoretical perspective, our paper seeks to extent literature on the role of MW in technological settings with a particular emphasize on age-related differences. This goes in line with current literature on MW, emphasizing the relevance of age [9, 15]. Our paper contributes to a better understanding of how age influences individuals' MW while using different types of systems, i.e., hedonic and utilitarian systems. Therefore, research can benefit from this study as a point of departure for further research on how individual characteristics influence MW while using technology. For example, other individual differences (e.g., culture, gender) can be explored. Furthermore, in addition to the measurement scales we use, eye-tracking [44] or Electroencephalography (EEG) [45] could be integrated to provide not only a subjective but also an objective insight into individuals' MW. The investigation of MW as supplement to established concepts in IS, including mindfulness (e.g., [46]) and cognitive absorption (e.g., [47]), is an important step to a more holistic understanding of human cognition and behavior in technology-related settings.

From a design perspective, our research provides insights in how the design and the use experience of certain systems affect MW in light of age. We contribute to a better understanding of how IS should be designed by considering individual characteristics (e.g., age) to influence individuals' MW. This goes in line with literature on human computer interaction, emphasizing the importance of individual characteristics [48, 49].

Our research is also beneficial from a practical perspective. It contributes to a better understanding of the relationship between use behavior and MW. Therefore, it provides important insights to stimulate (e.g., creative jobs) and reduce individuals' MW (e.g., jobs that depend on productivity). Organizations should take MW in consideration when designing future workplaces since MW can provide unique benefits, including a positive influence on creativity, which can lead to performance increases in the long term [8]. Our paper contributes to a better understanding how to consider individual characteristics, such as age, to enhance individuals' creativity or productivity.

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